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Determinants of Domestic Risk Prevention Behavior: The Importance of Separating Effects Within-Persons and Between-Persons

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The effects of vulnerability, severity, costs, effort, and effectiveness on prevention behavior, derived from protection motivation theory and the health belief model, have been extensively tested in the literature and have all been shown to predict rather well. In this study we test the effects of these determinants in a new context: the domestic risk prevention domain. The specific behaviors under study are related to the risks of burglary, fire, and water damage. In addition to previous studies, our multilevel research design allows us to evaluate which differences in the performance of domestic prevention behavior can be attributed to differences between persons and which to differences between behaviors within persons. Our results show that all determinants are relevant predictors for domestic risk prevention behavior. Disentangling the within-person and between-person effects shows that prevention behavior depends more on the relative evaluation of the prevention behavior determinants for a given person (e.g., a person perceives a smoke alarm to be more effective than antiburglar strips), than on the differences between persons regarding the general perception of these determinants (e.g., some persons find prevention behaviors in general more effective than other persons). To increase the performance of domestic risk prevention behaviors, we advise that interventions should focus on increasing a person's perception of risks and prevention behaviors relative to other risks and prevention behaviors rather than focusing on changing people's general perceptions of all risks and behaviors or focusing on specific target groups.

KEY WORDS: Domestic risk prevention behavior; health belief model (HBM); multilevel regression analysis; protection motivation theory (PMT); risk perception

1. INTRODUCTION

People are susceptible to various risks that can bring damage to their homes, the content of their homes, and themselves. The consequences of risks such as fire damage, water damage, and burglary can be covered by insurance policies, although not always completely. Taking measures to prevent a risk or mitigate the consequences of a risk is preferred over the more passive approach of repairing and claiming the damage after the fact, as it can save people a lot of hassle, money, and emotional loss. Even in a country such as the Netherlands, where 98.3% of the households have a home and/or contents insurance, there is still a lot to gain in terms of the number and quality of prevention measures that people could take to

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protect their homes (CBS, 2016; Janssen, Van Den Berg, & Tieben, 2009).

Two frequently applied theories consider how people deal with risks and risk prevention are the protection motivation theory (PMT; Rogers, 1975) and the health belief model (HBM; Rosenstock, 1966). The basic idea behind PMT and HBM is that the perceived likelihood of a risk and its perceived consequences create a motivation for self-protection, and a (perhaps implicit) cost-benefit analysis that results in taking action or not. The determinants[1] derived from PMT and HBM, vulnerability, severity, costs, effort, and effectiveness, have been extensively tested in various areas of prevention behavior research. Most studies consider the health domain but other domains such as environmental risk and traffic safety have also been studied (Bamberg, Masson, Brewitt, & Nemetschek, 2017; Bubeck, Botzen, & Aerts, 2012; Floyd, Prentice-Dunn, & Rogers, 2000; Janz & Becker, 1984; Milne, Sheeran, & Orbell, 2000). The general conclusion in the literature is that these hypothesized determinants are indeed relevant predictors for prevention behavior albeit with varying degrees of importance (Bamberg et al., 2017; Floyd et al., 2000; Janz, Nancy. K., Becker, 1984). In this article we test whether these determinants are relevant predictors in the domestic risk prevention domain.

In addition, the more important contribution of this article is a methodological one: we want to address the importance of separating between-person and within-person effects when testing the effects of prevention behavior determinants. Suppose that one finds that the perceived effectiveness of a behavior correlates with the probability that someone indeed performs this behavior, as several researchers have found (Floyd et al., 2000; Janz, Nancy. K., Becker, 1984; Milne et al., 2000). This could mean that, on the one hand, persons who find prevention behaviors in general more effective than other persons are more likely to perform prevention behaviors, a "between-persons" effect. On the other hand, it could mean that for a given person, prevention behaviors that are perceived as more effective than other behaviors are more likely to be performed, an effect "between behaviors within-persons." Although these two interpretations are not the same, the literature on PMT and HBM does not make this distinction explicit. In fact, most studies do not clearly state which interpretation is more appropriate, although the (mostly implicit) general argument made seems to be on the within-person level. If, say, the perceived effectiveness of a prevention behavior would become higher for a given person and everything else remained equal, then that person would be more likely to perform that behavior. Although the general argument is on the within-person level, correlational studies perform analyses solely between-persons, perhaps mistakenly thinking this allows testing a within-person effect (Chatterjee & Mozumder, 2014; Jayanti & Burns, 1998; Lindell, Arlikatti, & Prater, 2009; Martin, Bender, & Raish, 2007; Zaalberg, Midden, Meijnders, & McCalley, 2009). This is a common problem in psychology, and also addressed as such by several scholars (Collins, 2006; Curran & Bauer, 2011; Fogg, 2003; Molenaar, 2004; Mroczek, Spiro, & Almeida, 2003).

Whether the effects are primarily within or between persons has important implications for initiatives directed at influencing prevention behavior. When effects are mainly between persons and hence depend on personal characteristics (e.g., on a person's general perception of the effectiveness of prevention behaviors, sociodemographics, etc.), it would make sense to direct general prevention initiatives at specific target groups with the appropriate characteristics, or to try to influence people's general perception of all risks and behaviors. However, when effects are mainly between behaviors within persons, it would make more sense to focus on a general audience and try to influence their perception of the characteristics of specific risks and behaviors (relative to other risks and behaviors). This is typically the way both theories are interpreted, and hence, how behavior change attempts are designed (see, for instance, Cismaru & Lavack, 2007). We discuss this subtle but crucial issue in more detail in Section 2.

This study contributes to the existing literature in several ways. First, we apply and test arguments as put forward in PMT and the HBM in a context in which they have not been tested before: the domestic risk prevention domain. That is, we consider which of the determinants—vulnerability, severity, costs, effort, effectiveness, and awareness—determine domestic risk prevention behavior, and to what extent. Second, and most important, our research design allows us to evaluate which differences in the performance of domestic prevention can be attributed to differences between persons or to differences between behaviors within persons. This gives a more thorough understanding of the prevention behavior

[1] Other labels for the term determinants in the literature are components, (explanatory) factors, variables, and antecedents.

decision making process and has direct implications for the choice of possible interventions. Third, we test the robustness of our findings by considering whether the determinants that drive prevention behavior differ across persons and types of behaviors. We discuss our findings and conclude with implications for policymakers and others interested in motivating people to increase their (domestic) risk prevention behavior.

