Protection Motivation Theory and intention to reduce fossil fuel consumption in response to
climate change

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Abstract

Climate change represents a significant threat to society and the ecosystem at large, but many do not respond to this threat. This study investigates whether constructs within Protection Motivation Theory (PMT) explain individuals' intention to reduce their fossil fuel consumption. US residents (N=541) completed a cross-sectional survey of intention to reduce fossil fuel consumption and PMT constructs. Correlational results were consistent with the PMT; threat appraisal and coping efficacy constructs were correlated with intention to change behaviour. In a regression model, all constructs accounted for unique variance in intention to reduce fossil fuel usage. However, maladaptive response rewards had an unexpected positive relationship with intention in this model. Interestingly, this was not observed in structure coefficients. PMT constructs accounted for 59% of intention to reduce fossil fuel use. These findings support the unique contributions of the PMT constructs in the context of individual pro-environmental behaviours and highlight potential targets for interventions.

Keywords: Protection Motivation Theory, Climate change, Environmental psychology

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1. Introduction

Fossil fuels are the main contributor to global energy production (International Energy Agency, 2017), yet their continued use is unsustainable (The Intergovernmental Panel on Climate Change, 2018). Reserves for oil, gas and coal are estimated to be depleted between 2042 and 2112 (Shafiee & Topal, 2009) and their use for energy production accounts for 58% of carbon dioxide emissions globally (International Energy Agency, 2017). It is essential to decarbonise electricity generation by 2050 in order to mitigate climate change (The Intergovernmental Panel on Climate Change, 2018). Individual actions can contribute to a rapid reduction in CO₂ emissions (Dietz, Gardner, Gilligan, Stern, & Vandenberg, 2009). However, despite the availability of low-carbon and renewable energy sources, transition away from fossil fuels remains sub-optimal (International Energy Agency, 2017). Understanding factors that motivate reduction of fossil fuel use may inform interventions to increase this behaviour and contribute to the minimisation of harm (Clayton et al., 2015). Existing theories of persuasive communication provide one avenue to identifying these targets (Cismaru, Cismaru, Ono, & Nelson, 2011).

1.1 Protection Motivation Theory

A number of theories have been identified as relevant to pro-environmental behaviours (Nisbet & Glick, 2008; Pronello & Gaborieau, 2018). One such theory is Protection Motivation Theory (PMT), which seeks to explain how fear-appeals induce behaviour change (Rogers, 1975), and has been applied to health threats, cyber security (Ifinedo, 2012; Woon, Tan, & Low, 2005), natural hazards (Mulilis & Lippa, 1990) and climate change (Cismaru et al., 2011; Rainear & Christensen, 2017).

The theory postulates that engagement in adaptive (i.e. protective behaviour) or maladaptive responses (i.e. avoidance of or failure to engage in the protective behaviour) in response to a threat event, is determined by two parallel cognitive processes - threat appraisal and coping appraisal (Norman, Boer, Seydel, & Mullan, 2015; Prentice-Dunn & Rogers, 1986; Rogers, 1975). Threat appraisal is determined by perceptions of seriousness of the threat (severity); likelihood of personal exposure to the threat (susceptibility); and benefits of engaging in the maladaptive response (maladaptive response rewards; Prentice-Dunn & Rogers, 1986; Norman et al., 2015). When severity and susceptibility are high and maladaptive response rewards are low, the overall threat appraisal is high. Coping appraisal is determined by perceptions of the effectiveness of the adaptive response in averting the threat (response efficacy); personal capability to perform the protective behaviour (self-efficacy); and costs that might arise from adopting the protective behaviour (response costs; Norman et al., 2015). High response efficacy and self-efficacy and low response costs result in high coping appraisal. These processes determine intention to adopt a protective behaviour; specifically, intention to engage in protective behaviour increases when both threat and coping appraisals are high (Maddux & Rogers, 1983; Norman et al., 2015; Prentice-Dunn & Rogers, 1986; Rogers, 1975).

A recent review of the PMT in the context of pro-environmental behaviours (Kothe et al., 2019) found evidence for a relationship between each PMT construct and intention from at least one study, however there was heterogeneity dependent on the type of behaviour and the population. The review identified a need to test the entire PMT model in pro-environmental behaviours in order to provide evidence for the use of this theory within environmental and conservation psychology (Kothe et al., 2019). As such, this study applied PMT to the prediction of intention to reduce fossil fuel consumption.

