

Simply Criminal: Predicting Burglars' Occupancy Decisions with a Simple Heuristic

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Abstract Rational choice theories of criminal decision making assume that offenders weight and integrate multiple cues when making decisions (i.e., are compensatory). We tested this assumption by comparing how well a compensatory strategy called Franklin's Rule captured burglars' decision policies regarding residence occupancy compared to a non-compensatory strategy (i.e., Matching Heuristic). Forty burglars each decided on the occupancy of 20 randomly selected photographs of residences (for which actual occupancy was known when the photo was taken). Participants also provided open-ended reports on the cues that influenced their decisions in each case, and then rated the importance of eight cues (e.g., deadbolt visible) over all decisions. Burglars predicted occupancy beyond chance levels. The Matching Heuristic was a significantly better predictor of burglars' decisions than Franklin's Rule, and cue use in the Matching Heuristic better corresponded to the cue ecological validities in the environment than cue use in Franklin's Rule. The most important cue in burglars' models was also the most ecologically valid or predictive of actual occupancy (i.e., vehicle present). The majority of burglars correctly identified the most important cue in their models, and the open-

ended technique showed greater correspondence between self-reported and captured cue use than the rating over decision technique. Our findings support a limited rationality perspective to understanding criminal decision making, and have implications for crime prevention.

Keywords Bounded rationality · Burglary · Matching Heuristic · Franklin's Rule · Crime prevention

Burglars' choice of a particular residence to burgle is often based on occupancy cues such as the presence of vehicles (see Bennett & Wright, 1984; Rengert & Wasilchick, 2000), and deciding on the occupancy of a residence can be a critical precursor for the decision to break-in. For example, Cromwell, Olson, and Avary (1993) reported that the default decision for burglars is "residence occupied" unless cues suggest the residence is unoccupied, and 93% of their burglars said they would never enter an occupied residence purposely. Nee and Meenaghan (2006) found that 76% of their burglars preferred the residence to be unoccupied, and made checks to infer occupancy status. DeFrances and Titus (1993) noted that the presence of an occupant often led to a burglary being aborted. Indeed, considerable research has shown that cues indicating occupancy can act as deterrents, thus reducing the risk of burglary victimization (e.g., Coupe & Blake, 2006; Nee & Meenaghan, 2006; Taylor & Nee, 1988; Wright & Logie, 1988). Therefore, to develop more effective burglary prevention strategies, it is important to understand how burglars make decisions about residence occupancy.

Occupancy is a central tenant of routine activities theory, which suggests that capable guardians ought to deter offenders (Cohen & Felson, 1979). This assumption is also compatible with rational choice theory in criminology

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(Cornish & Clarke, 1986), which assumes that individuals are free to choose to engage in criminal behavior. Rational choice theory also assumes that offenders are goal oriented, make rational calculations, and are influenced by factors associated with the situation. Thus, believing that a residence is occupied increases the chances of detection and reduces the chances of a successful burglary where one evades apprehension.

Rational choice theorists have proposed that criminals are fully rational decision makers who attach values to the possible rewards and the costs associated with an action, calculate the probabilities of these rewards and costs, weigh the values of rewards and costs by their respective probabilities, and choose the course of action that maximizes gains and minimizes losses (see Becker, 1968; Cornish & Clarke, 1986; Piquero & Tibbetts, 2002). Although many proponents of this theory now appear to believe that the maximization of costs and benefits is beyond an individual's capabilities, the basic premise that criminals use *compensatory* decision strategies that weight and integrate information—even if less than optimal—remains.

By contrast, others have argued that criminal decision making is best understood through a limited (or bounded) rationality perspective (see Johnson & Payne, 1986; Tunnell, 2002). For instance, building on Simon's (1956) ideas, it has been proposed that a burglar using a satisficing heuristic would search a number of potential targets (i.e., residences) sequentially until one is found that meets a certain aspiration level (Cromwell, Olson, & Avary, 1991). More recently, it has been argued that people may make “fast and frugal” decisions using heuristic strategies that are often *non-compensatory* under the constraints of limited time, information, resources, and cognitive processing capacity (see Gigerenzer, Todd, & The ABC Research Group, 1999), as well as (sometimes) psychopharmacological agents.