2. THEORY AND HYPOTHESES

Both PMT (Rogers, 1975) and HBM (Rosenstock, 1966) provide a framework to explain why individuals do or do not engage in actions to prevent or mitigate the consequences of risks. While PMT was originally developed for the explanation of fear appeals, it has later been revised into a more general theory for prevention behavior (Rogers, 1983). Both PMT and HBM originate from applications in the health domain, for example to explain smoking behavior (Maddux & Rogers, 1983; Mantler, 2013), HIV prevention (Bengel, Belz-Merk, & Farin, 1996; Rosenstock, Strecher, & Becker, 1994), and breast cancer prevention (Wiegman, Taal, van den Bogaard, & Gutteling, 1992; Yarbrough & Braden, 2001), and have later been applied to other areas of risk, such as earthquakes (Mulilis & Lippa, 1990), floods (Ejeta, Ardalan, Paton, & Yaseri, 2016; Zaalberg et al., 2009), wildfires (Martin et al., 2007), and burglary prevention (Wiegman et al., 1992).

Although the specific behaviors under study can be different, the general arguments why people engage in prevention behaviors are similar. According to both PMT and HBM the desire to avoid or mitigate a negative outcome creates motivation for self-protection. This desire is based on the perceived likelihood that the risk will materialize and the perceived severity of the consequences if it does materialize. In order to act, someone must feel that the prevention behavior is effective in reducing the likelihood or severity of the risk, and this benefit must outweigh the costs, such as time, effort, money, and inconvenience. Both theories make the assumption that the behavioral determinants relate to the subjective perceptions of a person and not to the objective state of a risk or behavior. Although the theories share more similarities than differences, the main theoretical difference is that PMT attributes the prevention behavior determinants to two cognitive processes ("threat appraisal" and "coping-appraisal") while HBM is organized as a catalog of variables (Floyd et al., 2000; Rosenstock, 1966).

In line with arguments in these previous studies, we expect that vulnerability, severity, costs, effort, and effectiveness influence domestic risk prevention behavior. Furthermore, we expect awareness, the extent to which one is familiar with the specific prevention behavior, to play a role. We now discuss the potential determinants of domestic risk prevention behavior in some detail.

2.1. Evaluation of Risk: Vulnerability and Severity

According to both PMT and HBM, the motivation to take preventive action arises from the evaluation of the risk (referred to as threat appraisal in PMT, and perceived threat in HBM) (Maddux & Rogers, 1983; Rogers, 1975; Rosenstock, 1966). Someone must feel that there is a probability of being exposed to the risk: the *perceived vulnerability* (or perceived likelihood, or perceived susceptibility). The second factor for the evaluation of the risk is the *perceived severity* (also referred to as perceived seriousness): the more severe the expected consequences, the higher the motivation to take action to reduce the likelihood of the risk (e.g., do not use candles) or to mitigate the consequences in case of the risk materializing (e.g., buy a fire blanket).

Multiple studies have found positive effects of perceived vulnerability and severity on prevention behavior (Bamberg et al., 2017; Bubeck et al., 2012; Floyd et al., 2000; Janz & Becker, 1984; Milne et al., 2000; Valkengoed & Steg, 2019). With respect to determinants that influence prevention behaviors in the areas of domestic fires, burglary, or water damage, there is much less literature available. The one study that we found concerning burglary showed a small impact of perceived severity on burglary prevention, but perceived vulnerability did not affect prevention behavior (Wiegman et al., 1992).

Although positive relations of vulnerability and severity with prevention behavior have been found, correlations tend to be small, which might be explained by measurement problems (Bubeck et al., 2012; Milne et al., 2000; Weinstein, Rothman, & Nicolich, 1998). Most studies are cross-sectional and investigate the performed prevention behaviors of individuals at the same time point as their perceived vulnerability and severity level. This can result in less strong, absent, or even negative correlations as someone might no longer feel vulnerable to the risk or will perceive its consequences differently after the prevention measures have been incorporated

(cf. Milne et al., 2000). This issue is also addressed by Siegrist (2013) who emphasizes the need for experimental and longitudinal studies in order to test the "true" causal relationships of risk perception variables with prevention behavior.

In line with the literature, we expect that perceived vulnerability and severity are relevant determinants for prevention behavior (see Fig. 2).

2.2. Evaluation of Prevention Behaviors: Awareness, Effectiveness, Financial Costs, and Effort

Before even considering a specific prevention behavior, one must first be aware of the behavior and its preventive aspects. Although awareness of the (preventive aspects of the) behavior is not officially operationalized as a determinant for prevention behavior in PMT or HBM, it is a commonly studied determinant, for instance in cyber security prevention (Hanus & Wu, 2016; Talib, Clarke, & Furnell, 2010), earthquake prevention (Vincente, Ferreira, Maio, & Koch, 2014; Yang, Gao, Liu, He, & Fan, 2010), and health risk prevention (Tenkorang, 2018). For domestic risk prevention we argue that people are more likely to perform a behavior, if they are aware of the behavior and its preventive aspects. Some behaviors might be not so well known, such as the fact that a smoke alarm needs to checked on a regular basis (Clark & Smith, 2018), while other behaviors might be known but its preventive aspects might be unknown (for instance knowing that cleaning the kitchen hood prevents a grease fire from getting bigger).

PMT and HBM also contend (Rogers, 1975, 1983; Rosenstock, 1966) that the motivation to take preventive action depends on an evaluation of the benefits and costs of the different prevention behaviors (in PMT this is referred to as the coping appraisal, which includes self-efficacy). We will label the benefits as the *perceived effectiveness* (referred to as response efficacy in PMT, and as perceived benefits in HBM) of the behavior: the perceived extent to which the behavior reduces the probability of the risk or mitigates the consequences of the risk. The *perceived costs* (referred to as response costs in PMT, and perceived barriers in HBM) refer to the potential negative aspects that are attached to the prevention behavior and for example include one or more of the following aspects: financial costs, time, effort, discomfort, painfulness, and unpleasantness, depending on the type of behavior (Floyd et al., 2000; Rosenstock, 1966). In HBM the costs of the behavior are reflected by one single item, while in PMT the various type of costs are represented by multiple items (Weinstein, 1993). In the domain of domestic risk prevention behavior, especially *financial costs* and *effort* seem important, similar to findings in the domain of environmental risk prevention (Lindell et al., 2009; Poussin, Botzen, & Aerts, 2014). We follow PMT in this respect and include both type of costs in our study.

