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Relevance of health warnings on cigarette packs: A psycholinguistic investigation

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Abstract

Although most research on the effect of tobacco warnings has been focused on attitude changes following the presentation of tobacco warnings, this paper takes a somewhat new perspective by investigating cognitive processing of tobacco warnings by adolescents of different ages (i.e., 14-, 16- and 18-year-olds). More specifically, this paper investigates the way adolescents encode different textual elements presented in tobacco warnings. By means of a standard psycholinguist paradigm (i.e., sentence evaluation paradigm), we evaluated tobacco warnings differing along three variables: (1) *Severity*, (2) *Time consequence* and (3) *Target* (*health* vs. *others*). Our main result demonstrated noticeable differences between the age groups and between smoking experiences in the cognitive processing of tobacco warnings. Our experimental paradigm represents an important step in identifying the mechanisms through which certain types of written warnings are cognitively processed, which in turn may well set a critical base for understanding decision makers' responses to risky behaviors such as smoking and for constructing adequate health warnings.

Relevance of health warnings on cigarette packs: A psycholinguistic investigation

Current and past research targeted at improving the efficacy of health warnings (e.g., Hammond, Fong, Borland, Cummings, McNeil, & Driezen, 2007; White, Webster, Wakefield, 2008) has essentially focused on *design particularities* (i.e, graphical display, pictures, text size and colors) and their impact on specific behaviors. In this present study, we extend this focus by investigating the cognitive components of the mechanisms involved in processing a written warning. At the heart of this investigation are issues most relevant to psycholinguistics, more specifically to text comprehension research. In the present paper we conciliate psycholinguistic concepts with health concerns by investigating the mental models constructed by adolescents when processing cigarette warnings. In a somehow similar vein, recent models have increasingly directed their attention to human information processing models, integrating social theories, cognitive models, and information processing components (Wogalter, Conzola, & Smith-Jackson, 2002) to provide a more complete picture of decision processes associated to health issues. As such, it appears crucial that health warnings must deal with receivers' cognitive capacities, attention, comprehension, attitudes, beliefs, and motivation. In this endeavor, we believe that psycholinguistic paradigms, such as the one used in this paper, can provide valuable information on the way *specific* receivers process smoking warnings.

Specific population

Some authors (e.g., Strahan, White, Fong, Fabrigar, Zanna & Cameron, 2002; Krugman, Fox, Fischer, 1999) have suggested that health warnings are only pertinent when taking the specificity of the targeted populations into account. Although in Switzerland, as recently raised by Keller, Krebs, Radtke and Hornung (2007), 25% of adolescents between the ages of 14 and 19 were smokers, very few studies have been conducted on this population. Cummings, Morley, Horan, Steger and Leavell (2002) even suggested that most (adult) smokers start smoking before the age of 18 and only a few of them start after the age of 25. As a consequence, the tobacco industry has increasingly been targeting teenagers, suggesting that some cigarette brands were *cool*, *smooth,* and

associated with a *great image* (Cummings, Morley, Horan et al., 2002). Freeman, Brucks, Wallendorf and Borland (2009) further added that exposure to tobacco advertising potentially led to *complex* yet *positive* traces in children and young adolescents' minds. Unfortunately, the relative small number of health prevention programs targeted towards a younger population is not particular to Switzerland, as others have also raised this concern (Goodall & Appiah, 2008). However, we believe this population to be particularly challenging for both prevention and research programs. Adolescents seem to have difficulties in grasping and weighing the risks surrounding tobacco consumption, to be more motivated by fun and excitement (Slovic, 2000), to be more likely to engage in risky behaviors (Gardner & Steinberg, 2005), and to show increased levels of psychological reactance (e.g., Miller, Burgoon, Grandpre & Alvaro, 2006). Most importantly, the adolescent years are characterized by a great deal of turmoil, and some behaviors – tobacco consumption typically – are embedded in more global relations, culture, and individual psychological needs (Booth-Butterfield, 2003). Arnett (1999) further showed that risky behaviors (i.e., substance use) were most prevalent in late adolescence, as the negative consequences of these behaviors were less likely to be foreseen in this period. Late adolescents seem to mainly focus on the positive feelings associated with risky behaviors. In this present paper, we targeted three different adolescent populations, namely 14- (7th grade), 16- (9th grade) and 18-year-olds (second high school grade), for one main reason. Although we believe *adolescence*, in general, to be a crucial factor in the decision process that may lead pupils to smoke, we believe that each adolescent population is characterized by very different issues that might have distinct impacts upon young people's smoking behaviors. In 7th grade, pupils have not generally been extensively exposed to cigarettes and do not yet have important and independent decisions to make regarding their future (Arnett, 2000). One could argue that they represent the most *naïve* pupils of our sample. In 9th grade, which represents the final year of obligatory education in Switzerland, pupils are at the very edge of adolescence. These *emerging adults* (Arnett, 2000) have now to consider different options in reference to their education and professional career and are gradually building an identity and a

social network which may endure over time. In the second high school grade, pupils most likely belong to a specific social network on which they feed. They are certainly the most exposed to cigarettes. In addition to this, they are increasingly considered as adults, as they are gradually approaching the age of legal, hence decisional, independence. Although the distinction between the three age groups is not always made in literature, some authors (e.g., Arnett, 2000) believe this distinction to be crucial. It particularly underlines that adolescence is a crucial period characterized by important cognitive process variations resulting in specific risky behaviors. If those risky behaviors are often targeted by prevention programs, only a few studies focused on the cognitive processes involved when engaging in these behaviors.

Cognitive processes involved when reading tobacco warnings

By *cognitive processes*, we refer to the processes by which a message is read, encoded, and included in a reader's mental representations of what they are reading. In the field of health prevention, to our knowledge, the approach presented in this paper is new. By the term *new*, we do not (at all) pretend to revolutionize tobacco warnings research, but we wish to further acknowledge the complexity of the psychological processing of health warnings by introducing notions pertinent to the way text – here tobacco warnings – is processed. For this reason, we next present a comprehensive introduction of the psycholinguist concept of mental representations, more specifically of *mental models*, as first defined by Phil Johnson-Laird (1983), and its relation to health warnings. In particular, we believe that the approach proposed in this paper may be an important and unavoidable first step in creating and assessing the relevance of health messages found on cigarette packs (as well as other communication channels).

A common assumption underlying reading comprehension processes is that a mental representation, or simulation, of the situation presented in the text is constructed during comprehension (van den Broek, Young, Tzeng, & Linderholm, 1998; Graesser, Singer, & Tabasso, 1994). The process by which this mental representation is constructed is divided into different levels. At a surface level, for a short period, the exact words and the syntax are represented. This

somehow shallow level of representation requires minimal processing effort. At a text based level, explicit text propositions and elements needed for text cohesion are included. The final level, the most elaborate one, the *mental model* level (Johnson-Laird, 1983), which is of particular interest for health warning understanding, includes the *situation* that is conveyed by the words and the sentences in the text (Zwaan, Magliano, & Graesser, 1995), or more specifically, information about the people, settings, actions, and events either described explicitly or implied by the text (Garnham & Oakhill, 1996). This latter level of representation can be considered as the foundation for any behavioral response to the information portrayed in the text. Of special relevance is the fact that readers mentally represent a *model* of the situation, therefore it may include information that is not explicitly mentioned in the text. Such information consists of information derived by the process of *inference* making (McKoon & Ratcliff, 1992; Graesser et al., 1994). In this paper, we are only interested in the *behavioral* inference (i.e., *quit* or *don't quit smoking*, *begin smoking* or *don't begin smoking*, etc…) that adolescent readers generate and include in their mental models when reading tobacco warnings. Importantly, these mental models set the basis of decisions made subsequently.

