

Keeping the home fires burning: The affect heuristic and wood smoke pollution

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Abstract

This study examined the role of affect and risk perceptions in maintaining wood burning behavior in 256 residents of a small Australian city characterized by high levels of winter wood smoke pollution. Our analyses revealed that users of wood heaters, relative to non-users, had more positive affective associations with wood heating, perceived fewer health risks from wood smoke, and exhibited less support for wood smoke control policies. Moderation analyses revealed that the predictive effects of risk perceptions on policy support and switching behavior were weaker for respondents who had more positive affective associations with wood heating and stronger for those with more negative affective associations. Theoretical implications relating to the role of affect in decision-making are discussed, together with practical implications for developing more effective interventions to reduce wood smoke pollution.

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1. Introduction

“Nothing beats the warmth of a wood fire” reads the advertising slogan for a popular brand of wood-burning heater (“Norseman”, 2006, p.30). The advertisement does not address the economic benefits (or otherwise) of burning wood, nor does it mention the heating efficiency (or otherwise) of the heater. It simply appeals to our positive affective associations with wood fires. For many individuals, the mere thought of a wood fire in winter conjures up innate feelings of comfort, goodness, happiness and warmth. These warm feelings about wood fires are no mere passing fad. They have probably evolved over the past 350,000 years during which humankind has burned wood for heating purposes (Rolland, 2004). For many people, burning wood for home heating is a well entrenched part of a “natural” lifestyle. Approximately 30 million homes (one-third of all households) in the United States burn

wood for residential space heating (Houck, Tieg, McCrillis, Keithley, & Crouch, 1998).

A major concern of health and environmental authorities throughout the world is that wood smoke contributes to harmful levels of air pollution in many urban areas and rural centers. The World Health Organization (1997) estimates that wood smoke is responsible for 2.7–3 million premature deaths worldwide. Wood smoke is a complex blend of air pollutants including carbon monoxide, nitrous oxide, air toxics and particulate matter, which collectively are associated with a wide range of health problems, from minor eye irritations and headaches, to more serious diseases of the respiratory, nervous, reproductive, developmental and immune systems (New South Wales Department of Health, 2003). In addition, some air toxics generated during wood burning are known or suspected carcinogens. Wood smoke can have a detrimental effect within homes, in neighborhoods where wood heating is used, and in towns where pollution from wood heaters persists in the outdoor air, particularly when weather conditions are cold and still (New South Wales Department of Health, 2003).

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One city badly affected by wood smoke pollution is Armidale, Australia (Roberts & Lin, 1998), a rural center of around 25,000 people. The amount of wood smoke pollution in Armidale during winter is substantial. The Australian National Environmental Protection Council's acceptable limit for airborne particulate matter (the pollutant most relevant to air toxics) is a daily maximum of $50 \mu\text{g}/\text{m}^3$ (micrograms per cubic meter) with only 5 days allowed to exceed that limit per year. This permitted level is similar to that set in the United Kingdom and Europe, whereas in Japan, it is $100 \mu\text{g}/\text{m}^3$ and in the United States, $150 \mu\text{g}/\text{m}^3$ (Australian Government Department of the Environment and Heritage, 2002). In each of the 3 years to 2003, during the winter months of June, July and August, Armidale exceeded the $50 \mu\text{g}/\text{m}^3$ limit on an average of 40 days. It exceeded $100 \mu\text{g}/\text{m}^3$ an average of 12 days each year, and on 2 days each year it exceeded $150 \mu\text{g}/\text{m}^3$ (Armidale Dumaesq Council, 2003).

In recognition of the environmental problem, local Government authorities in Armidale, as well as several other cities in Australia, New Zealand and the United States, have introduced wood smoke reduction programs. Although the specific details vary from location to location, in general these programs are aimed at educating the public about proper wood heater use, providing incentives to change to cleaner heating sources and, in some cases, imposing fines on recalcitrant offenders. Within Armidale, community education programs have been effective in increasing *awareness* of the wood smoke problem, but there has been no demonstrable reduction in wood smoke pollution itself (Armidale Dumaesq Council, 2003). This should not come as a surprise. As Kollmuss and Agyeman (2002) note, research as early as the 1970s established that increased environmental knowledge and awareness do not necessarily lead to pro-environmental behavior. The special issue in which their article appeared was devoted entirely to an investigation of *the gap* between environmental awareness and pro-environmental behavior (see, for example Courtenay-Hall & Rogers, 2002; Gough, 2002; Jensen, 2002; Maiteny, 2002; O'Donoghue & Lotz-Sisitka, 2002).

