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Heat protection behaviors and positive affect about heat during the 2013 heat wave in the United Kingdom

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ABSTRACT

Heat waves pose serious health risks, and are expected to become more frequent, longer lasting, and more intense in the future under a changing climate. Yet, people in the UK seem to feel positive when thinking about hot weather. According to research on the affect heuristic, any positive or negative emotions evoked by potentially risky experiences may be used as cues to inform concerns about risk protection. If so, then their positive feelings toward hot weather might lead UK residents to lower intentions to adopt heat protection behaviors. Here, we examine the relationships between heat protection behaviors during the July 2013 UK heat wave and self-reports of having heard heat protection recommendations, feeling positive affect about heat, seeing heat protection measures as effective, and trusting the organizations making those recommendations. Responses to a national survey revealed that 55.1% of participants had heard heat protection recommendations during the 2013 UK heat wave. Those who reported having heard recommendations also indicated having implemented more heat protection behaviors, perceiving heat protection behaviors as more effective, feeling more positive about heat, and intending to implement more protection behaviors in future hot summers. Mediation analyses suggested that heat protection recommendations may motivate heat protection behaviors by increasing their perceived effectiveness, but undermine their implementation by evoking positive affect about hot weather. We discuss our findings in the context of the affect heuristic and its implications for heat protection communications.

1. Introduction

In July 2013, the UK experienced a heat wave where maximum temperatures exceeded 30 °C for seven consecutive days, from 13 to 19 July, and exceeded 28 °C on nineteen consecutive days, from 6 to 24 July (Met Office, 2013). This heat wave was the most significant since July 2006, with the summers of 2007–2012 having mostly been cool and wet compared to the long-term average (Met Office, 2014). Heat waves are projected to become more frequent, longer lasting, and more intense as climate change unfolds (IPCC, 2013). Heat protection behaviors will, therefore, become increasingly important for UK residents (Hajat et al., 2014).

Daily mortality rates tend to rise as temperatures move above the long-term local average (Curriero et al., 2002). In the temperate climate of the UK, individuals can experience thermal discomfort when outside temperatures reach 22 °C or 71.6 °F (Fuller and Bulkeley, 2012). Prolonged exposure to high temperatures during heat waves is associated with excess deaths, primarily in older age groups (Hajat et al., 2007; Kosatsky, 2005). The 2003 European heat wave caused around 35,000 deaths (Robine et al., 2008) including 2000 in England (National Health Service (NHS), Public Health England (PHE), and Met Office, 2013). Heat waves have also been associated with increased hospitalizations and emergency-room visits (Johnson et al., 2005; Kovats et al., 2004; Knowlton et al., 2009; Semenza et al., 1999). Summer heat can have rapid health

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consequences including heat stroke (Knowlton et al., 2009; Kilbourne, 1997), which can be fatal or cause neurological sequelae (Bouchama and Knochel, 2002). Although the 2013 heatwave was more notable for its length than for its intensity (Met Office, 2013), initial syndromic surveillance data suggest minor but significant increases in heat-related illness that are in line with previous hot periods (Elliot et al., 2014). Morbidity and mortality statistics have not yet been published.

Because adverse health outcomes from heat are more likely among older people and those in poor health (Bouchama and Knochel, 2002; Kovats and Hajat, 2008), heat protection messages often target these groups. However, heat protection messages are also relevant to healthy individuals of younger ages, who can experience heat illness as a result of prolonged exposure to high temperatures or vigorous outdoor physical activity in hot weather (Kovats and Hajat, 2008; Kilbourne, 1992; Glazer, 2005). Reaching young people is also important because once risk protection behaviors are learned they are more likely to be continued (Caspersen et al., 2000).

In England, the National Health Service (NHS), Public Health England (PHE) and the Met Office publish an annual Heatwave Plan (2013) with warnings about the dangers of heat and guidance on which heat protection behaviors to implement during heatwaves (see Methods). Despite being moderate in intensity, the prolonged heat in July 2013 reached sufficient levels to trigger health warnings from the 13th to the 23rd (Met Office, 2013; Elliot et al., 2014) Hence, the release of these warnings provided the opportunity to test people's responses, given the conditions of the 2013 heatwave. As described below, research on risk perception and communication has identified several factors that may motivate risk protection behavior (Bruine de Bruin and Bostrom, 2013). The present study examines the relationship of hearing heat protection messages with three of those factors: (1) perceiving the recommended protection behaviors as more effective, (2) feeling less positive about the risk (here: heat), and (3) having more trust in those issuing the recommendations.