An important aspect of inference making relates to the fact that readers combine different sources of information to construct a mental model of the situation (van den Broek et al., 1998; Gernsbacher, 1997; Graesser et al., 1994). Generally, it is accepted that readers activate previously acquired knowledge that is stored in long-term memory, and combine it with information explicitly mentioned in the text (Kintsch, 1988; Gernsbacher, 1997). Therefore, readers go beyond mere linguistic processes when comprehending text. For example, in the sentences, *We got some beer out of the trunk. The beer was warm.* (from Haviland and Clark, 1974), readers might infer that it was a sunny day. This inference derives from the information provided in the text as well as common knowledge about what happens when you leave your car in the sun. The latter information is not presented in the text, but combining information from the text and from knowledge previously acquired enables readers to form a mental model of the situation and consequently comprehend the text. The nature of this *acquired knowledge* has received significant attention (Marmolejo-Ramos,

Elosúa de Juan, Gygax, Madden, & Mosquero, 2009), mainly focused on identifying the components associated to readers' general knowledge that may automatically be activated when reading text. As readers do differ in the amount and nature of acquired knowledge, identifying the relevant activated components has proven to be intricate, yet not impossible (Marmolejo et al., 2009).

In this line of thinking, it is reasonable to assume that when reading a tobacco warning, or for that matter, any health warning, readers integrate some information explicit in the text, but also integrate information that is not presented in the text. For example, when reading sentence (a) below:

(a) Jane opened a magazine and came across a warning stipulating that:

and sentence (b),

(b) Tobacco is likely to give you rotten teeth.

Readers may infer (i.e., include the information in their mental models of the situation) something along the lines that Jane *will not want to smoke* or *will (or be tempted to) quit*, if Jane is a smoker. This inference is based on the text (i.e., the rotten teeth in sentence (b)), as well as general knowledge about one's unpleasant feeling associated to having rotten teeth. One interesting cognitive issue inherent to inference making is whether particular inferences are drawn *automatically* or *strategically* (McKoon & Ratcliff, 1989). To these terms, some authors have preferred those of *on-line* and *off-line* (Graesser et al., 1994), reflecting the production of inferences either *during reading* (i.e., as the words are encountered) or *at retrieval* (i.e., once the sentence has been thought about). This issue is relevant in the present paper, as the paradigm used can potentially access both off-line (i.e., proportion of particular responses) and on-line (i.e., response time) inference processes. This particularity is further explained later.

Several paradigms have been proposed to assess this kind of inferential process, all of them based on the same idea: information that has been previously activated is more easily, hence more rapidly, accessible. In the passage presented above, if readers indeed infer something like *Jane will*

not want to smoke, they should process the sentence (c) below more readily and more rapidly than sentence (c').

(c) Jane does not want a cigarette.

(c') Jane wants a cigarette.

Importantly, the speed and ease by which a piece of information is processed is believed to mirror how well this piece can be mapped onto readers' current mental representation. In essence, the more a piece of information resembles the content of readers' mental models, the faster readers process it. To measure if something is readily mapped onto readers' mental models, one can examine reading speed, or, as in the experiment presented in this paper, *congruency evaluation* speed and the *proportion of positive answers*. Typically, readers are asked to evaluate whether the final sentence (i.e., sentence (c) or (c') in the above example) is a *sensible continuation* of the preceding sentences. Such a paradigm has been used, for example, in Gygax, Gabriel, Sarrasin, Garnham, and Oakhill (2008), to demonstrate that readers' mental representation of gender when reading role names (e.g., *mechanics*) written in the masculine form (supposedly interpretable as a generic form) was male biased. In their experiment, French-speaking participants, for example, responded positively, more often and more quickly, to the question *Is sentence (g) a sensible continuation of sentence (f)* when the sentence contained male characters.

(f) Les assistants sociaux marchaient dans la gare.

[The social workers were walking through the station.]

(g) Du beau temps étant prévu plusieurs *femmes*/*hommes* n'avaient pas de veste.

[Since sunny weather was forecast several of the women/men weren't wearing a coat.]

In English, participants' proportion of positive responses and response times depended on the stereotype of the role names. The strength of this paradigm resides in the fact that it provides two different measures, as in this experiment: the proportion of positive answers and the time it takes participants to respond. The former may be considered as a measure over which participants have most control. If some participants feel that they should answer *no* – as a politically correct signal for

example – they may easily change their automatic drive to respond positively. Interestingly, the latter measure – response time – addresses this issue. Controlling an automatic process imposes constraint to the decision system, hence increases response time (e.g., Bonnet, 1998). One can therefore argue that if the proportion of positive answers may be polluted by control processes (i.e., the proportion of positive answers is rather high implying that people always respond in a politically correct fashion), response times give a better indication of processes that occur *on-line*, as the text is being processed. In sum, a positive answer that is strategically activated takes more time to give.

Effectiveness of multiple variables in health warnings

The present paper investigated the way adolescents process and encode different textual elements presented in tobacco warnings. The tobacco warnings created in this experiment differed along three variables: (1) *Severity*, (2) *Time consequence* and (3) *Target* (*health* vs. *others*).

By *severity*, we refer to the well-established and broadly researched notion of *fear appeal* (Witte & Allen, 2000). This notion is rooted in different theoretical models (e.g., Extended Parallel Process Model from Witte, 2000; Fishbein et al., 2001), which broadly argue that people must (a) feel a great threat to change their risky behaviors, (b) feel a certain vulnerability, which may be often underestimated (Weinstein, 1999), and (c) realize the physical and psychological consequences of their behaviors. Only once they have weighed the benefits and the costs of their behavior(s) will they decide whether to quit smoking or not. According to these authors, fear appeal is particularly effective to improve healthy behaviors and to diminish undesirable behaviors.

Although earlier theories (e.g., McGuire, 1968) raised the issue that fear could act both as a facilitator and as an interferer, more recent models of fear (e.g. Witte, 1998) concentrated on explaining the sequences by which a message, and its content, is appraised and evaluated in terms of both threat and efficacy of recommended response. A *high threat* typically means that the negative outcomes of a particular action are highly probable for a person and *high efficacy* means that the recommended behavior(s) (e.g., smoking cessation) is effective and can be achieved by that

person (Schmitt & Blass, 2008). Fear *arousal*, on the other hand, is mostly generated by the severity of the information contained in the message as well as the personal susceptibility to it (Ruiter, Verplanken, Kok & Werrij, 2003). In terms of appraisal sequence, individuals who consider a message as *threatening* are subsequently more motivated to evaluate their potential efficacy in adopting the recommended behavior, and even more so if a recommended behavior is suggested. Conversely, individuals who consider a message as *not threatening* have a tendency to ignore the fear appeal. If the threat is serious, people are afraid and the fear motivates them take actions to alleviate it.

Note that although *fear appeal* - in our case *perceived severity* - remains a controversial concept, most current research demonstrates that fear can be an effective motivator (Schmitt & Blass, 2008; Ordoñana, González, Espín-López and Gómez-Amor, 2009) and that the stronger a fear appeal is, the more likely are a respondent's attitudes and behaviors to change (Witte & Allen, 2000). Schmitt and Blass (2008), for example, tested whether fear-arousing persuasive messages (i.e., video anti-smoking campaigns) could modulate intentions, attitudes and behaviors. In their *threat* condition, students expressed stronger anti-smoking intentions than did the students in the control condition. More recently, Ordoñana, et al. (2009) showed that fear appeals (i.e., high or low threat) had an impact on psychophysiological responses and on later behavioral changes. When the threat was high, undergraduate students demonstrated increase in heart rate accompanied by higher skin conductance and an increase in self-reported fear and perceived threat. Thus, it seems that it is necessary to elicit a particular fear response to generate appropriate attention to the message (Ordoñana et al., 2009). In the same line of thinking, Biener, Wakefield, Shiner and Siegel (2008) suggested that high level of emotional intensity was a strong predictor of perceived effectiveness, particularly in terms of recall of anti-smoking advertisements by youth (i.e., 12- to 17- year-olds).