Meta-analyses have shown that both the perceived costs and the perceived effectiveness are important predictors for preventive behaviors, and in general, have stronger effects than the perceived vulnerability and severity (Bamberg et al., 2017; Bubeck et al., 2012; Floyd et al., 2000; Janz & Becker, 1984; Milne et al., 2000; Valkengoed & Steg, 2019). A study in the burglary prevention domain also found a small effect of perceived effectiveness on burglary prevention, but perceived costs were not included in this study (Wiegman et al., 1992). In line with the literature, we expect the perceived effectiveness and perceived costs (more specifically financial costs and effort) to be relevant determinants for performing domestic risk prevention behaviors (see Fig. 2).

A concept that has later been added to the original versions of PMT and HBM is self-efficacy (Rogers, 1983; Rosenstock, Strecher, & Becker, 1988), which refers to "the conviction that one can successfully execute the behavior required to produce the outcomes" (Bandura, 1977, p. 193). Empirical evidence shows that this determinant is an important predictor in the domains of health risk and environmental risk (Floyd et al., 2000; Milne et al., 2000; Valkengoed & Steg, 2019), although there are also studies that show no effects of self-efficacy (Lindell & Prater, 2002; Lindell & Whitney, 2000; Zaalberg et al., 2009). A possible explanation might be that self-efficacy can be very closely related to the costs or barriers of a behavior, so that the effect of self-efficacy on top of the other variables is limited (Weinstein, 1993; Zaalberg et al., 2009). Because we expect that self-efficacy is largely reflected by the perceived costs (financial costs and effort) in the domain of domestic risk prevention, we excluded self-efficacy from our study.

2.3. Separating Effects Within-Persons versus Between-Persons

Although there are differences with respect to the way in which previous studies have been

conducted, several research design choices are common. Often, researchers test the determinants of prevention behaviors by performing regression type analyses on cross-sectional survey data. Most studies cover one particular risk, and ask people to indicate whether they (intend to) perform a specific behavior for a given risk (e.g., Chatterjee & Mozumder, 2014), or which behaviors from a set of behaviors they (intend to) perform (e.g., Martin et al., 2007; Zaalberg et al., 2009). When studying multiple prevention behaviors, these are often transformed into a single scale score measuring "the extent to which someone performs prevention behavior." A further difference between studies is whether the determinants are evaluated at the level of the requested prevention behaviors ("what is the effectiveness of behavior X") (e.g., Dang, Li, Nuberg, & Bruwer, 2014; Lindell et al., 2009; Lindell & Prater, 2002; Martin et al., 2007; Zaalberg et al., 2009) or on a more general level (e.g., "what is the general effectiveness of prevention behaviors", as in e.g., Jayanti & Burns, 1998). Although in the former case every determinant is being evaluated for every behavior, the scores are typically aggregated in a single scale score per determinant per person and analyzed as such.

What these research designs have in common is that between-person effects (some persons tend to perform more prevention behaviors than others) cannot be distinguished from within-person effects (a person finds some prevention behaviors more attractive to perform than other behaviors), as either the data consider a single prevention behavior for a single risk, or scores have been aggregated per individual and can therefore only be analyzed at the between-person level. This is peculiar, as the (often implicit) argument of these underlying theories seems to be a within-person argument, where a change in an independent variable will result in a change in a dependent variable for a given person. This issue does not only relate to PMT and HBM but is a common problem is psychology, where typically psychological theories make intrapersonal inferences while these inferences are tested on a interindividual level (Collins, 2006; Curran & Bauer, 2011; Molenaar, 2004; Mroczek et al., 2003). An example explained by Curran and Bauer (2011) that makes the importance of separating within- and between-person effects clear is the following: people are more likely to have a heart attack during or directly after exercising compared to less strenuous activities or no activity at all (a within-person effect), while at the same time, people that exercise more than others have a lower likelihood of having a heart attack (a between-person effect) (Curfman, 1993; Mittleman et al., 1993). Distinguishing both effects results in a more complete understanding of the true nature of the relationships. Moreover, it would be an error of inference to generalize the between-person effect to the individual level (Collins, 2006).

Table I. Hypothetical Scores of Effectiveness of Two Individuals (A, B) for Two Prevention Behaviors (P, Q)

	Prevention Behavior P	Prevention Behavior Q
Individual A	1	2
Individual B	4	5

Note. 1 = not effective at all; 5 = very effective

The within-person argument for prevention behavior can be described as follows: if an individual does not perform a specific prevention behavior, then affecting a characteristic of this behavior, such as increasing its perceived effectiveness, will cause that particular individual to become more likely to perform this prevention behavior (see e.g., Cismaru & Lavack, 2007; Maddux & Rogers, 1983; Sheeran, Harris, & Epton, 2014). This "within-persons between-behaviors" type argument is explicitly mentioned in Rosenstock (1966, p. 7): "The direction that the action will take is influenced by beliefs regarding the relative effectiveness of known available alternatives in reducing the disease threat to which the individual feels subjected. His behavior will thus depend on how beneficial he thinks the various alternatives would be in his case." The comparable but different "between-persons" argument is that persons who consider prevention behaviors in general as more effective (compared to other persons) are more likely to perform prevention behaviors. Both arguments assume that the perceived effectiveness of the behavior affects the likelihood of the performance of the behavior, but there is a crucial difference, as illustrated by the following hypothetical case (see Table I). Suppose individual A considers prevention behavior P not effective at all and prevention behavior Q a bit more effective than P. Instead, individual B considers prevention behavior P quite effective and, similar to individual A, also finds prevention behavior Q a bit more effective than P. Using the logic of the "between-persons" argument, type B individuals are more likely than type A individuals to perform any of these prevention behaviors because they find both behaviors more effective than type A