Two models have been widely applied to explain the gap between environmental awareness and pro-environmental behavior: Schwartz's (1977) norm-activation model (NAM), and Ajzen's (1991) theory of the planned behavior (TPB). NAM posits that two conditions must be met for a moral norm, such as working to improve or protect the environment, to be activated. Individuals must be aware of the potential consequences of their actions, and accept personal responsibility for these consequences. Thus, in the absence of personal responsibility, the gap between awareness of consequences and pro-environmental behavior is predicted to remain.

According to TPB, the primary determinant of pro-environmental behavior is behavioral intention, which itself is influenced by three main factors: (1) attitude toward the behavior, which is defined as (2) subjective

norms, and (3) perceived controllability of the behavior. In TPB, attitudes are defined in expectancy-value terms as a function of the perceived likelihood and value of personal outcomes stemming from a given behavior. Thus, attitudes in TPB are similar to awareness of consequences in the norm activation model. Subjective norms typically are operationalized as the product of an individual's personal beliefs about how important others would like them to act and their motivation to comply with those expectations. Finally, perceived controllability of behavior refers to individual's perceptions of personal control over the successful completion of a behavior, a construct very similar to Bandura's (1986) notion of self-efficacy. Thus, according to the TPB model, simply being aware of possible negative consequences of one's current actions is often not sufficient to elicit a shift toward pro-environmental behavior in the absence of normative pressure from significant others and the belief that one can complete pro-environmental behavior successfully.

Although both NAM and TPB have been very successful in predicting a wide range of pro-environmental behaviors (e.g., Bamberg, Ajzen, & Schmidt, 2003; Guagnano, Stern, & Dietz, 1995; Heath & Gifford, 2002; Knussen, Yule, MacKenzie, & Wells, 2004), both models suffer from an important limitation; they focus exclusively on cognitive determinants of decision making and behavior, while ignoring the potential role of affect.

Zajonc (1980) was among the first to suggest that affective reactions to a stimulus preceded deliberative reactions and guided subsequent information processing and judgment. More recently, Slovic, Finucane and colleagues (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic, Finucane, Peters, & MacGregor, 2002; Finucane & Holup, 2006; Slovic, Finucane, Peters, & MacGregor, 2004) extended Zajonc's work by introducing the notion of an *affect heuristic*. The affect heuristic model is based on the premise that two distinct information processing systems guide human judgment and decision-making: (1) an experiential system that is passive, effortless, rapid and intimately tied to intuition and affect, and (2) an analytic system that is intentional, effortful, logic-based, and largely affect free. The analytic system is under the conscious control of the individual and is assumed to operate in a manner similar to that proposed by traditional decision models, which emphasize the conscious evaluation of risks and benefits.

The experiential system, on the other hand, is assumed to operate automatically, often with little conscious input from the decision maker. According to Finucane et al. (2000), thoughts and images stored in memory are marked with negative or positive affective tags of varying strengths. Stimuli in the decision context activate the relevant thoughts and images, which in turn spread activation to their associated affective tags. Activated affective tags combine to form an *affective pool* (a general feeling of goodness and badness) that guides subsequent judgments, decisions, and behavior.

It is important to note that the output from experiential and rational systems will sometimes come into conflict. That is, the experiential system may favor one type of decision or behavior, whereas the rational system may favor another. This is sometimes described as a conflict between heart and head. Such conflicts represent a promising explanation for the gap between environmental knowledge and behavior. Even if individuals are consciously aware of the potential negative consequences of their behavior for the environment and/or themselves, they may still persist in the behavior if they have positive experiential associations promoting its continuance.

In the current study, we examine whether the affect heuristic model can help explain why many Armidale residents oppose the introduction of new policies to control wood smoke and are reluctant to switch from wood heating to less-polluting alternatives. We predict that users of wood heaters, compared to non-users, will have more positive affective associations with wood heating, perceive fewer health risks associated with wood smoke, and be less inclined to support government policies to manage wood smoke pollution. Based on the notion that human judgment and behavior are controlled by two distinct information processing systems (experiential and rational), we predict that affective associations with wood heating will moderate the effects of risk perceptions on policy support and switching behavior. That is, we expect the magnitude of the predictive effects of perceived health risks on support for wood smoke control policies and switching behavior will be weaker for individuals with positive affective associations and stronger for those with negative or neutral affective associations.

2. Method

2.1. Participants

Participants were 256 (116 male and 140 female) residents of Armidale, New South Wales, Australia. Respondents' ages ranged from 18 to 91 years ($M = 45.15$, $SD = 15.45$). In terms of education, 8% of the sample indicated that they had not completed high school, 39% had a high school diploma, 21% had at least 2 years of college or university, 15% possessed a university undergraduate degree, and 17% had completed a post-graduate or professional degree. Just over half the respondents (53%) used wood heaters as their primary source of winter home heating, and 16% of the sample had recently applied for and received cash rebates from the local council to replace their wood heaters with alternative cleaner heating systems.