According to Ruiter et al. (2003), we need both severity as well as personal susceptibility to generate fear. Threatening messages are only effective in inducing attitude and behavior changes if adolescents believe that the recommended action can avert the threat and if they feel confident to be

able to perform the recommended action. Note that Ruiter et al. (2003) make a distinction between *fear control*, essentially an affective response to reduce the impact of the message, and *danger control*, a cognitive response evaluating the threat at stake. If this distinction is not under investigation per se in the present experiment, what is important is the fact that firstly, threatening information can be essential, most likely if accompanied by adequate coping information, to effective communication (Ruiter, Abraham & Kok, 2001) and secondly, that our present experiment was not so much interested in the impact of severity on attitudes, emotions, or perceived efficacy[1] as in the cognitive processes by which messages carrying *stronger* vs *weaker severity* contents were encoded. For this manipulation, changes were mainly apparent in the verb tense that was used in each message. For example, the future tense was mostly used for *stronger severity* (i.e., you *will* suffer from breathing difficulties) whereas the conditional tense was mostly used for *weaker severity* (i.e., you *might* suffer from breathing difficulties). In addition to this, adverbs were also added to strengthen the manipulations (i.e., *possibly*, *certainly*,…).

Of course, because we focused our experiment on three specific adolescent populations, we had to make sure that our severity manipulation was also perceived as such by those populations. We therefore conducted a manipulation check to examine perceived severity. This manipulation check is presented in detail before the exposition of the actual experiment.

In our second manipulation, we investigated the effect of *time* on the processing of health warnings. More specifically, we manipulated the notion of time in our warnings, whether activated in regard to the *length of the problem* that may be encountered if smoking, or in regard to the time *before the occurrence of the problem*. To our knowledge, such a manipulation had only rarely been examined. In Gnesa & Gygax (2005), for example, participants (i.e., university students) were presented with different prevention messages on fictitious diseases. In each prevention message, a disease was presented and followed by the appropriate behavior. The disease was presented either as short-term or long-term (other variables were manipulated, but these are not relevant here). When presented as long-term, participants always took longer to read the sentence containing the

appropriate behavior to adopt to avoid a particular disease, hinting at what the authors interpreted as increased concentration. In our experiment, we were particularly interested in this manipulation as adolescents' perception of time is somehow very different to that of adults. Adolescents may see time as a free resource, something that is only slowly evolving and therefore bearing very little consequences (Bruno, 1996). Consequently, long-term consequences, such as cancer or heart disease, may well have little effect on adolescents, as their perceived probability of experiencing those consequences may be too low (Burke, Salazar, Daugherty & Becker, 1992).

The third variable that we manipulated, *target*, pertains to Godin's (2002) caution that not all behaviors that are *healthy* are decided on the grounds of health, but on other grounds such as *interpersonal relationships*. According to the *Health Belief Model* (Rosenstock, 1974), a person will care about her/his health specifically if she/ he has sufficient knowledge about the medical implications of a particular behavior, if health is considered as something very important for her/him, and if she/he feels a threat of possible illness. However, not smoking, especially for an adolescent population, might be relevant only if the positive impact upon interpersonal relationships outweighs the negative ones. This may be irrelevant of the health consequences. Stufin, Szykman, Chapman Moore (2008) tried to examine smoking and non-smoking adolescents' responses to anti-tobacco ads containing three different themes: *endangering others* (i.e., how smokers endanger the health of others), *negative life circumstances* (i.e., how cigarette smoking represents a loser lifestyle) and *industry manipulation* (i.e., efforts of industry to deny the addictive and nocive nature of smoking). A fourth condition was added that carried no information on smoking (i.e., control condition). Results showed that when exposed to *the negative life circumstances* ads adolescents reported less intentions to smoke than those exposed to the control condition and those exposed to the *industry manipulation* condition. Participants who viewed *endangering others* ads reported more negative emotions than participants who viewed *negative life circumstances* ads. Overall, smokers had more negative thoughts (e.g., *irritating*, *ridiculous* or *stupid*) about the ads than non-smokers. The authors suggest that focusing on negative life circumstances is the best way to

improve tobacco programs aimed at adolescents. No other links were found. However, Smith and Stutts (2003) showed that smokers do react differently if the target of an advertisement is health (i.e., “smoking kills”) or cosmetic related (i.e., “smoking stinks”). Their results showed a gender difference between girls and boys. Long-term health fear appeals were more effective to girls, whereas short-term cosmetics were more effective to boys. On a different note, Burke et al. (1992), showed that perceptions of family’s and friends’ attitudes toward smoking was a significant predictor of self-reported measures of concurrent smoking.

In all, the balance between messages based on health and those based on interpersonal relationships may well be of crucial importance in tobacco warnings, especially to adolescent populations. In our experiments, messages that were expressing interpersonal issues were based either on family or on significant others.

The last (but not least) variable that we manipulated was the impact of a graphical supplement to the message. Borland (1997) suggested that messages that were accompanied by graphical displays were more likely to increase the frequency by which messages are seen. Others have even suggested that picture-based warnings improve message recall and motivation to quit smoking (Hammond, Fong, Borland, Cummings, McNeil & Driezen, 2007). If graphical messages may act as an attentional cue to the message itself, Hammond, Fong, McDonald, Cameron & Brown (2003) argued that they also have an effect on deeper cognitive processes (i.e., not just perception or attention), leading to more thorough treatments of the messages and more attitudinal changes. To illustrate those deeper processes, Hammond et al. (2007) showed that the new Canadian warnings on cigarette packs including both visual and textual information led to increased emotional responses, in turn reinforcing the motivation to quit. O’Hegarty, Pederson, Nelson, Morwery, Garble & Wortley (2006) supported this view by showing that young adults between 18 and 24 years consider messages accompanied by images as more efficient for prevention, for motivating someone to quit, and for motivating someone not to start. White et al. (2008) further showed that graphical warning labels on cigarette packs increased adolescents’ (i.e., 12- to 17- year-olds)

frequency of thoughts about quitting, reducing smoking, or *not* starting to smoke. Pictures may also alter smokers' *brand* perception (Wakefield, Germain & Durkin, 2007) by actually removing the trendy image of cigarettes from the packages. In a sense, visual cues (specific to the brand) associating positive elements to smoking cigarettes are replaced by cues associating the behavior to negative aspects.

Brown and Locker (2009) opposed this view by arguing that when presented with distressing pictures, participants tried to avoid the accompanying messages. When exposing drinkers to an emotively anti-alcohol message accompanied by a distressing picture, the latter seemed to underestimate the risk associated with drinking.

In our experiment, we evaluated whether the implementation of an image accompanying the message would have an impact on the processing of tobacco warnings. This is especially important, as in Switzerland, for example, new messages accompanied by pictures have been in demand since 2008.

To our knowledge, most literature on smoking prevention focused on the way warning labels were framed, in terms of losses or of gains of smoking cessation (Rothman & Salovey, 1997) and their impact upon attitudes and behaviors. Rothman & Salovey (1997), basing their ideas on Kahneman and Tversky's (1979) *Prospect Theory*, underlined that the motivation to engage in a healthy behavior depends on the framing of the warning. As such, Ruiter et al. (2001) suggested to frame messages in terms of precautionary information and promotion of action (i.e., gain framed) instead of presenting frightening pictures about health risks (i.e., loss framed). Although most research on the matter has suggested that gain-framed warnings were more influential, Goodall and Appiah (2008) recently showed that adolescents perceived loss-framed warnings as more effective than gain-framed warnings. In our experiment, based on adolescents' information processing, we followed Goodall and Appiah's line of research by presenting our participants with mostly loss-framed messages, as we expected them to be more effective (i.e., participants would be more sensitive to them) with our specific population.

Personal factors.

In this present paper, we were also interested in evaluating whether some individual variables pertinent to participants' socio-demographic particularities as well as smoking habits (i.e., number of smoking friends, presence of smokers in the family, sport, etc…) could influence the way tobacco warnings were processed and integrated in readers' mental models. Readiness to quit as well as the smoking behaviors of parents and peers have been linked to adolescent smoking cessation (Kleinjan, Engels, van Leeuwe, Brug, van Zundert & van den Eijnden, 2009). We measured attitude towards smoking, intention to smoke or quit smoking (i.e., presently and in a few years), as well as *motivation to quit smoking*.