1.1. Perceived effectiveness of heat protection

Although hot weather poses potential health threats, many UK adults seek the outdoors during hot weather, without protecting themselves from heat (Diffey and Norridge, 2009; Jones et al., 2000). When going on holiday, tourists from the UK (and other northern European countries) deliberately spend many hours in the sun, including during the hottest time of day (Elliott et al., 1998; Evans et al., 2001; Manning and Quigley, 2002; Wachsmuth et al., 2005). Interviews with UK migrants to Spain suggest that they are less likely than local residents to implement behaviors that protect them against heat (such as closing blinds), because they question the effectiveness of doing so (Fuller and Bulkeley, 2012). Even vulnerable older adults in the UK perceive heat protection behaviors as ineffective and unnecessary (Abrahamson et al., 2009; Wolf et al., 2010). Taken together, these findings suggest that UK residents who do perceive heat protection behaviors as more effective are more likely to implement them.

1.2. Positive affect about heat

Risk researchers increasingly recognize the importance of feelings (or 'affect') in shaping risk perceptions and responses to risk communications (Slovic et al., 2004; Finucane et al., 2000). Classic studies have suggested that affective responses to experiences are automatic and serve as cues for subsequent perceptions of risk (Slovic et al., 2004; Finucane et al., 2000; Bruine de Bruin and Wong-Parodi, 2014). According to research on the affect heuristic, potentially risky experiences that evoke negative feelings will fuel concerns about risk protection and potentially risky experiences that evoke positive feelings will soothe concerns about risk protection (Slovic et al., 2004; Finucane et al., 2000; Keller et al., 2006). Indeed, some risks are unique in the sense that they tend to evoke positive affect among specific audiences, including wood-burning fire places (among home owners), risky driving (among younger men), and sunbathing (among Northern Europeans) (Bränström et al., 2001; Hine et al., 2007a; Rhodes and Pivik, 2011). In line with research on the affect heuristic, people who report more positive affect for these experiences tend to judge the need for risk protection behaviors to be lower (Bränström et al., 2001; Hine et al., 2007a; Rhodes and Pivik, 2011).

In the UK, thoughts of hot summers often evoke positive affect (Fuller and Bulkeley, 2012; Wolf et al., 2010; Harley, 2003). Many UK residents (especially in the North) respond positively to the prospect of warmer summers (Palutikof et al., 2004), in contrast with Americans' negative responses (Leiserowitz, 2006). Older UK residents, who are especially vulnerable to heat, still describe heat as enjoyable (Harley, 2003). Accordingly, it is possible that messages about risks of hot weather inadvertently evoke positive (rather than negative) feelings about heat among UK recipients, thus reducing the perceived need for risk protection. Indeed, messages that evoke positive moods may decrease perceptions of risk (Johnson and Tversky, 1983). Taken together, these findings suggest that UK recipients who report less positive affect about heat after hearing heat communications will be more likely to protect themselves against heat.

1.3. Trust in organizations

According to the risk perception and communication literature, trust in the communicating organizations is essential for effective risk communication, because people are more likely to listen to the organizations they trust (Cvetkovich and Löfstedt, 1999; Siegrist et al., 2007; Visschers and Siegrist, 2008). Especially when people know relatively little about a risk, their decisions about whether to follow a recommendation may depend on how much they trust the communicating institutions (Siegrist and Cvetkovich, 2000a). During UK heat waves, recommendations to protect against heat are released by the National Health Service, Public Health England, and the Met Office (2013). Overall, these findings suggests that people who report greater trust in those agencies are more likely to implement heat protection behaviors (Matthies et al., 2008; Renn and Levine, 1991; Siegrist and Cvetkovich, 2000b).

1.4. The current study

The July 2013 UK heat wave provided a unique opportunity to examine public responses to heat protection messages, including the role of perceived effectiveness, positive affect about heat, and trust. In a UK-wide survey conducted in October 2013, we assessed four specific research questions: 1) Who heard heat protection recommendations? 2) Was hearing heat protection recommendations associated with perceived effectiveness of behaviors, positive affect about heat, and trust in communicating organizations? 3) Was hearing heat protection recommendations related to heat protection behaviors during the 2013 heatwave – and, if so, what was the role of perceived effectiveness, positive affect about heat, and trust? 4) Was hearing recommendations, perceiving effectiveness, having positive affect about heat, and reporting trust related to intentions to implement heat protection behaviors in the future?