The limited rationality perspective on offending is now generally accepted as ethnographic studies of burglary and interviews with burglars provide compatible evidence. For instance, it has been found that burglars use sequential search, focus on relevant cues, and employ automatic and speedy strategies (e.g., Bennett & Wright, 1984; Nee & Meenaghan, 2006). Burglars often report using “good enough” strategies (Cromwell et al., 1991), suggesting that heuristics may be used by burglars to make various decisions, such as selecting a time of day, area in the city, and a specific target (Bennett & Wright, 1984; Rengert & Wasilchick, 2000).

However, the research so far has rarely attempted to specify the precise cognitive strategies that offenders may use to make decisions. Past research has focused primarily on the nature of the information that may be related to

offenders' decisions, and typically does not comment on how offenders process this information. Recently, Garcia-Retamero and Dhimi (2009) attempted to fill the gap in the literature by modeling burglars' choices of residences to burgle with two different types of cognitive strategies. They found that a non-compensatory heuristic strategy called Take-The-Best, which based decisions on only one cue (out of eight predicted burglars' choices) with an average of 72% accuracy. By contrast, a weighted additive strategy, which used all of the available cues (i.e., a compensatory strategy), had an average 63% predictive accuracy. In fact, 85% of the burglars' decision policies were classified as being better predicted (by 10% points or more) by the heuristic strategy. In this article, we extend this line of research by examining the validity of a different non-compensatory strategy (i.e., the Matching Heuristic) in capturing burglars' decision making, and by studying a different task faced by burglars (i.e., deciding on residence occupancy).

Simple Heuristics

Gigerenzer et al. (1999) recently introduced the notion that people use simple heuristics to make a range of decisions. Heuristics are step-by-step process models that embody principles for information search, stop, and decision making. For instance, cues may be searched in a specific order or randomly, and search may stop when the first cue supporting a particular decision is found (or if out of time). The decision-making process is considered to be fast and frugal as the heuristics search and use little information in a short period of time.

The Matching Heuristic developed by Dhimi and Ayton (2001), which is the focus of this article, is used for binary classification tasks such as a burglar deciding whether or not a residence is occupied (see Table 5 in Appendix). For example, in the burglary task, imagine that the focal decision is “unoccupied” while the default is “occupied”. Figure 1 shows an example of a burglar's Matching Heuristic model where the maximum number of cues searched (K) is two (i.e., vehicle and curtains at ground level). When presented with a residence, the heuristic assumes that the burglar searches these two cues in rank order for reasons (or critical cue values) to determine occupancy. If a critical value is found for a cue that is searched (e.g., no vehicle parked outside), then search is stopped and the heuristic predicts that the burglar decided that the residence was unoccupied. If a critical value is not found (e.g., there is a vehicle parked outside), then search continues until the last cue is searched and if, by this time, none of the cues has a critical value (e.g., curtains at ground level are drawn) then the heuristic predicts that the burglar decided the residence

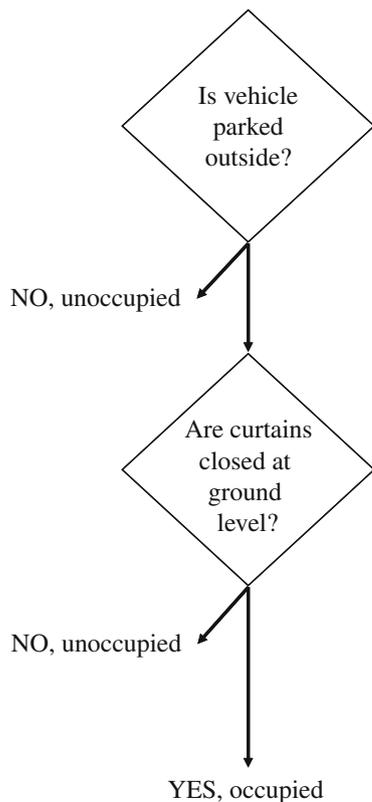


Fig. 1 Example of Matching Heuristic for the residence occupancy decisions, with maximum cue search ($K = 2$)

was occupied. (There are different rules for when information on a cue is missing or unavailable depending on the task; see Dhami, 2003.)