Method

Population

Participants were recruited through the four schools that participated in the study. Consent was solicited from students, teachers, and school directors. Participants were equally balanced across the different conditions in terms of age and smoking status. In the data that we present in this paper, not all participating adolescents are presented. We took out participants that were non-native speakers and those that struggled to understand the instructions. Still, all participants that are presented below are part of the data set that we analyzed in this paper.

14-year-olds. Fifty-one 7th grade adolescents (23 girls and 28 boys) in their 14th year (mean age : 13 years and 4 months) were randomly chosen from two different schools. In each school, we asked the teachers to choose the children from different classes, to avoid any potential cohort class effects.

16-year-olds. Twenty-nine 9th grade adolescents (15 girls and 14 boys) in their 16 year (mean age : 15 years and 2 months) were randomly chosen from the same schools as the previous group. Again, we asked the teachers to choose the children from different classes, to avoid any potential cohort class effects.

18-year-olds. Thirty-eight 2nd *high school* adolescents (21 girls and 17 boys) in their 18th

year (mean age : 17 years and 8 months) were randomly chosen from two different high schools.

Materials

Based on the warnings that are used in Switzerland and those in France, we created our health warnings and experimental passages in which the warnings would be embedded, according to the three aforementioned variables[3] (i.e., *Severity*, *Time consequences*, *Target*). To ensure that our variable manipulations were pertinent, we conducted a manipulation check.

Manipulation check. In total, we created 32 experimental warning messages, similar to those presently on cigarette packs in Switzerland or France, hence using a typical lexicon of tobacco warnings (e.g., provoquer [to cause] or risques [risks]). In these 32 warnings, we had twenty-four loss-framed warning messages (e.g., People addicted to cigarettes, undoubtedly and very quickly, show important cardiovascular difficulties) and eight gain-framed warning messages (e.g. Stopping smoking diminishes the risks of death by breast cancer) differing along our three variables[3]. Each variable had two possibilities (i.e., severity: weaker vs stronger, time: short vs long-term, target: health related vs others (i.e., other people) involved), Hence each health warning had eight different versions considering all possible combinations. In total, 256 health warnings were created (i.e., eight versions times thirty-two messages). For our manipulation check, the 256 messages were divided into eight lists (i.e., eight different questionnaires) each comprising 32 passages. If a participant saw one version of the message, she or he could not see another version of it, simply to avoid any possible repetition effect. In each list, all variables combinations were presented. So for example, in the first list, the first four warnings were weaker, short-term and health related, the subsequent four were stronger, short-term and health related and so on. In the second list, the first four warnings were simply four different versions of the first four warnings in the first list. So for example, this time, the first four warnings were stronger, short-term and health related, and so on. Each participant only saw one list with 32 warnings, all presented in a random order. Importantly, each list was comprised of all variable combinations (i.e., four messages per combination), and all possible combinations for each warning were presented across the lists.

For this manipulation check, to ensure that the messages would be interpreted as intended and relevant to the participant, fifty-one adolescents between 14, 16, and18 years of age each received a questionnaire with 32 passages. For each presented message, participants had to answer three questions*:* (1) *Is this message talking about short or long-term consequence*? (1= short-term, 2=long-term, 3= none)*,* (2) *According to you, what is the severity of this message*? (1=weak to 7=strong)*,* (3) *According to you, does the message focus on health problems or on other people* (1=health, 2= both, 3= others). None of the participants in this manipulation check participated in the subsequent experiment.

We analyzed the results of each warning message to see if our variables were understood according to our expectations. For the variable time, we expected a mean score close to 1 when it was a warning message with a short-term consequence and a mean score close to 2 if it was a message with a long-term consequence. All items with a mean score above 1.5 for the short-term condition and above 2.5 for the long-term were modified. For the category *stronger severity*, if a mean score of the message was under the score of 3.5 (i.e., not severe), we changed its content. Finally, we expected a mean score under 1.5 for the messages focused on health and between 1.5 to 2.5 for the messages focused on others, otherwise we reformulated our items. Although our primary and foremost concern was that each individual item was consistent with our intended manipulations, we also carried out overall statistical analyses on our manipulation check. Both *time consequence* (t (31) = 4.23, $p<.01$) and *target* (t (31) = 4.23, $p<.01$) showed the intended pattern of differentiation between each variable modalities. Our *severity* manipulation did not show such an apparent differentiation (t (31) = .63, $p>.05$), mainly due to noticeable ambiguity of the adverb "assurément" [undoubtedly]. We therefore most importantly changed those items including this adverb. To ensure that all items, including the new ones, were adequate in terms of our severity manipulation, we ran an extra manipulation check on 47 18-year old participants. Each item was presented both in the *weaker-severity* as well as the *stronger-severity* versions, and participants had to indicate which version was presenting *stronger-severity* elements. On average, our items were

93% of the time correctly assessed. Note that the pertinence of graphical displays was separately pre-tested. In this separate pre-test, participants were simply asked to evaluate the pertinence of the graphical displays in regard to the warnings. All modified sentences were evaluated by three independent judges in regard to the investigated variables.

Personal factors. A questionnaire on smoking habits and socio-demographic measures was also administered to the participants. Although not of prime interest, we wished to evaluate whether some variables (e.g., *has never smoked* vs. *has already smoked once/several times*, *parental* and *friends' smoking habits, etc…*) could influence the way tobacco warnings are read and processed and consequently the content of readers' mental models.

Experimental Procedure

As in the manipulation check, eight lists were created, for the very same reasons explained above. If in the manipulation check, the warnings were presented in a questionnaire, in the experimental phase, they were embedded in small passages presented on a computer screen. Based on the manipulation check, we tested health warnings embedded in passages such as:

(a) Laura is watching an ad whose message is:

(b) If you quit smoking for a few years, your family will be proud of you.

(c) Laura knows that she does not want to start smoking again.

The passages were presented, one after the other, in random order. Each passage was presented in three parts, and the participant simply had to press a specific button to go from one part to the other. Note that, in order to diversify the content a little, on six occasions, the context sentence stated that the message was verbally given to the main protagonist (e.g., *The teacher told Laura that:*).

We monitored both the time it took participants to evaluate whether a target sentence comprising a particular behavior (i.e., sentence (c) in the example) was a sensible continuation of the preceding context (i.e., as defined by a health warning (b) and a premise sentence (a)) and the number of positive evaluations participants made. Each participant responded to 64 small passages

of one list (i.e., read 64 tobacco warnings). As the 32 experimental passages were constructed as to favor a positive answer (i.e., the protagonist's behavior was always congruent), 32 additional filler passages were constructed as to initiate a negative answer. This was important in order to maintain participants' attention and to avoid that they automatically answered positively without concentrating. Half of our participants were also shown images accompanying the warnings.

Sentence (b) – the health warning – was always presented inside a black frame, the same way as it would be on a normal cigarette pack, at least in Switzerland. In addition to this, in each age group, half of the participants were presented with part (b) including a picture congruent with the health warning (see above for details). The last sentence, the target sentence, was always presented in red to cue participants to respond. The participants were instructed to read, at a normal pace, the first sentence, then press a button to get the second question on the screen, and again press the button to get the third sentence, and then to decide, as quickly as possible, whether the last sentence was a *sensible/congruent* continuation of the first two sentences (using a *yes* and a *no* button). Each participant's dominant hand was always on the *yes* button, to avoid any delay when they wanted to respond positively. After each passage, participants were prompted by the sentence "*Are you ready for the next passage*?". If they were, they simply had to press the *yes* button.

Data were collected during class periods in the school classrooms. Four participants always took the test together, each in front of one computer. Once the computer session was over, each participant had to complete our socio-demographic questionnaire.

Results

We conducted three main analyses considering each age group separately. For each age group, we present two specific sets of analyses. One concerning the *proportion of positive answers* (i.e., closer to off-line processes) and one the *time* it took participants to answer positively (i.e., closer to on-line processes).