2. Methods

2.1. Participants

A total of 762 UK participants took part in an online survey conducted by survey research company Research Now (researchnow.com). Participants were recruited through email invitations that especially targeted older adults. We excluded 61 participants because they had missing responses for key variables, and hence could not be included in all analyses. The remaining participants ($N = 701$) had complete data.

Sample characteristics are presented in Table 1, with a comparison to the UK population appearing in Table S1 of the Electronic Supplemental Materials. Our sample had more males, was less ethnically diverse, and had completed higher levels of education, compared to the overall population (all $p < .001$). Additionally, our sample was markedly older than the general population, $t(700) = 12.45$, $p < .001$, reflecting our strategy to oversample older adults. Our analyses tested our research questions while taking into account these demographic variables.

2.2. Procedure and measures

Participants received an email invitation to an online survey about 'weather' and were paid £1 for completion. They were part of the no-intervention control group in a larger study that tested strategies for influencing feelings about hot weather and intentions to protect against heat. Therefore, our participants only received the following instructions: "We are interested in your thoughts about the weather. We will also ask questions about your health and other background information." No additional information regarding the survey was provided. Questions relevant to our analyses are described below.

2.2.1. Reports of having heard heat protection recommendations

Participants reported whether, during the summer of 2013, they had heard specific public recommendations about how to protect themselves from heat. Possible answers were 'yes' and 'no.' Those answering 'yes' were asked where they had heard these recommendations, with the options being Heatwave Plan, Public Health England, NHS, Met Office, Internet, Doctor's practice or hospital, Flyer, TV, radio, word of mouth, 'I can't remember,' and 'Other'.

2.2.2. Perceived effectiveness of heat protection behaviors

Participants rated ten heat protection behaviors for their effectiveness on a 5-point scale ranging from 1 (=completely ineffective) to 5 (=very effective) in response to the question "How effective do you think the following strategies are to *protect yourself from heat in the summer?*" Specifically, they rated the effectiveness of (a) keeping out of the sun between 11:00am and 3:00pm, (b) staying in the shade, (c) applying sun screen, (d) avoiding extreme physical exertion (such as exercise, running, or playing sports), (e) having plenty of cold drinks, (f) avoiding excess alcohol, (g) keeping windows that were exposed to the sun closed during the day, (h) opening windows at night when the temperature has dropped, (i) closing curtains that received morning or afternoon sun, and (j) using electric fans. All except for (c) 'applying sun-screen' were taken directly from the Heatwave Plan published by the National Health Service, Public Health England, and the Met office (2013). Reliability across the ten items was sufficient to warrant computing each participant's mean rating, reflecting overall perception of heat-protection effectiveness (Cronbach's $\alpha = .85$).

2.2.3. Positive affect about heat

Participants rated their positive affect about hot weather, on six items, using a scale anchored at 1 (=strongly disagree) to 5 (=strongly agree). They considered (a) I love hot weather, (b) I want to get tanned, (c) I spend time in the sun when I can, (d) I am concerned about skin cancer (reverse coded), (e) A positive impact of climate change is that summers will get hotter, and (f) I go on holiday to seek out warm or hot weather. Reliability across the six items was sufficient to warrant the computation of each participant's mean rating, as reflecting overall positive affect about heat (Cronbach's $\alpha = .75$).

2.2.4. Trust in organizations

Participants rated how much they trusted the three agencies that collaborated on the Heat Wave Plan: (a) National Health Service, (b) Public Health England, and (c) the Met Office, on a scale from 1 (=completely distrust) to 5 (=completely trust). Reliability across the three items was sufficient to compute participants' average trust ratings (Cronbach's $\alpha = .81$).

Table 1
Linear regressions predicting ratings of effectiveness, affect, and trust.