1.2 Hypotheses

We hypothesised that individual’s intention to reduce fossil fuel usage would be positively associated with severity, susceptibility, self-efficacy and response efficacy and negatively associated to maladaptive response rewards and response costs.

2. Materials and Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

2.1 Participants

The sample described in this paper represents the control group of a larger experimental study. Participants were recruited to a “study investigating people’s responses to messages about scientific issues” via Amazon MTurk in exchange for \$1.10USD. In order to be eligible, participants needed to be 18 years or older and US residents. No worker qualifications or prescreens were applied via Amazon MTurk. Sample size was determined *a priori* as part of the larger study, the preregistration of that study can be found at: <http://osf.io/2trbk>. After removal of duplicate and incomplete submissions¹, 541 participants were included.

The demographic characteristics of the sample are shown in Table 1.

Table 1

Demographic characteristics of participants

¹ Complete removal of data from participants with duplicate submissions was required in order to avoid contamination between conditions. Removal of incomplete submissions was required because submission of the completed survey indicated consent

	Overall
n	541
Age in years (mean (sd))	35.81 (11.25)
Highest level of education (%)	
Associate's degree	76 (14.0)
Bachelor's degree	223 (41.2)
Doctorate	9 (1.7)
High school diploma or GED	47 (8.7)
Less than high school	1 (0.2)
Professional or Masters degree	67 (12.4)
Some college	118 (21.8)
Gender = Male (%)	263 (48.7)
Annual household income (%)	
\$10,000 - \$19,999	35 (6.5)
\$100,000 - \$149,999	50 (9.2)
\$20,000 - \$29,999	58 (10.7)
\$30,000 - \$39,999	73 (13.5)
\$40,000 - \$49,999	72 (13.3)
\$50,000 - \$59,999	49 (9.1)
\$60,000 - \$69,999	51 (9.4)
\$70,000 - \$79,999	47 (8.7)
\$80,000 - \$89,999	32 (5.9)
\$90,000 - \$99,999	24 (4.4)
Less than \$10,000	23 (4.3)
More than \$150,000	18 (3.3)
Prefer not to say	9 (1.7)

Ideology - General (mean (sd))	4.42 (2.98)
Ideology - Economic (mean (sd))	4.87 (2.99)
Ideology - Social (mean (sd))	4.04 (3.12)

2.2 Procedure

All participants completed an online questionnaire. The first component included measures of demographic variables, then participants proceeded directly to the PMT questionnaire (n.b. some participants in the larger study received an experimental manipulation before completing the questionnaire; data from those participants is not reported here). The order of items within the PMT questionnaire was randomised to reduce order effects. At the conclusion of the study, participants were invited to provide feedback on the survey via a free-text response box. The questionnaire did not include any attention checks.

2.3 Measures

2.3.1 Demographics. Participants completed demographic items at the beginning of the study. This included items regarding age, gender, highest level of education completed, annual household income, and political ideology. Political ideology was measured with reference to “politics in general”, “economic issues” and “social issues” using three 0-10 point scales (0 = “Very Liberal”: 10 = “Very Conservative”), and the stem “When it comes to ... would you consider yourself”.

2.3.2 Intention. Intention was measured as the mean of three items (1= Strongly Disagree, 5 = Strongly Agree) regarding the referent behaviour “reduce my use of fossil fuels

from now on” (e.g. “I intend to reduce my use of fossil fuels from now on”). Higher scores indicate greater intention to reduce use of fossil fuels ($\alpha = 0.94$).

2.3.3 Maladaptive Response Rewards. Participants rated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items indicating benefits of climate change occurring (e.g. “The climate changing would have some advantages for me”). Items were averaged to create a composite score. Higher scores indicate greater maladaptive response rewards ($\alpha = 0.49$).

2.3.4 Severity. Participants rated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items regarding the severity of negative impacts of climate change (e.g. “The negative impact of climate change will be very severe”). Items were averaged to create a composite score. Higher scores indicate greater perceived severity of climate change ($\alpha = 0.84$).

2.3.5 Susceptibility. Participants rated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items indicating that they are vulnerable to the negative impacts of climate change (e.g. “Climate change will have serious consequences for someone like me”). Items were averaged to create a composite score. Higher scores indicate greater perceived susceptibility to negative impacts of climate change ($\alpha = 0.84$).

2.3.6 Response Efficacy. Participants rated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items that indicated that reducing their use of fossil fuels would be effective in reducing climate change (e.g. “If I reduce my use of fossil fuels it will have a meaningful impact on the consequences of climate change”). Items were averaged to create a composite score. Higher scores indicate greater perceived response efficacy ($\alpha = 0.82$).