Before conducting the statistical analysis on the response times, we transformed the data principally to account for the fact that the target sentences (i.e., the sentence for which the

participants had to make a decision) were not all the same length. The transformation procedure was inspired by Trueswell, Tanenhaus and Garnsey (1994) and was conducted as followed: For each participant, we produced a regression equation of time (i.e. response time) against length (i.e. number of characters in the target sentence). The actual calculation is fairly simple: for each participant, a time by sentence length regression was calculated by computing the slope and the intercept of the regression. Residual response times for each participant were then calculated by subtracting the actual response times from the response times predicted by the regression equation. Statistical analyses were conducted on the residuals. Negative residual times mean that response times were longer than expected. Although relatively complex, this data transformation was needed to address differences in item length as well as variations between participants. In this sense, a baseline response measure is not needed for each participant, as it is already accounted for by the participant's regression line. One should consider this transformation not as a *different* representation of response times, but merely as a representation of response times when *eliminating* the fact that sentences were of different lengths and the fact that each individual has a *natural* response pattern, irrelevant of the condition under which the responses take place. In the response time analysis that we present below, we only analyzed the positive responses. Those were most important, as a positive response already signals that the health warning had a desired impact. As we only analyzed positive answers, most of the residuals are positive. Negative residuals are usually representative of negative answers. What is important here is to realize that with our calculation, the *higher a residual time is, the faster the participant was to respond.* This is important, as we do present residual time figures.

For each age group, we first conducted a main 2 x 2 x 2 (*Severity* x *Temporal outcome* x *Target*) repeated measure ANOVA considering all factors as within-subject factors. We then conducted two separate analyses including first *Image* and second *Sex of participant* as between-subject factors. All other variables (i.e., personal factors) were added to the main 2 x 2 x 2 analysis in a similar fashion in a series of additional ANOVAs. The main reason for including these

variables in separate analyses was that we did not expect them to interact in the influence that they may have had on the way the messages (i.e., linguistic factors) were processed. In the following sections, we only present the results that were significant and pertinent[2].

Fourteen-year-olds

Proportion of positive responses. All proportions of positive responses were rather high (i.e., between .88 and .93). There was neither a main effect nor any interaction in the analyses. Fourteen-year-olds seemed to be sensitive to all messages. No effect was apparent when also considering *Image* and there was neither any affect of *Sex of participant* nor any effect considering the questionnaire.

Time to respond positively. The main analysis showed a main effect of *Severity* ($F(1, 50) = 13.77$, $p<.05$) demonstrating that the participants responded *yes* 278 milliseconds faster when the health message referred to *stronger* problems than when it referred to *weaker* problems. No other effect was significant. This result suggests that the fourteen-year-olds seemed to consider the problem's severity as a major aspect guiding their mental models.

Sixteen-year-olds

Proportion of positive responses. The main analysis showed a *Severity* by *Temporal outcome* interaction effect ($F(1, 28) = 4.72$, $p<.05$), qualified, as shown in Figure 1, by an increased sensitivity to messages that refer to *stronger* problems at a close distant time. When integrating *Image* as a between-subject factor, a significant main effect of *Image* also appeared ($F(1, 28) = 4.72$, $p<.05$), suggesting that sixteen-year-olds responded more often positively when an image was shown (.94) than when there was no image (.82). In addition to this, the factor *Sex* indicated that boys (N=14) overall responded more often *yes* (.93) than girls (N=15) did (.83). There was no other effect.

Time to respond positively. Although there were no effects of any of the factors when conducting the main analyses, there were interesting effects when considering participants that had already (N=8) or had never (N=20) smoked in their life (one missing value). As shown in Figure 2

there was an interaction effect between *Severity* and *Smoking experience*. Participants having never tried smoking responded positively more quickly when the message referred to *stronger* problems than to *weaker* problems, whereas this was the opposite for those who had smoked at least once before. Essentially, those who have never smoked are more sensitive to *stronger* problems whereas those who have smoked may inhibit the strong problems, as a sort of denial mechanism.

The distinction between participants who had already tried smoking and those who had not also showed an interesting *Temporal outcome* by *Target* by *Smoking experience* effect (F (1, 26) = 4.44, p<.05). This interaction effect is represented in Figure 3. Participants who had already smoked were more sensitive to messages that involved others in the long-term condition, whereas they were more sensitive to the health messages in the short-term condition. There was no such effect for the participants who had never smoked. Although interesting, one has to treat the effects of *Smoking experience* with extreme caution, as the number of adolescents who had already smoked was relatively low (N=8).

Eighteen-year-olds

Proportion of positive responses. The main analysis showed a *Severity* by *Temporal outcome* by *Target* interaction effect (F(1, 38) = 4.46, p<.05). To examine this interaction (see Figure 4), we ran two separate post-hoc analyses, one on responses associated to messages pertaining to *Others involved* and one on responses associated to messages pertaining to *Health related* issues. The first analysis showed a significant *Severity* by *Temporal outcomes* interaction effect (F(1, 38) = 4.89, p<.05), suggesting that the participants were more sensitive to messages pertaining to others when they focused on *short-term outcomes - weaker severity* or *long-term outcomes – stronger severity*. As for responses associated to messages pertaining to health related issues, although not significant, the pattern suggested that participants were always more sensitive to those messages when they focused on long-term issues. There was no other significant effect.

Time to respond positively. Although to be interpreted with extreme caution, there was an interesting close-to-significant *Temporal outcome* by *Target* interaction (F(1, 37) = 3.76, p<.06)

suggesting that when the message was targeting long-term effects, participants were more sensitive to messages on *health* issues. When the message was on short-term issues, participants were more sensitive to messages related to *others*. Actually, this pattern was much more pronounced, as shown in Figure 5, when separating the participants who smoked regularly (N=11) and those that did not smoke at all or regularly (N=27). Indeed, there was a significant *Temporal outcome* by *Target* by *Regular smokers* interaction ($F(1, 36) = 9.09$, $p<.05$). This interaction was qualified by a significant *Temporal outcome* by *Target* interaction ($F(1, 10) = 10.12$, $p<.05$) when only considering regular smokers and a significant main effect of *Target* ($F(1, 26) = 5.58$, $p<.05$) when only considering non-smokers. The latter seem to build mental models in which health issues are more prominent than *others* issues, whereas those who smoke regularly seem to be sensitive to long-term health problems and short-term *others* problems. There was no other significant or pertinent effect.

Discussion

In this experiment, we investigated reading processes of tobacco warnings by adolescents of three different ages. More specifically, we were interested in the mental models that adolescents may build when reading different types of health related information. We were mostly interested in three framing variables (i.e., *Severity*, *Target* and *Time consequences*) and one extra graphical variable (i.e., *with* or *without* a picture). The paradigm used in this experiment has been used in other research on psycholinguistic processes, but never, to our knowledge (except to an extent in Gnesa & Gygax, 2005 on general health warnings), in research on the pertinence of tobacco warnings. Although we think this paradigm to be crucial in establishing relevant health warnings, we do not pretend that it is exclusive. We will come back to this issue in the concluding comments.

Several results are of particular interest. First, and not surprisingly, there were noticeable differences between the age groups in both response times and proportions of positive answers, supporting Godin's (2002) claim that messages should be targeted differently depending on the chosen population, and most importantly, differences according to smoking habits. Our variable manipulation mainly demonstrated that different age groups, although all in the adolescent years,

are not sensible to the same type of information. These results underline that adolescence is a particular period characterized by important variations in cognitive processes, in turn leading to a variety of risky behaviors (as mentioned in Arnett, 2000). These crucial variations were even apparent to the extent that having *tried* smoking (i.e., in the 16-year-old group) already seemed to alter the automatic processes (i.e., as indicated by the response times) by which a warning was integrated in readers' mental models.