	Descriptives	Perceived effectiveness		Positive affect about heat		Trust	
		B (SE)	β	B (SE)	β	B (SE)	β
Independent variable							
Having heard recommendations	55.1%	.09 (.04)	.08*	.12 (.05)	.09*	.33(.05)	.23***
Demographic variables							
Age	$M = 54.13$ $SD = 18.91$	.01 (.00)	.19***	−.01 (.00)	−.18***	−.00 (.00)	−.11**
Female	47.8%	.22 (.04)	.19***	−.02 (.05)	−.02	−.06 (.05)	−.04
Non-white	6.3%	−.19 (.09)	−.08*	−.19 (.11)	−.06	−.02 (11)	−.05
High income	40.7%	.04 (.04)	.04	.15 (.06)	.11**	.01 (.05)	.00
No university degree	56.3%	.04 (.04)	.04	.05 (.05)	.03	.06 (.05)	.04
Rating health as 'poor'	4.3%	.15 (.10)	.05	−.27 (.13)	−.08*	.17 (.13)	.05
Prone to adverse heat effects	50.2%	.10 (.04)	.09*	−.14 (.05)	−.10**	.06 (.05)	.05
Taking care of elderly	26.1%	−.03 (.05)	−.02	.05 (.06)	.03	.03 (.06)	.02
Taking care of child below age 5	8.7%	.00 (.08)	.00	−.03 (.10)	−.01	−.02 (.10)	−.01
Model Statistics	–	$R^2 = .10$ $F(10,690) = 7.23$***		$R^2 = .07$ $F(10,690) = 5.29$***		$R^2 = .08$ $F(10,690) = 6.04$***	

Note: ***$p < .001$; **$p < .01$; *$p < .05$. The unstandardized B-coefficient indicates by how many measurement units the predictor variable changes per unit of the predicted variable. The standardized β-coefficient indicates by how many standard deviations the outcome variable changes per standard deviation change of the predictor variable.

2.2.5. Reports of heat protection behaviors during the 2013 heatwave

Participants rated how often they engaged in the ten heat protection behaviors referred to in section 2.2.2 "during the heat wave of July 2013." They used a scale ranging from 1 (=never) to 5 (=always). Reliability across the ten items was sufficient to warrant computing each participant's mean rating of 2013 heat protection behavior (Cronbach's $\alpha = .81$).

2.2.6. Intentions for future heat protection behaviors

Participants rated how often they would engage in each of the ten heat protection behaviors referred to in section 2.2.2 "next summer during very hot days." Ratings could range from 1 (=never) to 5 (=always). Reliability was sufficient to warrant computing each participant's mean rating of intended future heat protection behavior (Cronbach's $\alpha = .75$).

2.2.7. Demographic variables

Participants reported their age, gender, ethnicity, highest level of education completed, yearly household income before tax, and whether they looked after young children or elderly dependents. To avoid small response categories, we dichotomized ethnicity, education, and income for our analyses (see Table 1). Table S1 of the Electronic Supplemental Materials shows a more detailed demographic breakdown.

Participants self-rated their health as 'excellent,' 'good,' 'fair,' or 'poor,' as in previous work (Lawton et al., 1982). They also received the question "In your life, have you experienced the following outcomes as a result of heat?" They then answered 'yes' or 'no' for thirteen health effects, including dehydration, heat stroke, headaches, dizziness, nausea or vomiting, confusion, aggression, convulsions, loss of consciousness, tiredness, sun burn, skin cancer, and missed work. Reliability across the thirteen items (Cronbach's $\alpha = .78$) was sufficient to warrant calculating each participant's percent of reported adverse health effects. Because the distribution was significantly different from normal (skew = .73, $SE = .09$; kurtosis = .65, $SE = .18$; $K–S = .113$, $p < .001$), we performed a dichotomizing median-split: Participants with above-median adverse experiences were classified as relatively more 'prone to adverse experiences.' We also assessed whether participants experienced these adverse outcomes (except skin cancer) during the heat wave of July 2013, and found that those who reported above-median (vs. below-median) adverse heat outcomes in the past were more likely to report above-median adverse heat outcomes in 2013 (87.1% vs. 12.9%, $\chi^2 = 123.03$, $p < .001$).

2.3. Statistical analyses

Using Chi-Square tests and logistic regression, we assessed the relationships of having heard heat protection recommendations with perceived effectiveness, positive affect about heat, trust, and demographic variables. Relationships with implementing protection behaviors during the heat wave of July 2013 were assessed using *t*-tests and linear regression models. We used linear regression because averaged responses across multiple ratings should be treated as interval rather than ordinal data (Norman, 2010; Havlicek and Peterson, 1976). We used the Preacher and Hayes (2008) bootstrapping procedure to test whether the relationship between having heard heat protection recommendations and having implemented heat protection behaviors was mediated by perceived effectiveness of heat protection behaviors, positive affect about heat, and trust. Finally, using *t*-tests and linear regression models, we assessed predictors of intended future heat protection behaviors. All analyses were performed in SPSS 21.