2.2. Procedure

Households were invited to participate if they: (1) had participated in a recent cash rebate program for replacing wood heaters with cleaner alternative heating systems, or

(2) had been identified by local government officials as having excessive wood-smoke emissions. In addition, we also approached a random sample of houses on the same streets as those households who had received a cash rebate or who had received formal emission warnings.

Residents were contacted in their homes and the purpose of the study explained. If the resident agreed to participate, he/she was given a copy of the questionnaire, a plain envelope, and an information sheet containing contact details and information about the survey. A time and date for picking up the questionnaire was also arranged. To participate, residents had to be at least 18 years of age and responsible for operating and/or maintaining the heating system at the address where the questionnaire was distributed.

Overall, 551 homes were visited and 256 completed questionnaires were collected, yielding an overall response rate of 46%. For the sub-sample who participated in the cash-rebate program to replace wood heaters, the response rate was 52% (42 of 81). For those who were identified as heavy emitters, the response rate was 47% (51 of 108).

2.3. Measures

The questionnaire consisted of items and scales assessing respondents' affective associations with wood heating, perceived health risks associated with wood smoke pollution, perceived benefits associated with reducing wood smoke, perceived barriers associated with switching from wood heating to alternative home systems, support for policies to manage wood smoke pollution, and wood heater ownership status. Participants also provided details of their gender, age, education, and annual household income. In addition, data were obtained regarding whether wood heater owners had applied for and received a cash incentive from the local Council to replace their wood heater with a less polluting alternative. This information was used as a dichotomous dependent variable in the analyses that assessed the potential effects of affective associations and risk perceptions on decisions to switch from wood to other heating systems.

2.3.1. Affective associations

Affective associations with wood heating were assessed using an approach developed by Peters and Slovic (1996). Respondents were asked to list the first three thoughts or images that came to mind when presented with the cue phrase "Using wood to heat homes in Armidale", and then rate each thought/image on a scale ranging from 1 (very negative) to 5 (very positive). The three affective response scores were then averaged to form a composite index of affect valence (Cronbach's $\alpha = .66$).

2.3.2. Perceived health risks

Perceived health risks associated with wood smoke exposure were assessed by nine items. The items included statements regarding the potential health impacts of wood

smoke on children, older adults, individuals with respiratory disorders, and respondents themselves (e.g., “Wood smoke pollution represents a serious health threat to young children living in Armidale”). Several items also assessed the extent that respondents worried or were frightened by the potential health effects of wood smoke (e.g., I worry a lot about the negative effects of wood smoke on my state of health). All items were assessed on a 5-point scale (1 = strongly disagree, 5 = strongly agree), and were averaged to form a composite index of perceived health risks ($\alpha = .90$).

2.3.3. Support for wood smoke control initiatives

Three items were used to assess respondents’ support for government initiatives to control wood smoke pollution. The first item asked “How much extra per month in taxes would you be willing to pay to ensure that winter air pollution levels in all areas of Armidale would never exceed the air quality standards set by the National Environmental Protection Council?” The second item presented a hypothetical scenario in which local government had received a one-off AUD \$100,000 grant for improving Armidale, and respondents were asked to distribute the money among seven projects (improving roads and cycle ways; attracting new business; increasing tourism; reducing wood smoke pollution; improving community services such as parks, library, and swimming pool; improving water quality; and other). The third item asked how much local government should fine households that repeatedly emit excessive amounts of wood smoke from their homes (0 = AUD \$0, 5 ≥ AUD \$750). The three items were standardized and averaged to compute a single composite index of support for wood smoke reduction policies ($\alpha = .60$).

3. Results

3.1. Descriptive statistics

Means and standard deviations for the full sample (wood heater users and non-users) are presented in Table 1. Bonferroni-corrected contrasts revealed that wood heater users, relative to non-users, had more positive affective associations with wood heating, perceived the potential health impacts of wood smoke pollution to be lower, were

less in favor government funding allocations for wood smoke control, and preferred smaller fines for households that repeatedly emitted excessive wood smoke (all $ps \leq .01$). Wood heater users and non-users did not significantly differ in terms of their preference for tax increases to ensure that wood smoke pollution did not exceed national air quality standards.