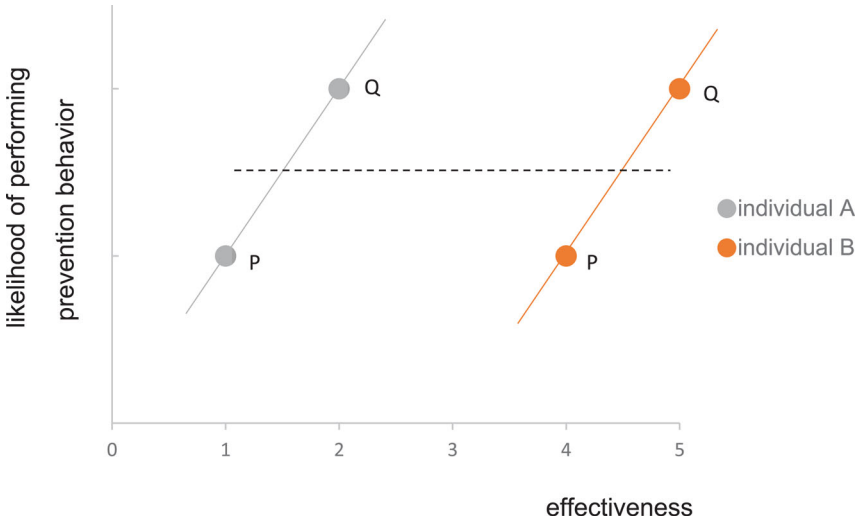

Fig 1. Graph to illustrate the difference between within-person effects and between-person effects. While a within-person effect holds for individual A and B, there is no between-person effect (i.e., the dotted line is horizontal). The dots represent two different prevention behaviors: P and Q.

individuals considers them. The logic of the "within-person" argument suggests that prevention behavior Q will be preferred over P and hence that Q will be executed more than P. The "within-person" argument concerns the characteristics of the behaviors (independent of the person), while the "between-persons" argument concerns the characteristics of the person independent of the behavior (i.e., a person finds all prevention behaviors effective, expensive, etc.). However, it may well be that there is a within-person effect for a given variable, while there is no between-person effect (or vice versa), as illustrated in Fig. 1. In such a case, failing to disentangle and hence averaging out both effects might cause misleading results.

Note that although this distinction is rare in the PMT/HBM literature, it is a common approach in research that employs mixed designs and is related to what is called "group mean centering in multilevel studies" (Blalock, 1984; Enders & Tofighi, 2007). Disentangling the two arguments is only possible in a research design in which multiple behaviors and risks are evaluated on multiple determinants per person, and are subsequently analyzed in a multilevel manner (Trafimow & Finlay, 1996). Given that we employ a mixed design, our hypotheses can be disentangled into both the within-person (H1a–H6a) and the between-person (H1b–H6b) arguments (visually represented in Fig. 2). We expect that the effects primarily will run within-persons, instead of between-persons, also given that most arguments in the literature seem to be based on this idea and given that this is consistent with the relatively small impact that individual characteristics seem to have on prevention measures in the literature. However, for clarity and completeness, we also formulate the between-persons hypotheses.

The probability that an individual performs a specific prevention behavior is larger for a prevention behavior that prevents or reduces a risk that this individual…

… perceives him or herself as more vulnerable to (compared to other risks) (H1a).

… perceives as more severe (than other risks) (H2a).

The probability that an individual performs a specific prevention behavior is larger for a prevention behavior that this individual…

… perceives as more effective (than other behaviors) (H3a).

… perceives as less costly (than other behaviors) (H4a).

… perceives as less effortful (than other behaviors) (H5a).

…is aware of (than one that one is not aware of) (H6a).

Individuals will perform more prevention behaviors if individuals score higher than other individuals on…

… perceived vulnerability (H1b).

… perceived severity of the risks (H2b).

… perceived effectiveness of the prevention behaviors (H3b).

… perceived costs of the prevention behaviors (H4b).

… perceived effort of the prevention behaviors (H5b).

… awareness of the prevention behaviors (H6b).

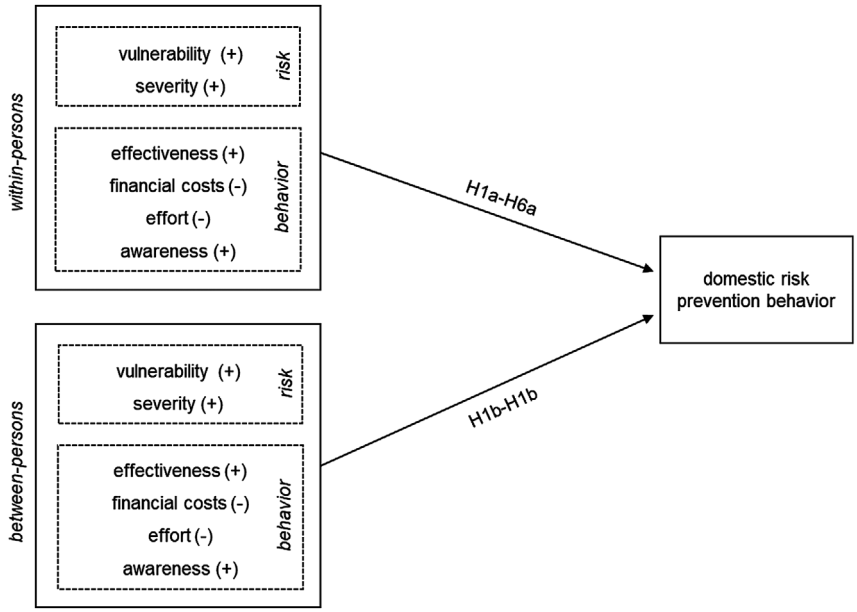

Fig 2. Hypothesized model of the prevention behavior determinants, disentangled into between-person and within-person variables, that influence domestic prevention behaviors (H1a–H6b). Between-person effects represent the mean of the determinants across persons. Within-person effects represent the deviation from the mean of the determinants per person. (+) represents a positive relationship. (−) represent a negative relationship.