3. Results

3.1. Research question 1: who heard heat protection recommendations?

More than half of our sample (55.1%) reported having heard heat protection recommendations through at least one channel during the summer of 2013. Participants also indicated hearing heat protection recommendations through the Met Office (38.7%) the National Health Service (30.7%), and Public Health England (12.0%). Other common responses were TV (43.2%), Internet (27.4%), word of mouth (26.1%), radio (25.8%), doctor's practice or hospital (12.0%), and the Heatwave Plan (7.0%).

Reports of hearing heat protection recommendations were more common among participants who experienced more adverse heat effects, both in their lifetime and in 2013, and among those who took care of isolated, elderly, or ill individuals (all $p < .05$). A logistic regression including all demographic variables found that reporting adverse heat effects over one's lifetime was the only significant predictor of hearing heat protection recommendations ($OR = 1.42$; *95% CI* = 1.07, 2.06; $p < .01$).

3.2. Research question 2: was hearing heat protection recommendations associated with perceived effectiveness of behaviors, positive affect about heat, and trust in communicating organizations?

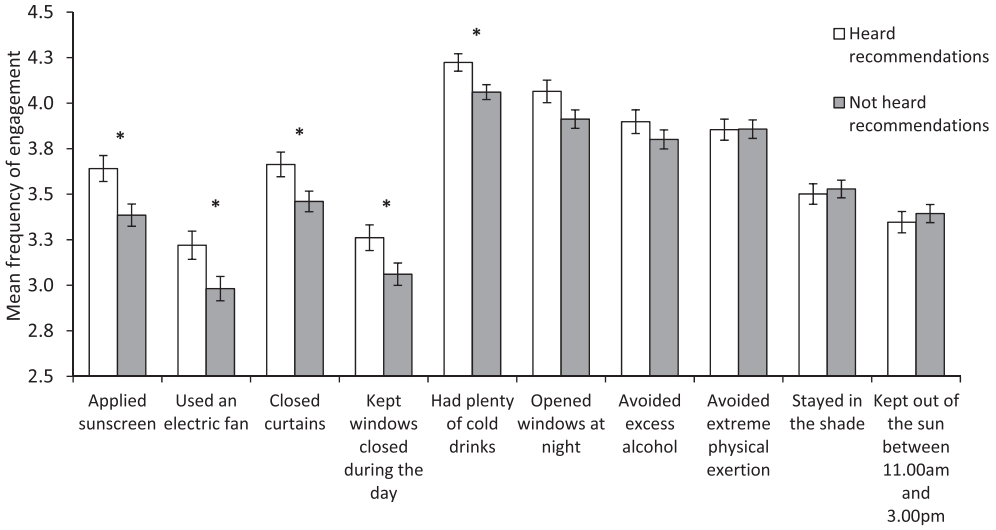
Participants who had heard heat protection recommendations rated heat protection recommendations as significantly more effective ($M = 4.03$, $SD = .57$ vs. $M = 3.94$, $SD = .56$; $t(699) = -2.19$ $p < .05$), reported significantly more positive affect about heat ($M = 3.10$, $SD = .70$ vs. $M = 2.95$, $SD = .71$; $t(699) = -2.70$ $p < .01$), and had greater trust in organizations making these recommendations ($M = 3.92$, $SD = .66$ vs. $M = 3.59$, $SD = .69$; $t(699) = -6.61$, $p < .001$).

Each of these three relationships held in linear regressions that included the demographic variables (see Table 1). In addition, there were significant associations with demographic variables in each model: First, perceived effectiveness of heat protection behaviors was significantly higher among participants who were older, female, white, and more prone to adverse heat effects. Second, positive affect about heat was significantly lower among participants who were older, reported lower income levels, rated their health as poor, and reported being more prone to adverse heat effects. Third, trust in organizations was lower among older participants.

3.3. Research question 3: was hearing heat protection recommendations related to reported heat protection behaviors during the 2013 heatwave – and, if so, what was the role of perceived effectiveness, positive affect about heat, and trust?

Participants who reported hearing heat protection recommendations indicated having implemented protection behaviors more often during the July 2013 UK heat wave, as reflected in higher average frequency ratings across the ten behaviors ($M = 3.61$, $SD = .64$ vs. $M = 3.44$, $SD = .68$; $t(699) = 3.37$, $p = .001$). As seen in Fig. 1, significant relationships also emerged for five of the ten individual behaviors: applying sun-screen, using an electric fan, closing curtains during the day, keeping windows exposed to the sun closed during the day, and having plenty of cold drinks.