Several simple heuristics have been used to capture peoples' decision policies. Some of these studies have been conducted on experienced (professional) participants in domains such as medicine and criminal justice (e.g., Dhami & Ayton, 2001; Dhami & Harries, 2009; Garcia-Retamero & Dhami, 2009; Snook & Mercer, 2010). For instance, Dhami and Ayton (2001) showed that in predicting judges' bail decisions, the Matching Heuristic performed as well as Franklin's Rule on the cases used to develop the models (i.e., 74% fit for both models), and outperformed Franklin's Rule on a new set of cases (i.e., 66 and 59% fit, respectively; see also, Dhami, 2003). Snook and Mercer (2010) found that, in predicting police officers' decisions about the veracity of suicide notes, the Matching Heuristic outperformed Franklin's Rule, on the cases used to develop the models (i.e., 73% vs. 70% fit).

One limitation of some of the studies using simple heuristics to model experienced (professionals) decision policies is that they examine participants' performance in unrepresentative decision tasks where, for instance, the distributions of cue values and the inter-cue correlations are disturbed (e.g., equal distributions and zero

correlations; exceptions include Dhami, 2003; Snook & Mercer, 2010). Unrepresentative stimuli may prevent participants from demonstrating their natural decision policies, and it may limit the generalizability of the findings beyond the research situation (Dhami, Hertwig, & Hoffrage, 2004). Therefore, we use a representative sample of stimuli (i.e., residences) to model burglars' decisions about whether or not residences in their natural environment (city) are occupied.

Although studies have shown that simple heuristics can fit the decision task environment and individuals' decision policies, as Harries and Dhami (2000) have pointed out, few researchers have studied both the environment and the individual (an exception is Snook & Mercer, 2010). Thus, it is unclear if peoples' decisions are accurate or if they use the most ecologically valid cue in their heuristic. In order to examine these issues, researchers need to document the actual criterion in the environment, and compute the ecological validities of the cues (for example, by correlating the cues with the criterion over a set of cases). However, in a review of 143 studies, Dhami et al. (2004) found that very few researchers included data on the criterion. We know the actual occupancy of the residences (i.e., the criterion), which means we can measure the accuracy of burglars' decisions and can assess if the models that best predict their decisions contain the most ecologically valid cues.

Lastly, few of the studies on simple heuristics have compared the captured policies with individuals' self-reported statements of their policies (an exception is Dhami & Ayton, 2001). Self-reports can be elicited using several techniques such as ratings of cue importance (Cook & Stewart, 1975). Summers, Taliaferro, and Fletcher (1970) showed that participants weighted cues roughly equally in their self-reported policies, whereas the (compensatory) models capturing their policies indicated that they relied heavily on one cue and ignored one other. Participants also reported using significantly more cues than indicated by their models. Finally, participants' decisions were better predicted by the cue weights in the models than the self-reported cue weights. However, such findings cannot conclusively demonstrate that people lack insight into (or awareness of) their decision policies because self-reports are affected by the limitations of memory, introspection, articulation, and social desirability response bias (e.g., Nisbett & Wilson, 1977). Reilly and Doherty (1992) found that people were more likely to accurately recognize their decision policy (from among other policies) than recall their policy. Thus, we obtain burglars' self-reports of cue importance in an open-ended task for each decision made (recognition), and in a rating task after all the decisions are made (recall).

The Present Study

The main goal of this research is to explore the cognitive strategies that offenders may use to make decisions. In particular, we test the extent to which burglars use non-compensatory decision strategies by examining how well the Matching Heuristic (compared to Franklin's Rule) captures experienced burglars' decision policies regarding the occupancy of residences. This research furthers study on burglary by exploring the cognitive processing that may underlie burglars' decisions. It also furthers the discussion of simple heuristics by determining whether the most ecologically valid cue appears as the most important cue in their models, by comparing the correspondence between individuals' self-reported cue importance with that indicated by their models, and, to a lesser extent, measuring individuals' accuracy in their decisions. Importantly, this research overcomes the limitations of some past studies on the Matching Heuristic using representative stimuli from the participants' environment.