2.4. Socioeconomic Variables

Studies that test the PMT or HBM variables, often also incorporate socioeconomic variables such as gender, age, education, or home ownership (Bubeck, Botzen, Laudan, Aerts, & Thieken, 2017; Chatterjee & Mozumder, 2014; Grothmann & Reusswig, 2006; Lindell & Perry, 2000; Lindell & Whitney, 2000; Pakenham, Pruss, & Clutton , 2000; Siegel, Shoaf, Afifi, & Bourque, 2003; Zaalberg et al., 2009). Although results differ, in general, correlations of the socioeconomic variables with prevention behavior are small (Lindell & Perry, 2000; Zaalberg et al., 2009) and tend to be weaker than the effects of the PMT/HBM variables (Bubeck et al., 2012; Bubeck et al., 2017; Grothmann & Reusswig, 2006). In this study we incorporate the following socioeconomic variables as control variables: age, gender, education, family situation, home ownership, year of construction, and type of home.

3. METHOD

3.1. Participants and Procedure

The data were collected through a survey sent to a consumer panel managed by a research company in the Netherlands. The survey was sent on April 29th in 2016. The criteria for participation were: participants had to be customers of a specific insurance company in the Netherlands and had to own a contents or a home insurance. As an incentive, participants received points that they could exchange for gifts. In total 263 participants completed the survey. The majority of the participants (77.9%) completed the survey within 5–15 minutes, with a median of 613 seconds.[2] In the invitation it was made clear that the research was conducted by the specific insurance company and that the survey was about prevention behavior. It was stated that the survey questions could be best answered by the person in the household who is most involved with burglary, fire, and water damage prevention. It was stressed that there were no right or wrong answers and that the responses were confidential and would only be used for research purposes.

3.2. Measures

3.2.1. Background Questions

The background questions included gender, age, education, household composition, home ownership, type of home, construction date of the home, indication fire-place (beyond the scope of this article), and who has the primary responsibility for domestic prevention behaviors within the household.

[2]The mean duration was 829.5 seconds ($SD = 1{,}303.8$). However, the mean duration time is not a good representation here, since if participants did not close their browser, time kept on running.

Table II. Measured Prevention Behaviors and Their Risk Categories, the Type of Behaviors and Their Prevalence (%)

Risk	Type	Prevention Behavior	Prevalence[a] (%)
Burglary	Curtailment	Lock doors when leaving	90.1
	Investment	Antiburglary strips	(not available)
		Alarm system	12.6
Fire	Curtailment	Clean kitchen hood	48.0
		Check smoke alarm	17.0
	Investment	Smoke alarm	78.0
		Fire blanket	36.1
Water damage	Curtailment	Clean roof top gutter	53.0
	Investment	Dripping tray for washing machine	21.5

[a]The prevalence of prevention behaviors was based on an earlier study (Jansen et al., 2016). The prevalence of antiburglary strips was not included in that study.

3.2.2. Prevention Behavior Self-Reports

Prevention behavior was measured with nine prevention behavior self-reports. We coded all behavioral self-reports into 0 ("no") or 1 ("yes"). Appendix A shows all items of the prevention behavior self-reports and the cutoff values that were used. The answer possibilities "I do not know' and "not applicable" were treated as missing values. The nine prevention behaviors were selected based on a spread in the risks involved, curtailment, and investment behaviors[3], and expected prevalence (see Table II). The expected prevalence was based on an earlier study (Jansen, Willemsen, & Snijders, 2016).

3.2.3. Prevention Behavior Determinants

Participants were asked to rate the perceived vulnerability and perceived severity for the risks that can be prevented or mitigated by these nine prevention behaviors. These risks were: burglary, grease fire, a fire of reasonable size, leaking washing machine, and a leaking gutter, all measured with seven-point Likert scales. We measured vulnerability with the following item "How high do you perceive the probability of the following risks for your home to be?" (1 = very low; 7 = very high). Severity was measured through "How severe do you perceive the consequences of the following risks for your home to be"? (1 = not severe at all; 7 = very severe). Participants were asked to evaluate the other determinants (effort, effectiveness, financial costs, and awareness) for every prevention behavior. Effort was measured with "How much effort is it for you to (lock the doors every time when you leave your home)?" (1 = very little effort; 7 = a lot of effort). Effectiveness was measured with "How effective do you find the following measures for your home, to prevent or mitigate the consequences of (burglary; fire; water damage)?" (1 = not effective at all; 7 = very effective). For the item regarding the perceived costs, respondents could fill out an amount in euro. We log-transformed this variable, as is common for variables where differences for smaller values are more pronounced than differences for larger values. The awareness of the prevention behaviors was measured with "Were you, before filling in this questionnaire, aware of the following prevention behaviors in order to prevent or mitigate (burglary; fire; water damage)?" (No = 0; Yes = 1).

3.3. Data Analysis

We analyzed our data using multilevel logistic regression analyses (Stata 14, 2015), since the data is hierarchically structured so that prevention behaviors are nested within individuals. Our multilevel research design, where every person evaluates multiple prevention behaviors, allows to study the effects of the prevention behavior determinants on two levels: within-persons (i.e., "the individual level" or "Level 1") and between-persons (i.e., "the cluster level" or "Level 2") (Enders & Tofighi, 2007). The between-person variables are defined as the mean of a variable for a person (for instance, the mean effectiveness that a person perceives for the nine behaviors). The within-person variables are defined as the deviations from the person mean. This procedure is

[3]The terms "curtailment behaviors" and "investment behaviors" are adopted from the energy conservation domain. Curtailment behaviors are behaviors someone has to perform regularly in order to conserve energy. Investment behaviors are behaviors that, in general, require a one-time action such as an investment or the purchase of an energy-efficient appliance (Karlin et al., 2014).

referred to as group-mean centering (GMC) or centering within cluster (CWC).