As seen in Table 2 (Model 1), having heard heat protection recommendations was associated with more frequent implementation of heat protection behaviors, even when including the demographic variables. Significant independent contributions emerged for being older, female, and prone to adverse heat effects.



Note. Error bars represent Standard Error of the Mean, * indicates $p < .05$)

Fig. 1. Mean past heat protection implementation split by whether or not participants had heard protection recommendations.

Adding perceived effectiveness of the heat protection behaviors and positive affect about heat increased the predictive ability of the model (Table 2, Model 2).

Auxiliary analyses examined whether the relationship between hearing heat protection recommendations and implementing behaviors may vary between demographic groups. We found one significant interaction ($p = .01$) such that younger participants who heard recommendations implemented heat protection behaviors more frequently (see Table S2 of the electronic supplemental materials).

A multi-mediation analysis that included demographic variables listed in Table 1 (including being prone to adverse health effects), found that the relationship between having heard heat protection recommendations and having implemented heat protection behaviors was mediated by perceived effectiveness of the heat protection behaviors (95% CI = .003, .11), and suppressed by positive affect about heat (95% CI = −.06, −.01), with no independent mediation role for trust (95% CI = −.02, .02). Fig. 2 shows the significant steps of the multi-mediation analysis, including that (a) having heard heat protection recommendations was associated with stronger perceptions of the behaviors' effectiveness as well as more positive affect about heat; (b) perceptions of the behaviors' effectiveness were positively associated with implementing the heat protection behaviors, whereas positive affect about heat was negatively associated with implementing them; (c) the positive association between having heard heat protection recommendations and implementing heat protection behaviors was reduced after taking into account perceived effectiveness of behaviors and positive affect about heat. Of the demographic variables in this model, only being female ($p < .01$) and being prone to adverse health effects ($p < .05$) had significant additional effects, although excluding these variables did not affect overall conclusions. In addition, we found that this multi-mediation model was significant for each protection behavior.

3.4. Research question 4: was hearing recommendations, perceiving effectiveness, having positive affect about heat, and reporting trust related to intentions to implement heat protection behaviors in the future?

Participants who had heard heat protection recommendations reported stronger intentions for implementing heat protection behaviors in the future than those who had not ($M = 3.61$, $SD = .58$ vs. $M = 3.50$, $SD = .56$; $t(699) = 2.41$, $p = .02$). Significant differences emerged for two specific behaviors: applying sun screen ($M = 3.66$, $SD = 1.13$ vs. $M = 3.45$, SD = 1.15; $t(691) = 2.37$, $p < .02$) and using electric fans ($M = 3.32$, $SD = 1.17$ vs. $M = 3.06$, $SD = 1.29$; $t(694) = 2.75$, $p < .01$).

Table 3 shows that having heard heat protection recommendations was no longer related to future intentions after accounting for the demographic variables, with significant relationships for age, being female, being in poor health, and having experienced more adverse heat effects (Model 1). Model 2 improved predictions of future intentions, by including their positive relationship with perceived effectiveness and their negative relationship with positive affect about heat (Model 2), even after controlling for past behavior (Model 3).

4. Discussion

Public health concerns are expected to become more serious as heat waves increase in frequency, intensity and duration over future decades (IPCC, 2013). Policy makers therefore recognize the importance of promoting heat protection behaviors (Kovats and Hajat, 2008). In a UK sample, we examined the role of having heard heat protection messages, perceived effectiveness of recommended behaviors, trust in communicating organizations, and positive affect about heat, in reported behaviors during the July 2013 UK heat wave and intentions for future behavior. Below, we discuss findings associated with our four main research questions.

Our first research question focused on who heard heat protection recommendations during the 2013 heatwave in the UK. We found that more than half of our participants had heard recommendations about how to protect themselves during the July 2013 heath wave. Having heard recommendations was more likely among those who indicated being in poor health, having experienced more adverse heat effects, and taking care of the elderly. However, age was not a predictor of having heard heat protection messages, even though older people are intended targets because they are at greater risk for adverse heat effects (Abrahamson et al., 2009; Wolf et al., 2010).