3.2. Affect, risk perceptions and support for wood-smoke-control policies

Multiple regression was used to test our hypothesis that positive affective associations would moderate the relationship between risk perceptions and policy support. Policy support, the dependent variable, was operationalized as the mean of the three standardized policy variables described in the method section (i.e., support for tax increases, government funding, and fines to control wood smoke pollution). Affective associations, risk perceptions, and their interaction served as predictors. Following the recommendations of Cohen, Cohen, West, and Aiken (2003) both main effects were centered at zero, and multiplied together to compute the interaction. A summary of the analysis is presented in Table 2.

Together, the predictors explained 50% of the variance in policy support, with affective associations, risk perceptions, and their interaction all making unique contributions to the prediction model. Given the main effects were qualified by the significant interaction, only the interaction will be discussed. To interpret the interaction, we created a plot and computed standardized simple slopes tests using SPSS syntax developed by O’Connor (1998). Examination of the simple slope coefficients revealed that higher perceived health risk was significantly associated with increased support for wood smoke control policies at all three levels of affect (1 *SD* below the mean, at the mean, and 1 *SD* above the mean), but that the effect was stronger for respondents with negative ($\beta = .71$) or neutral ($\beta = .58$) affective associations with wood heating, and weaker for those with positive affective associations ($\beta = .45$, ps for all simple slopes $< .01$). This finding is consistent with our hypothesis that positive affective associations with wood heating would attenuate the relationship between respondents’ risk perceptions and their support for policies to reduce wood smoke pollution.

Table 1
Variable means and standard deviations for full sample, wood heater users and non-users

Variable	Sample <i>M</i> (<i>SD</i>)	Wood heater users <i>M</i> (<i>SD</i>)	Non-users <i>M</i> (<i>SD</i>)	<i>t</i> (254)	Cohen’s <i>d</i>
Affective associations	3.34 (1.09)	3.71 (.88)	2.91 (1.16)	−6.27 ^a	−.79
Perceived health risks	2.59 (.81)	2.34 (.69)	2.89 (.84)	5.81 ^a	.73
Support for tax increase	1.82 (1.32)	1.69 (1.08)	1.97 (1.21)	2.00	.25
Support for government funding	\$12,919 (16,219)	\$9,560 (11,762)	\$16,909 (19,600)	3.70 ^a	.46
Support for pollution fines	1.51 (1.66)	1.17 (1.44)	1.91 (1.82)	3.68 ^a	.46

^a $p < .01$, Bonferroni-corrected α for multiple comparisons.

Table 2
Summary of multiple regression analysis: affective associations, risk perceptions, and their interaction as predictors of support for wood smoke control policies

Predictors	Adj R^2	B	β	r	sr^2
Model	.50**				
Affective associations (A)		-.12**	-.17	-.48**	.02
Perceived health risk (B)		.53**	.58	.68**	.25
$A \times B$		-.11**	-.13	-.21**	.02

* $p < .05$, ** $p < .01$. In the table, r and sr^2 refer to the uncorrected Pearson correlation and squared semi-partial correlation between each predictor and policy support.

Table 3
Summary of logistic regression analysis: affective associations, risk perceptions, and their interaction as predictors of switching from wood to an alternative heating system

Predictors	R^2	β	SE	Wald	Exp (β)
Model	.20**				
Affective associations (A)		-.40	.25	2.59	.67
Perceived health risk (B)		.71	.34	4.43*	2.03
$A \times B$		-.80	.32	6.43*	.45

In the table, R^2 refers to Nagelkerke's Pseudo R^2 . * $p < .05$, ** $p < .01$.

3.3. Switching from wood to alternative home heating systems

We conducted a second analysis to determine if the effects reported in the previous section would generalize from policy support judgments to an actual behavior—switching from wood heating to a cleaner alternative system. As in the previous analysis, affective associations, risk perceptions (both centered at 0), and their interaction served as predictors. The dependent variable was whether or not the respondent applied to the local council for a cash incentive to replace their wood heater with cleaner alternative system. Given that the dependent variable was dichotomous, logistic regression was employed.¹ Results are summarized in Table 3.

Together the predictors explained 20% of the variance in switching behavior. Examination of the logistic coefficients and corresponding Wald statistics revealed a significant main effect for risk perceptions and a significant *affect by risk perception* interaction. To interpret the interaction we created a plot and simple slopes following the guidelines presented by Jaccard (2001). The plot and simple slopes indicated that higher perceived health risks were associated with increased switching behavior for respondents with negative ($\beta = 1.32$) and neutral ($\beta = .54$) affective associations with wood heating, but not for respondents with positive affective associations, who exhibited a weak trend

in the opposite direction ($\beta = -.24$). This pattern is consistent with the view that positive affective associations with wood heating attenuate the effects of risk perceptions on switching behavior.