Those who had tried smoking were more sensitive to short-term health related issues and long-term others related issues. Interestingly, this pattern was reversed in the regular 18-year old smokers who showed increased sensitivity to long-term health issues and short-term others related issues, as was mainly shown by the response times. These differential effects support Stufin et al.'s (2008) findings that smokers do react differently to health warnings than non-smokers. As the messages that were investigated in this experiment are meant to be presented on cigarette packs, hence targeted at those who will try smoking or who smoke regularly, this sensitivity pattern change makes things quite difficult. If we were to establish an applicable policy from this study – keeping in mind that we only addressed the way participants read the messages – we would suggest alternating between those conditions to ensure a complete set of combinations. Interestingly, our data show that the distinction between short- and long-term manipulations may not be as straightforward as previously thought (e.g., Burke et al., 1992).

Depending on the *target* of the message, the smoking experience and the age of the readers, this variable might have a very different impact. Altogether, we do not believe this variation to be surprising, especially if one considers the act of smoking as embedded in other behaviors (Booth-Butterfield, 2003). Sixteen-year-olds may start smoking for social benefits (i.e., to show off) and may later engage in regular smoking to develop relationships and seek similarities (i.e., create a social group).

In our experiment, graphical displays did not, except for 16-year-old participants, seem to increase the proportion of positive answers or shorten the time it took participants to respond.

Overall, graphical supplement did not seem to have any impact. Ruiter et al. (2001) did argue that presenting frightening pictures about health risks may not be the most efficient way to communicate and prevent risky behaviors.

However, this is not to say that graphical display cannot improve tobacco prevention. Graphical display may well be effective, even if only as an attentional cue to the message (Borland, 1997). Another interesting result is that 14-year-old participants were sensitive to how severe the consequences of smoking were presented. In this sense, it seems easier to target those adolescents, as they seem to respond positively more quickly to messages that are simply presented as being *stronger*. Such an ease is unfortunately not reflected in the other groups. Still, 18-year-old non-smokers respond more often positively *and* more quickly to messages focused on health long-term issues.

In all, one could say that warnings based on *health* issues have a small advantage over those based on *others* issues, especially when the health messages have stronger severity, supporting Ordoñana et al. (2009), as well as Schmitt and Blass (2008), who argue that fear or threat is necessary to induce adequate attention. However, it would be too hasty to take this result for granted, as there seems to be great variations, attributable to age and to smoking habits. Also, it is extremely important to stress that our study only focused on reading processes, meaning that although some messages seem to have a prominent rank in readers' mental models, this does not mean that they will have a great impact on attitudes and/or behavioral changes.

Note that in our experiment, we based the notion of *sensitivity* on the speed by which participants respond to the target sentence. By doing this, we may neglect the affective responses to the stimuli. In essence, a message may trigger a strong affective response, which may in turn slow the response process, as hinted by Brown and Locker (2009). We may therefore have misinterpreted some of the reaction times as mirroring non-sensitivity, whereas it was quite the opposite. Future research on the same paradigm may want to also measure affective responses (e.g., psychophysiological) to messages in order to partial out this interpretation.

In essence, this paper presents how health prevention could gain from psycholinguistic concepts. More specifically, it raises important issues about the initial mental processes that may lead to attitude changes as well as to particular healthy behaviors. This is not to say that the messages we have identified as promoting the integration of healthy behaviors in readers' mental models will necessarily lead to changes in attitudes or to healthy behaviors, but it does constitute a first step towards it. If a message that we have identified as relevant does not necessarily have an impact upon attitude changes or healthy behaviors, one that we identified as irrelevant will most certainly never lead to pertinent changes. Therefore, our paradigm may enable those interested in tobacco prevention to evaluate whether their messages are at least processed in a way that could lead to attitude changes.

This evaluation by no means represents a unique step in the process of evaluating tobacco warnings. It is essentially a first step, a second one being the evaluation of those messages, identified in this initial psycholinguistics stage, in terms of attitude changes, while a third step would be to evaluate behavioral changes[4].

Although this experiment only investigated the reading processes involved when encountering health messages, we believe it to add a new perspective, hopefully contributing to the on-going dialogue in the construction of pertinent health tobacco warnings. We argue that this new perspective provides the tobacco prevention community with an indication of the types of messages that are relevant and important to adolescents and young adults, at least in terms of *mental processing*. Whether these messages are relevant in terms of *attitude changes* (on-going investigation) or in terms of *behavioral changes* (i.e., quit or prevent smoking) is still to be examined. One other aspect associated to this kind of research that also needs to be addressed in future research is the strategies that smokers adopt in order to avoid reading those messages. For example, some smokers in our study have admitted that they often tried to cover the messages when buying a cigarette pack. They do this by simply putting a piece of paper between the covering plastic and the pack or by having a special case to put the pack in.

As a final note, we would like to stress the importance of multidisciplinary research, with respect to theoretical issues of course, but also with respect to methodological paradigms. A broader understanding of smoking behaviors, encompassing the very basic processes of reading to the more complex ones of decision making, all of which take place in particular temporal, psychological, and social contexts, will facilitate the construction of pertinent and effective health warnings.

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Footnotes

[1]Hastings and MacFayden (2002) actually suggested that simply asking smokers how effective they thought advertisements were was not the most adequate mean to determine the effectiveness of a message.

[2]Among the variables that did not bear any significance in our data were : *Family smoking history*, *peers smoking history*, *reasons to smoke, efforts to stop smoking, exposition to prevention* (at home or at school), *attitudes towards smoking* (e.g., how easy is it to quit for a smoker ?) and *sport activity*.

[3]Following Goodall and Appiah's (2008) findings, we initially built only loss-framed messages. We then decided to also include several gain-framed messages to ensure that participants in the experimental phase would not simply get used to the fact that all relevant messages are written in a loss-framed manner. An initial exploration of the experimental data revealed no different pattern in the gain-framed messages, hence we decided to analyze all messages together.

[4]We are currently running the second step, which entails three testing phases: (a) a pre-test phase, (b) a test phase and (c) a post-test phase. In the first phase, different participants than the ones in this present experiment (but of the same ages) will be given, from among several questionnaires, an *attitude toward smoking* questionnaire, a *need for cognition* questionnaire, a *social desirability* questionnaire, and a *motivation questionnaire* (BIS/BAS scale from Carver & White, 1994). Each participant will receive, several months later, the same questionnaires preceded by the presentation of a health warning identified in this present experiment as being prevalent in readers' mental models. All changes in the questionnaire will be monitored directly after the presentation of the warning, and also three months later.

Figure Captions

Figure 1.

Proportion of positive answers considering *severity* and *time consequences* in the 16-year-old group.

Figure 2.

Response times of positive answers considering *Severity* and *Smoking experience* in the 16-year-old group. Note that higher positive response residual times mean faster response times, hence indicating a possible match to readers' mental representation.

Figure 3.

Response times of positive answers considering *Time consequence* and *Smoking experience* in the 16-year-old group. Note that higher positive response residual times mean faster response times, hence indicating a possible match to readers' mental representation.

Figure 4

Proportion of positive answers considering *Severity*, *Time consequences* and *Target* in the 18-year-old group.

Figure 5

Response times of positive answers considering *Time consequence*, *Target* and *Smoking experience* in the 18-year-old group. Note that higher positive response residual times mean faster response times, hence indicating a possible match to readers' mental representation.