Our subsequent two research questions examined psychological mechanisms that may affect people's behavior in response to

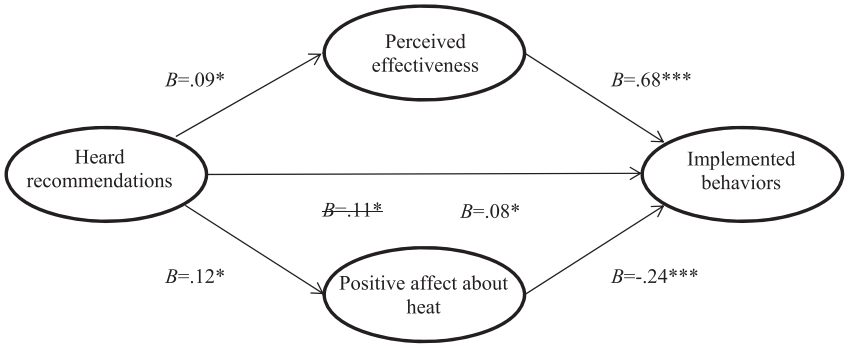
Table 2
Linear regressions predicting frequency of heat protection behaviors during the 2013 heatwave.

	Model 1		Model 2	
	B (SE)	β	B (SE)	β
Independent variables				
Having heard recommendations	.11 (.05)	.08*	.08 (.04)	.06*
Perceived effectiveness	–	–	.68 (.04)	.58***
Positive affect about heat	–	–	−.24 (.03)	−.26***
Trust in organizations	–	–	.01 (.03)	.01
Demographic variables				
Age	.01 (.00)	.16***	.00 (.00)	.01
Female	.27 (.05)	.20***	.11 (.04)	.08**
Non-white	−.17 (.10)	−.06	−.09 (.08)	−.03
High income	−.02 (.05)	−.02	−.01 (.04)	−.01
No university degree	.06 (.05)	.05	.04 (.04)	.03
Rating health as 'poor'	.24 (.12)	.07	.07 (.09)	.02
Prone to adverse heat effects	.19 (.05)	.14***	.08 (.04)	.06*
Taking care of elderly	.02 (.06)	.02	.06 (.04)	.04
Taking care of child below age 5	.03 (.09)	.01	.02 (.07)	.01
Model statistics	$R^2 = .10$		$R^2 = .51$	
	$F(10,690) = 7.70$***		$F(13,687) = 54.44$***	

Note: ***p < .001; **p < .01; *p < .05. The unstandardized *B*-coefficient indicates by how many measurement units the predictor variable changes per unit of the predicted variable. The standardized *β*-coefficient indicates by how many standard deviations the outcome variable changes per standard deviation change of the predictor variable. R^2 change from Model 1 to Model 2 is significant, $F(3,722) = 199.00$, $p < .001$.

recommended behaviors seem more effective. The mediation results also suggest that the impact of heat protection messages on reported behaviors was undermined by evoking positive affect about heat, consistent with the affect heuristic.

Thus, our findings suggest that warnings about impending heat may inadvertently make UK residents feel good, because they tend to have positive memories of hot summers (Fuller and Bulkeley, 2012; Wolf et al., 2010; Bränström et al., 2001). This is in line with the affect heuristic, which posits that potentially risky experiences automatically trigger positive (or negative) emotions, which are then used as cues to become relatively unconcerned (or concerned) about risk protection (Slovic et al., 2004; Finucane et al., 2000). While it may be rare for potential risks to evoke positive feelings, those that do (such as wood-burning fire places and sunbathing) tend to be perceived as requiring less risk protection (Hine et al., 2007b). The hot weather of 2013 may have especially triggered positive affect among UK residents because of the cool and wet summers in preceding years (2007–2012) (Met Office, 2014). If positive feelings about heat are used as cues to reduce the perceived need for heat protection behaviors, then messages may be more effective if they are designed to evoke less positive or more negative feelings about heat (Havlicek and Peterson, 1976; Finucane et al., 2000). One possibility for achieving such messages might be to remind people of any negative feelings they experienced when they felt uncomfortably hot in the past (Fischhoff et al., 2005).



Note: Perceived effectiveness and positive affect about heat significantly changed the relationship between having heard recommendations and having implemented behaviors, in a multi-mediation model accounting for trust and demographic variables ($p<.05$).