3.4. Data Preparation

We removed participants who did not vary their answers across the prevention determinants ($n = 10$). This reduced the dataset to $n = 253$, with in total 253 * 9 = 2,277 cases. The costs for behaviors that involve no financial costs (clean kitchen hood, check smoke alarm, and lock doors) were set to zero. For cleaning the roof top gutter, people were asked to fill out a zero for financial costs if they cleaned the gutter themselves, and to fill out a certain amount if they paid someone to do this. Some people (max. 5.2%) filled out a zero for the other prevention behaviors (alarm system, antiburglar strips, smoke alarm, fire blanket, dripping tray). We treated these zeros as missing values, since these measures obviously should have some (perceived) costs associated with them. With respect to the missing values of the prevention behavior determinants, costs had 14.8% missing values, whereas the other determinants had missing value percentages below 2%. Part of the missing values can be explained by the fact that some items were conditional. For example, a participant did not have to answer items about a dripping tray for the washing machine in case he or she did not own a washing machine. After taking all missing values into account, this results in 1,810 complete cases. With respect to the perceived vulnerability and severity of the risk of fire, we asked separately how high/severe participants perceived the probability and consequences of a general fire (linked to smoke alarm) and of a grease fire (linked to fire blanket). As the correlation between these variables was high (vulnerability $r = 0.84$; severity $r = 0.90$) we included only the variables concerning the general fire in the regression models. Correlations between the independent variables were low (< 0.28), making multicollinearity unlikely.

4. RESULTS

4.1. Descriptive Statistics

Descriptive statistics of our sample can be found in Table III.

Table IV shows the descriptive statistics of the prevention behavior self-reports and the prevention behavior determinants. The most prevalent behavior is "locking doors when leaving the house" (91.3%), which is also the behavior that most people are aware of (96.8%), is perceived as the most effective ($M = 5.78$), and perceived as the least effortful ($M = 1.87$). People feel most vulnerable to burglary ($M = 3.22$–3.27) while a fire is perceived as the most severe risk ($M = 5.03$–5.16).

4.2. Statistical Analyses

Running an empty multilevel logistic regression model showed that the variance in the probability of performing prevention behaviors at the individual level was very small ($\rho = 0.004$). Stated otherwise, most of the variance in prevention behaviors resides at the level of the prevention behaviors' characteristics (within-persons) and our data do not support the notion that prevention behavior strongly depends on personal characteristics (between-persons) (Killip, Mahfoud, & Pearce, 2004). Note that we can only make this assessment as a direct consequence of the research design in which we let every person evaluate multiple prevention behaviors.

To test the hypothesized relationships of Fig. 2 (H1a–H6a; H1b–H6b), we estimated a multilevel logistic regression model (model 1, Table V) with the within-person determinants and between-person determinants as predictors, controlling for all socioeconomic variables. Of the control variables, only age had a significant negative effect on prevention behavior. On closer inspection, this effect was caused largely by a difference between the 18–29 age group and all others ($b = 0.783$, $p = 0.001$). The results of the control variables can be found in Appendix B. Results (see model 1, Table V) showed that all within-person variables were significant, confirming H1a and H3a–H6a and rejecting H2a as the effect was significant in the opposite direction. Thus, an individual who perceives a specific behavior as more effective, less costly, and less effortful compared to other behaviors, and feels more vulnerable to the corresponding risk compared to other risks, is more likely to perform that specific behavior (compared to other behaviors). The only exception is the effect of severity. As the severity for a risk for a given individual increases, the probability of performing the corresponding behavior decreases. Of the between-person variables only "effectiveness" and "awareness" were significant, in line with H3b and H6b. This suggests that individuals who find prevention behaviors in general more effective and are more aware of prevention behaviors in general, will

Table III. Descriptive statistics of sample ($n = 253$)

Variable	Category	%
Gender	Male	66.4
Age	18–29	7.1
	30–39	14.2
	40–49	19.8
	50–59	19
	60–69	17
	> 70	22.9
Education	Primary education	0.8
	Preparatory vocational education	28.1
	Secondary vocational education or secondary education	36.8
	BSc. or MSc. level education	34.4
Household composition	Married/ living together, with Children at home	24.5
	Married/ living together, without children at home	41.9
	Single with children at home	4.4
	Single without children at home	29.3
Ownership home	Yes	64.4
Type of home	Detached home	17.4
	Bungalow	1.6
	Semidetached home	16.6
	Terrace home	36.8
	Apartment/ studio	19.4
	Room	0.4
	High-rise building	3.6
	Other	4.4
Year of construction[a]	< 2003	77.8
	2003 or later	14.2
	Do not know	7.9
Primary responsibility for prevention in home	MePartner	79.117.8
	Someone else	3.2

[a]Houses built in 2003 or later were obligated by law to have smoke alarms at the time of their construction.

perform more prevention behaviors compared to persons who score lower on these determinants. Comparing the predicted probabilities between the lowest and highest value of the predictors while keeping the other variables at their mean showed that all the within-person variables had larger effect sizes than the between-person variables (Table VI). When only looking at the within-person variables, effectiveness had the largest effect size (0.775) followed by effort (−0.722). Together, these results imply that all prevention behavior determinants also have significant effects in the domain of domestic risk prevention, and that effects run primarily within-persons. Whether people perform prevention behaviors depends more on the relative evaluation of the prevention behavior determinants within a person, than on general differences in average estimates between persons.

Our design allows us to illustrate that we would have received different, or at least incomplete, results if we had performed multi-level logistic analysis with "fixed effects" or if we had performed a linear regression analysis with aggregated scores as is more common in other PMT/HBM studies (Dang et al., 2014; Jayanti & Burns, 1998; Lindell & Prater, 2002; Martin et al., 2007; Zaalberg et al., 2009). First, we estimated a multilevel logistic regression model (model 2, Table VII) with the prevention behavior determinants as predictors, controlling for all socioeconomic variables. In this analysis all within and between effects are aggregated ("fixed effects"). The results of model 2 show that all prevention behavior determinants had a significant effect on performing prevention behavior in the expected directions, except for severity, which had a negative direction. Second, we estimated a between-persons regression model with the sum of prevention behaviors as the target variable and the mean scores of the prevention determinants as the independent variables (model 3, Table VII). In this case, the results showed that

Table IV. Prevention behavior self-reports and awareness of prevention behaviors in %, and mean (M)[a] and standard error (SE) scores on prevention behavior determinants