4. Discussion

4.1. Theoretical and practical implications

In this study, we investigated the role of the *affect heuristic* (Finucane et al., 2000; Finucane & Holup, 2006; Slovic et al., 2002) in guiding judgments and decisions related to wood burning behavior among residents of a small Australian city. The affect heuristic model is based on the notion that human behavior is controlled by two distinct information processing systems: an experiential system that is largely automatic, preconscious, and driven by affect, and a rational system that involves the conscious, deliberate assessment of expected risks and benefits. Our first set of hypotheses predicted that wood heater users should differ from non-users in terms of their affective associations with wood heating (output from the experiential system), perceptions of risk associated with wood smoke pollution (output from the rational system), and support for wood smoke control policies (an outcome variable assumed to be determined by both affective associations and risk perceptions). As predicted, wood heater users, compared to non-users, reported more positive affective associations with wood heating, perceived fewer health risks from wood smoke, and exhibited less support for wood smoke control policies.

Our second set of hypotheses predicted that affective associations with wood heating should moderate the effects of risk perceptions on respondents' support for wood-smoke control policies and their decisions to switch from wood to alternative home heating systems. Both these hypotheses were also supported. Respondents who viewed the wood smoke pollution to be a serious health risk exhibited stronger support for government initiatives to reduce wood smoke pollution, and were more likely to take steps to replace their wood heater with a less polluting alternative. But importantly, these effects were stronger for respondents who possessed negative emotional associations with wood heating and weaker for those with strong positive emotional associations. This attenuation effect was particularly strong for switching behavior, where a unit increase in positive affect was associated with over a 50% reduction in the effect size (i.e., the exponentiated β coefficient) describing the relationship between perceived health risk and the likelihood of switching from wood to alternative heating.

From a practical perspective, this finding suggests that educational interventions aimed at providing people with information about the health risks associated with wood smoke may be undermined by their positive affective associations with wood heating. Thus, interventions that effectively increase risk perceptions and provide concrete

¹Only those members of the sample who indicated they used wood heating or had recently switched from wood heating were included in this analysis.

strategies for switching to alternative heat sources may elicit little behavioral change if they fail to address the public's positive affective associations with wood burning. Our switching behavior data suggest that when there is a conflict between respondents' affective associations (i.e., output from the experiential system) and conscious risk perceptions (output from the rational system), affective associations appear to exert the greater influence on behavior. That is, in the current context at least, strong positive emotional responses appear to override rational assessment of risk. This is consistent with the view that the affect-based experiential system is the default system guiding decision making and behavior in most circumstances (e.g., Epstein, 1994; Finucane et al., 2000; Slovic et al., 2005), which further highlights the importance of developing environmental interventions that target affect, not just conscious beliefs about risks and benefits (Arvai, Campbell, Baird, & Rivers, 2004).

4.2. Limitations and future research

There are a number of limitations that should be considered when interpreting the present findings. First, although our results are consistent with the theoretical proposition that affective associations and risk perceptions guide behavior, it is important to emphasize that strong causal inferences are not warranted given that our data are correlational. Future research in which affect and risk perceptions are experimentally manipulated and/or tracked longitudinally would be useful in clarifying issues related to causality.

Second, the data reported here were derived from a sample of 256 respondents of a total 551 solicitations. It is not known to what extent wood heater users versus non-users were represented in the non-respondents, nor can it be assumed that the results of this study will generalize to Armidale as a whole, or to other communities that experience wood smoke pollution. Additional studies are required to establish the external validity of our findings.

Third, affect in the current study was assessed using a task that involved generating a list of free associates related to wood heating, and then rating each associate in terms of its affective valance (i.e., on a scale from very negative to very positive). Although we believe that this is a valid approach for measuring affect, it is worth noting that many dual process models of cognition argue that the experiential system often guides decision-making and behavior at a preconscious level. At present it is not clear whether preconscious affective content is distorted in any important way when measured using techniques that require conscious retrieval and evaluation, as in the current study. Research is needed to determine whether alternative measures of experiential cognition that do not require conscious evaluation (e.g., implicit attitude, reaction time, and EEG measures) produce similar results to the measure used in the current study.

5. Conclusion

In his recent Nobel Prize lecture, Daniel Kahneman (2003) described the *affect heuristic* as “probably the most important development in the study of judgment heuristics in the past few decades.” (p. 710). This paper has reported on the application of the affect heuristic to a particular human behavior that has detrimental effects for our health and the environment in which we live. In so doing, we have presented further evidence to support the proposition that our affective evaluations are leading determinants of many of our decisions and consequent behaviors. What we feel may be just as important as what we think.

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