2.3.7 Response Costs. Participants rated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items that indicated that there are costs

(including non-financial costs) associated with reducing fossil fuel use (e.g. “Reducing my use of fossil fuels is expensive”). Items were averaged to create a composite score. Higher scores indicate greater perceived response costs ($\alpha = 0.74$).

2.3.8 Self-Efficacy. Participants rated their agreement (from 1 = Strongly Disagree to 5 = Strongly Agree) with three items regarding their capacity to reduce their use of fossil fuels (e.g. “Reducing my use of fossil fuels would be difficult for me”). Items were averaged to create a composite score after reverse scoring. Higher scores indicate greater self-efficacy ($\alpha = 0.70$).

2.4 Data analysis

We used R (Version 3.5.1; R Core Team, 2018) and the R-packages *bindrcpp* (Version 0.2.2; Müller, 2018), *broom* (Version 0.5.1; Robinson & Hayes, 2018), *dplyr* (Version 0.8.3; Wickham, François, Henry, & Müller, 2018), *here* (Version 0.1; Müller, 2017), *knitr* (Version 1.24; Xie, 2015), *labelled* (Version 1.1.0; Larmarange, 2018), *papaja* (Version 0.1.0.9842; Aust & Barth, 2018), *readr* (Version 1.3.1; Wickham, Hester, & Francois, 2017), and *tableone* (Version 0.9.3; Yoshida & Bohn., 2018) for all analyses.

3. Results

3.1 Descriptive statistics

Pearson’s product-moment correlations were calculated to assess the relationships between PMT constructs. As shown in Table 2, all constructs demonstrated significant bivariate correlations in expected directions.

Table 2

Correlations between PMT variables

Variable	M	SD	1	2	3	4	5	6
1. Intention	3.41	1.06						
2. Maladaptive response rewards	2.55	0.85	-.15**					
3. Severity	3.88	1.01	.58**	-.35**				
4. Susceptibility	3.72	1.04	.54**	-.43**	.82**			
5. Response Efficacy	3.31	1.03	.58**	-.06	.52**	.46**		
6. Response Costs	3.26	0.94	-.44**	.28**	-.21**	-.23**	-.29**	
7. Self-Efficacy	3.05	0.90	.59**	-.11*	.29**	.24**	.40**	-.64**

Note. * $p < .05$, ** $p < .001$

Table 3

Linear regression of intention to reduce fossil fuel use on PMT constructs.

Predictor	β	b	95% CI	Structure coefficients	$t(531)$	p
Intercept	0.00	-0.15	[-0.71, 0.40]	NA	-0.55	.585
Maladaptive Response Rewards	0.08	0.10	[0.02, 0.18]	-0.20	2.43	.015
Severity	0.20	0.21	[0.11, 0.32]	0.75	3.96	< .001
Susceptibility	0.20	0.21	[0.10, 0.31]	0.70	3.96	< .001
Response Efficacy	0.23	0.23	[0.16, 0.31]	0.76	6.49	< .001
Response Costs	-0.08	-0.09	[-0.18, -0.01]	-0.57	-2.17	.030
Self Efficacy	0.35	0.41	[0.32, 0.50]	0.77	8.93	< .001

Note. $R^2 = .59$, 90% CI [0.54, 0.63], $F(6, 531) = 125.98$, $p < .001$

3.2 Regression analysis

Multiple linear regression was conducted to examine the relationship between intention and PMT variables in combination. The overall model was significant ($R^2 = .59$, 90% CI [0.54, 0.63], $F(6, 531) = 125.98$, $p < .001$), and all PMT constructs were unique predictors of intention (Table 3). However, maladaptive response rewards had a positive association with intention to reduce fossil fuel usage after accounting for other PMT constructs. In order to ensure that the results were robust after controlling for demographic characteristics, a regression model with demographic measures (age, gender, education, household income, & ideology (general) included was also conducted. The pattern of results was unchanged (see Supplementary Materials).

4. Discussion

This study examined whether PMT constructs predict intention to reduce fossil fuel consumption. Correlational findings provided support for the hypotheses derived from the theory. Multiple regression analysis demonstrated that PMT constructs account for a large proportion of the variance in intention to reduce fossil fuel consumption and that all PMT constructs were unique predictors of intention. The findings build on the small body of prior research that has used constructs from the PMT to investigate uptake of different pro-environmental behaviours.