Prevention behavior	Prevalence %	Awareness %	Vulnerability	Severity	Effectiveness	Cost in €	Effort
	(1 = yes)	(1 = yes)	M (SE)	M (SE)	M (SE)	M (SE)	M (SE)
1. Alarm system	17.8	87.0	3.27 (0.10)	4.75 (0.11)	4.43 (0.12)	617.3 (48.6)	4.03 (0.13)
2. Antiburglary strips	28.8	69.2	3.22 (0.10)	4.76 (0.11)	4.6 (0.11)	90.1 (12.3)	3.27 (0.12)
3. Lock doors when leaving the house	91.3	96.8	3.23 (0.09)	4.73 (0.10)	5.78 (0.10)	0	1.87 (0.09)
4. Smoke alarm(s) on every floor	56.3	87.8	3.0 (0.08)	5.03 (0.1)	5.58 (0.10)	85.4 (34.0)	2.69 (0.12)
5. Check smoke alarm(s)	26.5	85.0	3.02 (0.08)	5.03 (0.10)	5.46 (0.09)	0	2.74 (0.10)
6. Clean kitchen hood	43.1	71.2	3.02 (0.08)	5.03 (0.10)	5.22 (0.09)	0	2.68 (0.11)
7. Fire blanket	35.4	79.8	3.00 (0.08)	5.03 (0.10)	5.14 (0.10)	30.3 (1.7)	2.22 (0.10)
8. Clean roof top gutter	55.5	74.7	2.91 (0.10)	3.62 (0.12)	5.36 (0.10)	34.0 (7.0)[b]	2.84 (0.13)
9. Dripping tray	27.6	68.0	2.94 (0.10)	3.81 (0.11)	4.60 (0.12)	31.0 (2.1)	2.82 (0.13)

[a]Mean scores are presented for all cases that were included in the regression analysis. Missing cases are excluded.
[b]When removing the cases who filled out zero (62.2% people clean roof top gutters themselves) costs are $M = 89.9$, $SE = 16.4$.

Table V. Model fit statistics (χ^2, p, ρ), unstandardized coefficients estimates (B), standard errors (SE), significance level (p) for model 1 (multilevel logistic regression analysis with within- and between-person effects), controlled for socioeconomic variables

	Model 1			
	Within-persons		Between-persons	
	B	SE	B	SE
Costs	-0.130^{***}	0.030	−0.149	0.086
Effort	-0.385^{***}	0.054	−0.031	0.064
Effectiveness	0.587^{***}	0.062	0.160^{*}	0.066
Awareness	1.255^{**}	0.210	1.394^{***}	0.352
Vulnerability	0.145^{*}	0.077	0.054	0.060
Severity	-0.189^{***}	0.062	−0.021	0.050
χ^2	474.25			
p	0.000			
Pseudo R^2	0.206			

Note. Between-persons coefficient is based on the mean of the predictor across all persons. Within-person coefficient is based on the deviation of the mean of the predictor across behaviors for one individual.
Control variables were age, gender, education, family situation, house ownership, year of house construction, type of home.
$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Table VI. Effect sizes (margin difference between maximum and minimum value) for variables of model 1 (with between-person and within-person effects) controlled for socioeconomic variables

	Model 1	
	Within-personseffect size	Between-personseffect size
Costs	−0.343	−0.127
Effort	−0.742	−0.045
Effectiveness	0.805	0.221
Awareness	0.489	0.293
Vulnerability	0.309	0.063
Severity	−0.367	−0.030

both "effectiveness" and "awareness" are significant determinants for prevention behavior, which is comparable with the between-person results of the multilevel logistic regression analysis (model 1, Table V).

Analyzing the results by separating within-person and between-person effects (as in model 1) compared to analyzing the effects all together (as in model 2) or performing solely between-person analyses based on aggregated scores (as in model 3), allows to better understand the source of the effects. For example, in model 2, effort had a significant negative effect on prevention behavior, implying that the higher the perceived effort, the less likely the prevention behavior is performed. When separating the effects, the variable effort appeared to only have a significant negative effect within-persons, but not between-persons. Implying that the effect of effort only runs within-persons: the higher the perceived effort of a behavior compared to other behaviors by an individual, the less likely the prevention behavior is performed by that individual. When performing between-person analyses on mean scores, we could have had incorrectly concluded that "effort," "financial costs," "vulnerability," and "severity" had no effects in the area of domestic prevention behavior. While, when separating the effects, these determinants all appeared to have significant effects, with the nuance that these effects run within-persons.

Table VII. Model fit statistics, unstandardized coefficients estimates (B), standard errors (*SE*), significance level (p) for model 2 (logistic multi-level regression analysis with fixed effects), and model 3 (linear regression between-person analysis with aggregated scores), controlled for socioeconomic variables

	Model 2		Model 3	
	B	S.E	B	S.E.
Costs	-0.186^{***}	0.028	0.002	0.106
Effort	-0.234^{***}	0.044	−0.085	0.101
Effectiveness	0.400^{***}	0.049	0.342^{**}	0.105
Awareness	1.367^{***}	0.192	1.572^{**}	0.521
Vulnerability	0.102^{*}	0.048	0.013	0.095
Severity	-0.110^{**}	0.039	−0.040	0.080
χ^2 resp. F (23, 209)	247.49		3.97	
P	0.000		0.000	
ρ resp. R^2	0.030		0.304	

Note. Control variables were age, gender, education, family situation, house ownership, year of house construction, type of home.
$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

We ran several slightly different variants of the analyses to test the robustness of our results under different implementations of the model. Our results are robust to deviations in terms of the kinds of individuals or behaviors included: effects within-persons and between behaviors are generally larger than between-person effects. Also, statistical significances and effect sizes remain similar across analyses, although the within-effect of vulnerability is not that robust when excluding cases or persons (see Appendix C).

5. DISCUSSION AND CONCLUSION

In line with the previous literature we found that all PMT/HBM determinants were relevant predictors for domestic risk prevention behavior (Floyd et al., 2000; Janz & Becker, 1984). The determinant "awareness" that was added in this study, also appeared to significantly correlate with domestic risk prevention behavior. The determinants related to the evaluation of the prevention behaviors (effectiveness, costs, effort, awareness) correlated stronger with prevention behavior than the determinants related to the evaluation of the risk (vulnerability, severity), which is also in line with previous findings (Floyd et al., 2000; Milne et al., 2000). Our findings are also consistent with earlier studies in the domain of flood mitigation behavior that the effects of socioeconomic variables are weaker than the effects of the PMT/HBM variables (Bubeck et al., 2012; Bubeck et al., 2017; Grothmann & Reusswig, 2006).