Given that the small body of research on the Matching Heuristic has provided fairly consistent results, we predict that it will have at least a relatively similar level of fit to burglars' decision policies in line with Franklin's Rule. Furthermore, we predict that the Matching Heuristic will include significantly fewer cues than Franklin's Rule. Based on the fact that most burglars commit multiple burglaries over time and so have multiple experiences with deciding on residence occupancy, we also predict that their accuracy in deciding whether a residence is occupied or not will exceed that achieved by random choice (i.e., chance levels), and that the most ecologically valid cue will appear as the most important cue in their models. Lastly, because few studies have compared individuals' self-reported cue importance with the cue utilization validities in their Matching Heuristic models, we refrain from making a prediction about the correspondence between the self-reported and the captured cue importance. We predict, however, that a recognition-based rather than recall-based technique will demonstrate greater correspondence between the self-reported and the captured cue importance, in accordance with Reilly and Doherty's (1992) finding that people can better recognize their decision policies than recall them.

Method

Participants

Forty male, sentenced prisoners volunteered to participate in the study in return for \$10. They were identified by classification officers at the prison in the City of St. Johns

because they had been convicted of at least one burglary. The mean age of the sample was 27.85 years ($SD = 8.43$). The mean number of convictions for burglary was 7.27 ($SD = 9.69$), and the mean number of self-reported burglaries without arrest was 15.00 ($SD = 30.06$).

Stimuli

Photographs (8 × 10 in.) of 71 residences were used as stimuli. A Department of Engineering Street Map of the City of St. John's in Canada was used to select residences to be photographed. The map was divided into 10 areas (of 7.60 km² each), and streets were then selected randomly from each area. A property assessment search then determined the street numbers that corresponded with residences on the streets. Using the list of residential street numbers, one residence on each street was selected randomly. One of the authors (JMK) then visited each residence and asked the homeowner whether they would be willing to participate in the study. In cases where the homeowner was not at home or did not give consent immediately, a letter was left at the residence. Letters were also left at the residence opposite to the residence that was selected at random. Of the 289 residences visited, the response rate was 25% ($N = 73$). Upon obtaining consent from the homeowner, the same author revisited the home at one of five randomly selected times (i.e., 9 a.m., 12 p.m., 3 p.m., 6 p.m., and 9 p.m.) to take a photograph of the residence. After the photograph was taken, the home was checked for occupancy by either knocking on the door or ringing the doorbell.

All identifying characteristics such as street numbers and names, family name signs, and car license plates were eliminated from the photographs. The same author examined the photographs and observed the following eight cues: (1) vehicle, (2) security system, (3) windows above ground level, (4) curtains above ground level, (5) curtains at ground level, (6) landscaping to hide behind, (7) dead-bolt, and (8) attached garage. The cues observed by the researchers were the same as those most commonly reported by the burglars when viewing the photographs (e.g., Bennett & Wright, 1984), and were clearly visible in the photos.

The photographs were then coded by the same author and an independent researcher. Inter-rater reliability was assessed using Cohen's Kappa which ranged from .50 (landscaping to hide behind) to .97 (attached garage), with a mean of .78, indicating very good agreement between the two coders (Fleiss, 1981). Table 1 contains the cues, their values and distributions, as well as their ecological validities for the 71 photographs. The inter-cue correlations are contained in Table 2, and the mean inter-cue correlation was $r = .10$ ($SD = .16$) suggesting that the cues were relatively independent of each other.

Table 1 Cues, their values and distributions, and ecological validities

Cues	Values	Distributions (%)	Ecological validities (r_s)
Vehicle	1 = Present	48 (67.61)	.30
	2 = Absent	23 (32.39)	
Security system	1 = Visible	15 (21.13)	-.08
	2 = Not Visible	56 (78.87)	
Windows above ground level	1 = Open	26 (36.62)	.02
	2 = Closed	45 (63.38)	
Curtains above ground level	1 = Open	34 (47.89)	-.03
	2 = Closed	37 (52.11)	
Curtains at ground level	1 = Open	30 (42.25)	.28
	2 = Closed	41 (57.75)	
Landscaping to hide behind	1 = Yes	38 (53.52)	.12
	2 = No	33 (46.48)	
Deadbolt	1 = Visible	28 (39.44)	-.17
	2 = Not Visible	43 (60.56)	
Attached garage	1 = Yes	22 (30.99)	.17
	2 = No	49 (69.01)	