Fig. 2. Multi-mediation analysis.

heat protection messages. In regards to our second research question, we found that having heard heat protection recommendations was associated with perceiving the recommended behaviors as more effective, feeling more positive about heat, and having greater trust in the organizations behind the Heatwave Plan. More importantly, findings associated with our third research question suggest that hearing recommendations increased the likelihood of implementing heat protection behaviors. A subsequent multi-mediation analysis pertaining to our third research question found that the relationship between hearing heat protection messages and implementing the recommended behaviors was explained by perceiving the behaviors as more effective. However, positive affect about heat suppressed the relationship. The mediation results suggest that heat protection messages may have successfully promoted heat protection behavior during the 2013 UK heatwave, by making the

Finally, our fourth research question examined predictors of intentions for heat protection during future hot summers. Patterns were similar as seen for reported behaviors during the 2013 heatwave, such that reported intentions about future heat protection behaviors were similarly related to perceptions of their effectiveness and feelings about heat. Individual differences in trust seemed to play a minor role in promoting heat protection behaviors, perhaps because trust in the National Health Service, Public Health England, and the Met Office is generally sufficient.

One limitation to these results is that all analyses are correlational, limiting causal inferences. Although our mediation analysis supported a model motivated by theories of risk perception and communication (Fig. 2), alternative relationships are feasible. For example, people who feel positive about heat may have paid greater attention to heat warnings, or people who protect themselves more may have developed more positive feelings about heat due to their

Table 3
Linear regressions predicting intentions for future heat protection behaviors.

	Model 1		Model 2		Model 3	
	B (SE)	β	B (SE)	β	B (SE)	β
Independent variables						
Having heard recommendations	.05(.04)	.05	.03(.03)	.03	−.01 (.03)	−.01
Perceived effectiveness	–	–	.49(.03)	.47***	.10 (.03)	.10**
Positive affect about heat	–	–	−.30(.02)	−.37***	−.17 (.02)	−.20***
Trust in organizations	–	–	.04 (.03)	.05	.04 (.02)	.04
Behaviors during 2013 heatwave	–	–	–	–	.56 (.03)	.64***
Demographic variables						
Age	.01(.00)	.20***	.00(.00)	.05	.00 (.00)	.04
Female	.23(.04)	.19***	.12(.03)	.10**	.05 (.03)	.05*
Non-white	−.06 (.09)	−.03	−.02 (.07)	−.01	.03 (.05)	.01
No university degree	.04(.04)	.03	.03(.03)	.03	.01 (.03)	.01
High income	−.05 (.05)	−.04	−.02 (.03)	−.02	−.01 (.03)	−.01
Rating health as 'poor'	.23(.11)	.08*	.07(.08)	.02	.03 (.06)	.01
Prone to adverse heat effects	.20(.04)	.17***	.10(.03)	.09**	.06 (.03)	.05*
Taking care of elderly	.09(.05)	.07	.12(.04)	.09**	.09 (.03)	.07**
Taking care of child below age 5	.07(.08)	.04	.06(.06)	.03	.05 (.05)	.03
Model statistics	$R^2 = .12$ $F(10,690) = 8.94^{***}$		$R^2 = .50$ $F(13, 687) = 53.68^{***}$		$R^2 = .71$ $F(14, 686) = 117.89^{***}$	

Note: ***p < .001; **p < .01; *p < .05. The unstandardized *B*-coefficient indicates by how many measurement units the predictor variable changes per unit of the predicted variable. The standardized β-coefficient indicates by how many standard deviations the outcome variable changes per standard deviation change of the predictor variable. R^2 change from Model 1 to Model 2 is significant, $F(3,687) = 179.68$, $p < .001$; R^2 change from Model 2 to Model 3 is significant, $F(1,686) = 473.122$, $p < .001$.

safe enjoyment of hot weather. Experiments with random assignment to hearing (vs. not hearing) heat protection messages could inform these questions. A second limitation is relying on retrospective self-reports, in which people may misremember or misreport their summer feelings and behaviors. Third, our online sample may have underrepresented people vulnerable to heat due to poor health, even though we intentionally oversampled older adults. Finally, while the July 2013 heatwave was relatively long, maximum temperatures were not as high as in the 2006 heat wave. It is possible that heat protection warnings would evoke stronger negative affect and increased willingness to implement of heat protection behaviors during more severe heatwaves.

Within these constraints, our findings suggest that once heat protection messages reach their intended audiences, they convey the effectiveness of the recommended behaviors. However, these communications might have greater impact if they also induced unpleasant feeling about heat – before it actually has unpleasant effects.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2015.01.029.

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