Our study shows that disentangling within-person and between-person effects makes it possible to better interpret the results and draw conclusions that have not been adequately addressed in previous literature. Disentangling the within-person and between-person effects (known as "group mean centering in multilevel studies"; Blalock, 1984; Enders & Tofighi, 2007) is only possible in a research design in which multiple behaviors and risks are evaluated on multiple determinants per person. Most variance in the performance of prevention behaviors could be explained by differences in the characteristics of the prevention behaviors rather than by differences in the characteristics of persons. In line with this result is that within-person variables had a larger and more often significant effect on prevention behavior compared to the between-person variables. Even if we assume that (a larger) part of the variance in the within-person measurements is due to noise because the between-person measures averaged out the noise to some extent (cf. Falk et al., 2018, p. 1665), the size of the effects of the within-person measurements is so much larger (than the effect of the between-person measures) that it is unlikely to be explained away by just measurement error. The within-person variables "vulnerability," "effectiveness," "costs," "effort," and "awareness" all showed effects in the hypothesized directions. For instance, this means that there is a higher likelihood that a person performs a specific prevention behavior, when he perceives that behavior as more effective than another behavior. Concerning the between-person effects, only "effectiveness" and "awareness" had a positive and significant effect on prevention behavior. Persons who find prevention behaviors in general more effective and are more aware of prevention behaviors, have a higher likelihood of performing prevention behaviors compared to persons who score lower on these determinants. However, even for "effectiveness" and "awareness," both of which showed significant effects within-persons and between-persons, the within-person effects were larger than the between-person effects. Together, these results indicate that the likelihood of performing prevention behaviors depends more on the relative evaluation of the prevention behavior determinants within a person, than on the relative evaluation of the prevention behavior determinants between-persons.

An important issue is that our study is cross-sectional, so that the data only shows correlation and not causality. This problem is common in PMT/HBM studies and especially holds for the risk perception

variables, since someone's perception of a risk might change due to the prevention measure taken (Bubeck et al., 2012; Milne et al., 2000; Siegrist, 2013; Weinstein et al., 1998). The fact that severity in our study showed a negative relationship with prevention behavior might be the consequence of this issue. A person might already undertake prevention behaviors to mitigate the risk (e.g., own a smoke alarm, a fire blanket or a dripping tray) and therefore perceives the risk as less severe compared to other risks (Bubeck et al., 2012; Milne et al., 2000; Weinstein et al., 1998). Although this might be an explanation for the negative within-person effect found for severity, this (negative) relationship is not found for vulnerability (for which a similar argument could be made).

A second limitation of this study is that we selected nine prevention behaviors out of all possible prevention behaviors concerning fire, burglary, or water damage with a range of differences in prevalence. Although we see no obvious reason why the effects could not be generalized to other prevention behaviors related to these risks, the coefficients might differ when changing the set of prevention behaviors. Also, for some prevention behaviors other effects may play a role. For instance, because some measures are obligated by law in newly built houses (e.g., certified locks on doors) variables that were not significant in this study (e.g., year of house construction) might play a substantial role depending on local rules and regulations.

The findings of this study have important implications for those who want to persuade individuals to perform prevention behaviors, though the argument is a complicated one and can only partially be addressed here. When choosing what to try and influence, one has to take into account what is easiest to influence (which we did not consider), and what kinds of effects this then has on behavior. In principle, and regardless of our findings, it would be more efficient to influence someone's general inclination to perform prevention behaviors, as this would make all prevention behaviors more attractive. However, our results show that this general inclination between individuals cannot easily be explained away by individual differences. For instance, our findings suggest that convincing someone that performing prevention behaviors takes much less effort than they think—assuming that this would be possible to achieve—probably does *not* lead to more prevention behaviors. Instead, it seems to be the relative comparison of prevention behaviors that works better, so that, in the case of domestic prevention behaviors, it would actually be better to highlight that a single prevention behavior takes less effort than people thought. Their general inclination to carry out prevention behaviors would not change, but their likelihood to carry out that particular prevention behavior would increase. Matters become even more complicated when we consider how such arguments pan out when the between-person effect is small (instead of zero). In this case, even a small increase in the general inclination might be worthwhile as this small increase has an effect across a multitude of behaviors. This highlights a line of research that is currently largely absent: what are the net benefits of trying to influence either someone's general inclination versus trying to influence the perception of a single prevention behavior.

A second line of research that would be fruitful is to think through more carefully and elaborately which kinds of scenarios are consistent with the findings as we present them here. For instance, our findings are consistent with a scenario where individuals have a fixed "budget" for prevention behaviors that is relatively independent of what they think of prevention in general. Instead, they have a preference order over the different prevention behaviors and choose the ones that they prefer most. In such a scenario, influencing the rank order of prevention behaviors has large effects, whereas influencing the general inclination to prevent does not. We are not claiming that this scenario is necessarily the most likely one but theorizing about the underlying reasoning and behavior more thoroughly, and testing these theories with other than cross-sectional surveys also seems a necessary step.

It is nevertheless possible to come up with relatively straightforward practical implications based on our findings. First, if one wants to increase domestic prevention behavior, we find (for obvious reasons) that awareness is key: you have to make sure people know that the specific behavior exist. Second, influence the perceived effectiveness and/or perceived effort of a specific behavior (compared to other behaviors), given that these are the strongest effects that we find. Based on our results we advise against trying to increase people's general perception to risks, that is, increase people's perceived vulnerability and severity level for fire, water damage, and burglary all together. Additionally, selecting a specific target group to promote prevention behaviors, for instance people that feel particularly vulnerable to all risks or think all prevention behaviors require little effort,

also seems not very fruitful since the between-person effects were small and sometimes nonexistent.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table BI. Unstandardized coefficients estimates (B), standard errors (*SE*) and significance levels (*p*) for the socioeconomic variables of model 1 (with within- and between-person variables)