Figure 1

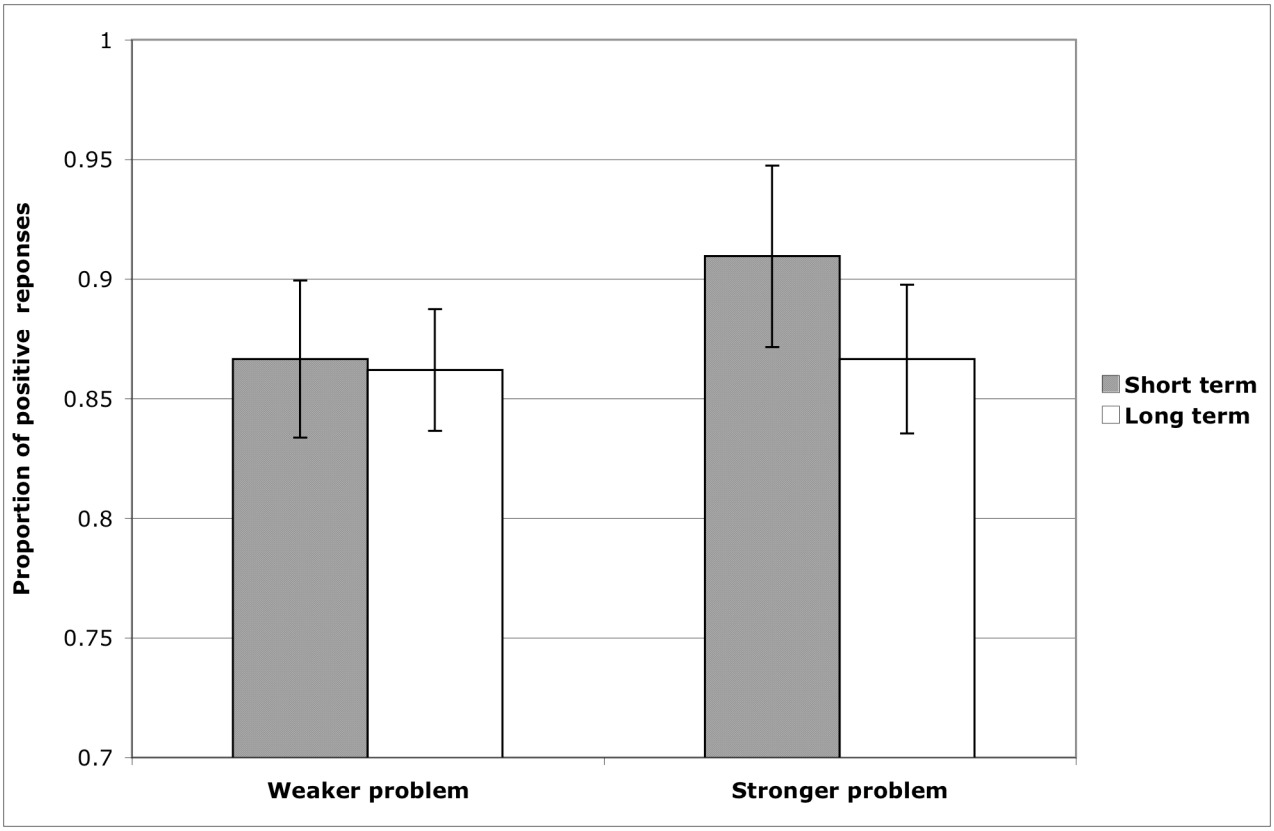

1
0.95
0.9
0.85
0.8
0.75
0.7
Proportion of positive reponses
Weaker problem
Stronger problem
Short term
Long term

Figure 2

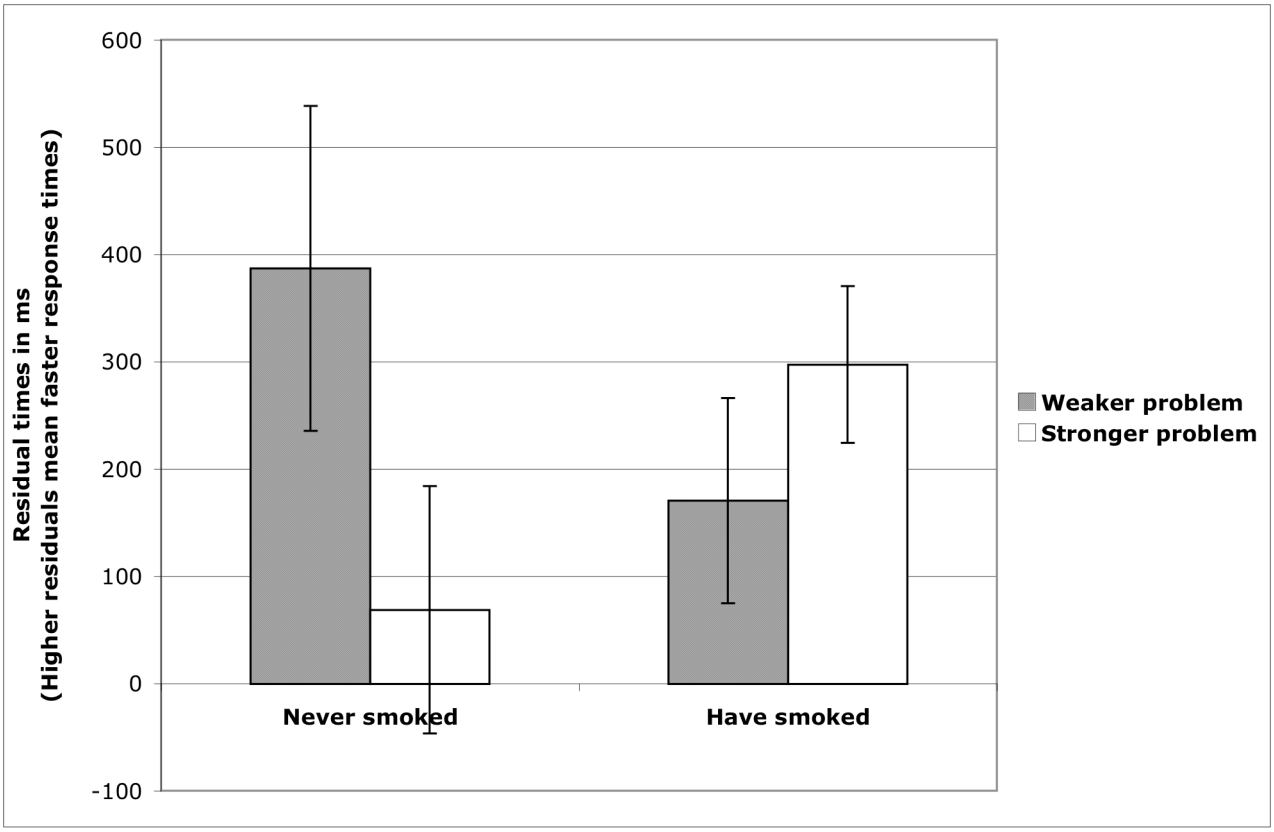

600
500
400
300
200
100
0
-100
Residual times in ms
(Higher residuals mean faster response times)
Never smoked
Have smoked
Weaker problem
Stronger problem