Consistent with previous studies of pro-environmental behaviours, susceptibility and severity were unique predictors of intention. However, while maladaptive response rewards was negatively correlated with intention at the bivariate level, an unexpected positive relationship was found within the regression analysis. This is in contrast with the relationships proposed by PMT (Prentice-Dunn & Rogers, 1986) and to the only previous applications of the model in the pro-environmental literature to include maladaptive

response rewards as a variable, which have all reported negative or null relationships (Almarshad, 2017; Bockarjova & Steg, 2014; Ibrahim & Al-Ajlouni, 2018).

One explanation of the unexpected positive relationship between maladaptive response rewards and intention is that this is caused by collinearity between the PMT constructs (see Pedhazur, 1982, p. 246). Indeed, some previous studies have chosen to exclude maladaptive response rewards on the basis of conceptual overlap with other theoretical constructs (e.g. Raine et al., 2017). However, exclusion of predictors is not the optimal approach to handling collinearity when all predictors are theoretically meaningful (see: Kraha, Turner, Nimon, Zientek, & Henson, 2012). Instead, structure coefficients can estimate relationship between a single predictor (i.e. maladaptive response rewards) and the $\hat{y}_{\text{intention}}$ value estimated on the basis of all predictors (Kraha et al., 2012; Zeglari, 2017). Structure coefficients indicate that the relationship between maladaptive response rewards and $\hat{y}_{\text{intention}}$ is negative ($r_s = -0.20$) and relatively small (Table 3). Given inconsistencies between different indicators of the maladaptive response reward-intention relationship, it is difficult to draw strong inferences on the basis of this finding. However, this pattern of results and the differences between these findings and the few previous studies that have used maladaptive response rewards to predict intention would support further consideration of this construct within the PMT literature.

Consistent with previous studies of pro-environmental behaviours, all coping appraisal constructs were significant predictors of intention at both bivariate and multivariate level. As expected, the relationship between intention and both self-efficacy and response efficacy was positive, whereas the relationship between response costs and intention was negative.

Self-efficacy was the strongest predictor of intention, however given the cross-sectional design it does not necessarily follow that interventions targeting self-efficacy would be more effective than interventions that target other constructs. Unfortunately, there is limited evidence that examines whether interventions that target PMT constructs can be effective in

increasing intention to engage in pro-environmental behaviours on which to evaluate such conclusions. To date, no studies have evaluated the impact of changes in self-efficacy, response cost, or maladaptive response costs on change in intention or behaviour using the PMT as a framework (Kothe et al., 2019). Only one study has experimentally manipulated response efficacy and measured corresponding change in intention (Kothe et al., 2019), and found no impact on intention to conserve water in response to drought (Kantola, Syme, & Nesdale, 1983). Experimental studies have shown that experimentally manipulating severity and susceptibility can lead to corresponding increases in intention to engage in pro-environmental behaviours (Chen, 2016; Huth, McEvoy, Morgan, & others, 2018). As outlined elsewhere (e.g. Kothe et al., 2019), experimental studies that test the causal pathways posited by the theory and supported by the associations reported here, are required in order to underpin principled theory-based intervention design.

Due to practical constraints it was not possible in the current study to gather data on engagement in reduction of fossil fuel consumption. However, previous research has found that intention significantly predicts engagement in pro-environmental behaviours (Kothe et al., 2019). Furthermore, while intentions and behaviour are not perfectly correlated, there is a reliable and strong association between them across a wide range of contexts (Webb & Sheeran, 2006). The PMT suggests that intention fully mediates the relationships between PMT constructs and behaviour. Therefore, even if behaviour had been measured, testing this part of the model would entail testing the intention-behaviour relationship rather than the relationships between other PMT constructs and behaviour. As this relationship has been established in other studies, the results still provide important insights into the pre-intentional components of PMT.

5. Conclusion

On average, individuals intentions to engage in fossil fuel reducing behaviours are highest when they perceive the risks of climate change to be high and also believe that they have the capacity to cope with this threat. Overall, the findings provide support for the development of interventions to engender behaviour change in fossil fuel consumption. As has been argued elsewhere (Raine & Christensen, 2017), the current body of predictive work applying the PMT in this context suggests that persuasive messages that seek to promote engagement in pro-environmental behaviours should focus not only on increasing the perceived risks associated with climate change, but also on increasing individuals' perceptions that they are capable of performing behaviours effective in ameliorating those risks. While the results of this study are not entirely consistent with PMT, they do highlight the importance of including all six constructs within studies to characterise the beliefs that are important in influencing intention. Future studies should test for causal relationships between these constructs and intention through experimental manipulation of PMT constructs.

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