Note: The ecological validity of a cue is defined as how well a particular cue predicts actual occupancy and is computed by Spearman's correlations between each cue and the criterion

Table 2 Inter-cue correlations

Cue	1	2	3	4	5	6	7
1. Vehicle							
2. Security system	.06						
3. Windows above ground	-.10	.25					
4. Curtains above ground	-.18	.26	.33				
5. Curtains at ground	.04	.12	-.06	.15			
6. Landscaping to hide behind	-.10	.14	-.05	.16	.17		
7. Deadbolt	-.24	.15	-.02	.15	.30	.29	
8. Attached garage	.01	.18	.31	.15	-.08	.14	.27

Procedure

All the participants completed the study individually with the same author (JMK) present in an interview room at the prison. First, each participant viewed a different random selection of 20 photographs one at a time and decided whether the residence was unoccupied when the photograph was taken. Second, participants viewed the same 20 photographs again and were asked in an open-ended question to indicate any number of aspects of the photographs that they believed led to their decision in each case. Finally, participants rated the importance of the eight cues in determining their occupancy decisions across the 20 cases on a 7-point scale (1 = *not very important* to 7 = *very important*). The study took, on average, 25 min to complete. Ethical approval for the study was obtained from Memorial University's Interdisciplinary Committee on Ethics in Human Research.

Model Fitting

The Matching Heuristic and Franklin's Rule were used to capture the individual participants' decision-making policies (i.e., cue-decision relations). See Appendix for details as to how the two models are computed.

Results

All the data analyses were idiographic (i.e., for each participant), and the subsequent results are summarized for the full sample. These analyses are typical of psychological research capturing individual's decision policies (see Cooksey, 1996; Gigerenzer et al., 1999).

Modeling Burglars' Decision Policies

Model fit. For each participant, the Matching Heuristic and Franklin's Rule were computed using all the 20 cases. In the Matching Heuristic, the focal decision was unoccupied (coded as 2), and the default decision was occupied (coded as 1). Across participants, the mean proportion of decisions predicted correctly by the Matching Heuristic was 80.00% ($SD = 10.38$, 95% CI = 76.78–83.20%) and 75.50% for Franklin's Rule ($SD = 6.68$, 95% CI = 73.43–77.57%). A paired-samples *t*-test revealed that the mean fit of the two models was significantly different, $t(39) = 3.40$, $p = .002$, $d = .83$, 95% CI = -2.39 to 2.90.

Table 3 Cue search and cue use for the Matching Heuristic and Franklin's Rule modeling decision policies

Cue	Percentage of participants for whom cue was searched in Matching Heuristic	Percentage of participants for whom cue was used to stop search in Matching Heuristic	Mean cue utilization validity in Matching Heuristic	Mean cue weight in Franklin's Rule
Vehicle	66.67	65.00	.77	.72
Security system	4.76	5.00	.48	.45
Windows above ground	7.14	7.50	.51	.45
Curtains above ground	.00	.00	.49	.46
Curtains at ground	4.76	5.00	.48	.45
Landscaping to hide behind	2.38	2.50	.48	.46
Deadbolt	7.14	7.50	.54	.49
Attached garage	7.14	7.50	.48	.45

In order to further explore the strategies that best predicted the participants' decision policies, we classified participants as either using the Matching Heuristic or Franklin's Rule according to the strategy that achieved the highest fit for them, and whether the two strategies differed by at least 10% points (for a similar procedure, see Garcia-Retamero & Dhimi, 2009). Those participants ($n = 22$) for whom the fit of the two strategies coincided or differed by less than 10% points were unclassified. For the remaining 18 participants, we found that 78.00% could be classified by the Matching Heuristic. Thus, the Matching Heuristic was a better fit to burglars' decision policies than Franklin's Rule.