Figure 3

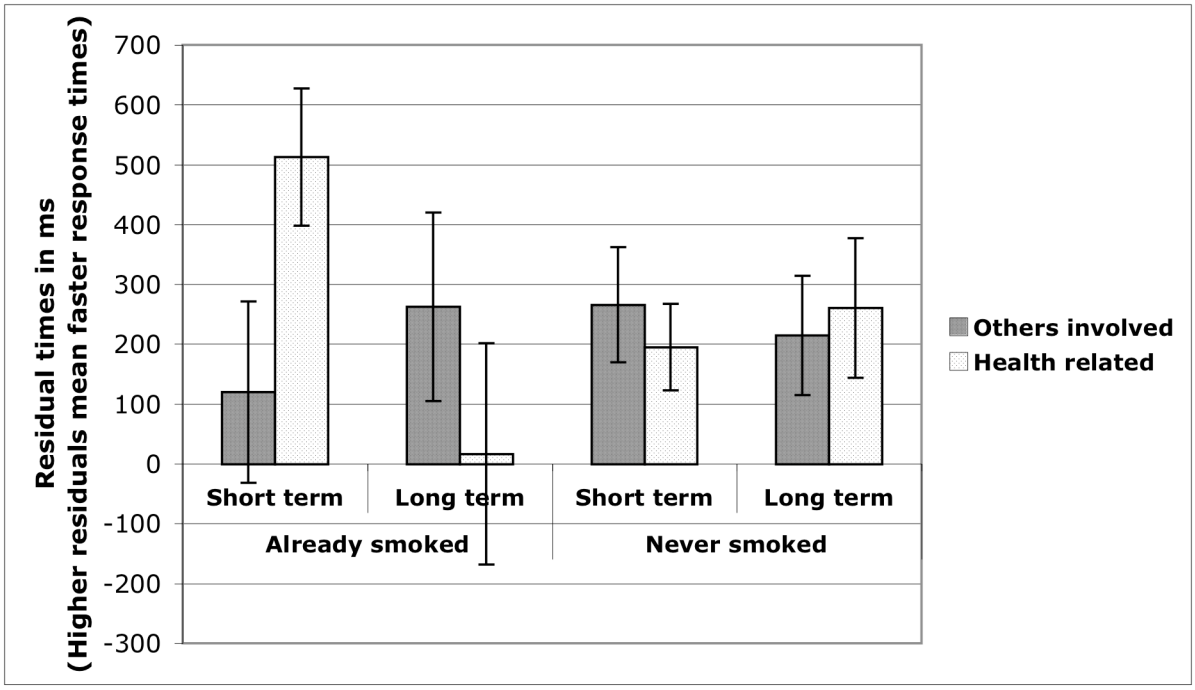

Residual times in ms
(Higher residuals mean faster response times)
700
600
500
400
300
200
100
0
-100
-200
-300
Short term
Long term
Short term
Long term
Already smoked
Never smoked
Others involved
Health related

Figure 4

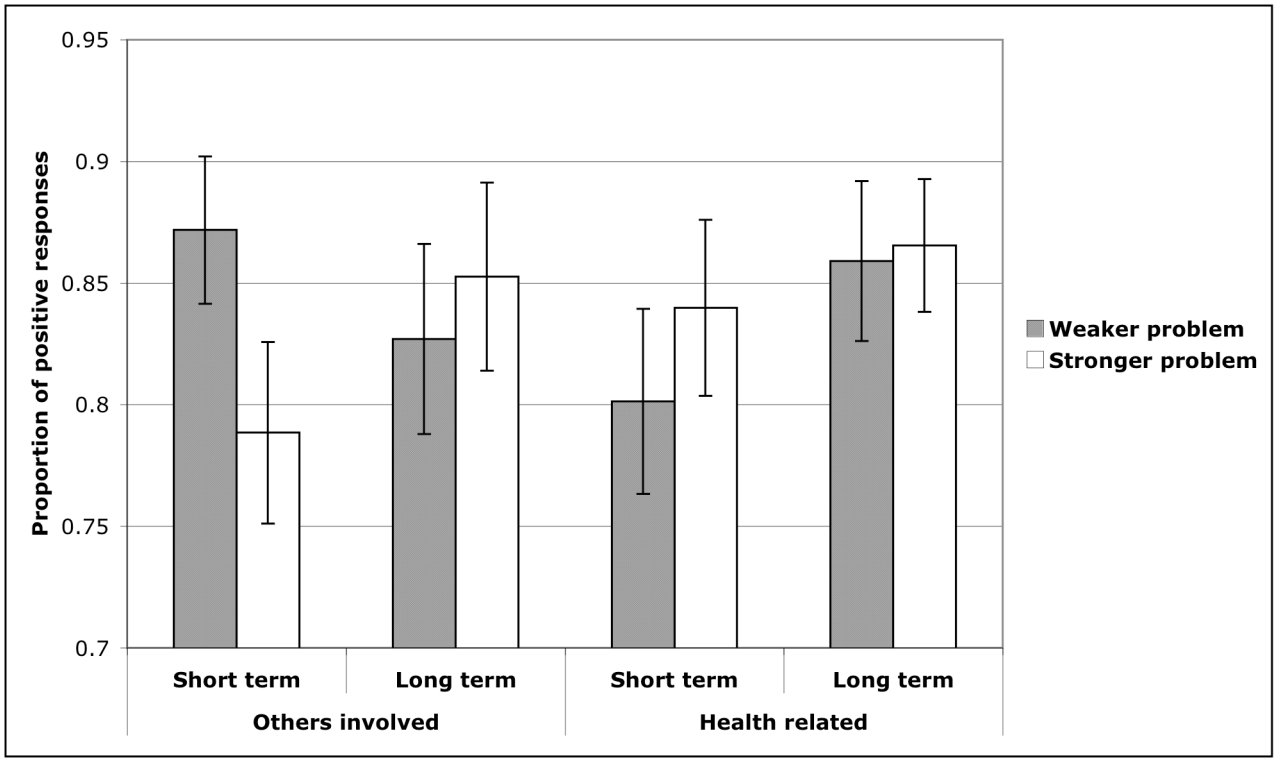
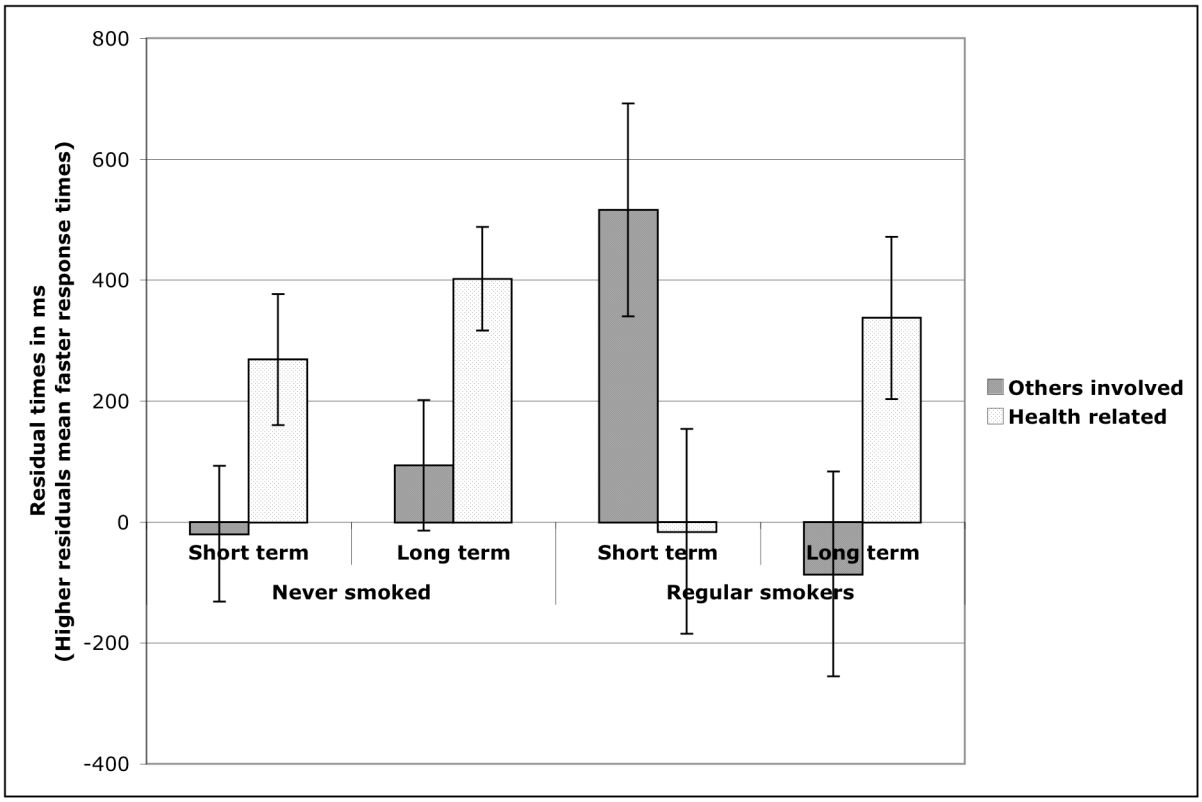

0.95
0.9
0.85
0.8
0.75
0.7
Proportion of positive responses
Short term
Long term
Short term
Long term
Others involved
Health related
Weaker problem
Stronger problem

Figure 5


800
600
400
200
0
-200
-400
Residual times in ms
(Higher residuals mean faster response times)
Short term
Long term
Short term
Long term
Never smoked
Regular smokers
Others involved
Health related