Information search and use in models. Franklin's Rule integrates all of the eight cues. By contrast, the number of cues searched (i.e., K) by the Matching Heuristic to predict participants' occupancy decisions ranged from one to two ($M = 1.05$, $SD = .22$, 95% CI = .98–1.12). Approximately 95% of the participants' Matching Heuristic models searched one cue and the remaining two participants' models searched two cues.

Table 3 contains the percentage of participants for whom each cue was searched and for whom each cue stopped search in the Matching Heuristic, along with the mean cue utilization validities (Matching Heuristic) and the mean cue weights (Franklin's Rule). As can be seen, the "vehicle" cue was, on average, given the greatest weight in both models. It was searched in 66.67% of the participants' Matching Heuristic models, and was used to stop search in 65.00% of these models. All other cues were searched or stopped search in 7.50% or less of the participants' Matching Heuristic models. The "curtains above ground" cue was not searched in any of the participants' Matching Heuristic models.

Burglars' Accuracy in Predicting Occupancy

Accuracy in decisions. The proportion of cases (out of 20) on which each participant made accurate

predictions was calculated. The mean predictive accuracy across participants over all decisions was 63.00% ($SD = 9.32$, range = 45.00–85.00%, 95% CI = 60.11–65.89%), and a one-sample t -test revealed that the burglars' ability to predict occupancy was significantly greater than chance, $t(39) = 8.82$, $p < .001$ (test value = 50%), $d = 1.39$, 95% CI = .95–1.83. Mean predictive accuracy was 68.56% ($SD = 14.95%$) and 54.17% ($SD = 16.72%$) for occupied and unoccupied residences, respectively.

Effective use of cues. As the ecological validities of the cues show, the "vehicle" cue was the most strongly related to actual occupancy (i.e., if a vehicle is present, then the residence is occupied and, if not, then it is unoccupied, see Table 1). The "curtains at ground level" and "attached garage" cues were also related positively to occupancy, and the "deadbolt" cue was related negatively to occupancy. With the exception of "vehicle" and "curtains at ground level", the correlations between the cues and the criterion were relatively low.

The results of the modeling exercise show that the vehicle cue was both the most ecologically valid cue weighted the highest by both models. For a more detailed examination of the effectiveness of participants' use of cues, for each participant, we calculated the correlation between the cue ecological validities (see Table 1) and the utilization validities (Matching Heuristic) and weights (Franklin's Rule) in their models. The mean correlation between the cue ecological validities and the utilization validities in the Matching Heuristic was $r = .43$ ($SD = .21$, 95% CI = .37–.50). The mean correlation between the cue ecological validities and the weights in Franklin's Rule was $r = .31$ ($SD = .36$, 95% CI = .19–.42). A paired-samples t -test confirmed that the two correlations are statistically different, $t(39) = 2.25$, $p < .05$, $d = .50$, 95% CI = .43–.61.

Burglars' Self-Reported Cue Importance

Cue importance for each decision. Overall, participants provided from one to four aspects of the residences in the 20 photographs (hereafter called “reasons”) that they believed led to their occupancy decisions in each case. We calculated the mean number of reasons given by each participant across the 20 cases, and the grand mean across participants was 1.51 ($SD = .23$, 95% CI = 1.49–1.52). In fact, 15.00% of participants provided only one reason for each of the 20 cases, 37.50% provided a maximum of two reasons, 35.00% provided a maximum of three reasons, and the remaining 12.50% provided a maximum of four reasons. Moreover, 11 of the 15 participants who gave a maximum of two reasons provided one reason 80.00% (16 of the 20 cases) of the time. Similarly, all of the 14 participants who provided a maximum of three reasons used three reasons in only 15.00% or less of their 20 decisions, and the five participants who provided a maximum of four reasons did so only once.

Next, we explored the reasons provided by participants, which were classified according to their order (i.e., first, second, third, and fourth). Two researchers coded these reasons independently, and Cohen's Kappa showed that inter-rater reliability was: .95 for the first reason, .89 for the second reason, .89 for the third reason, and 1.00 for the fourth reason. Table 4 contains the percentage of times a reason was given across the participants, and the cases by the order in which it was provided. As can be seen, the most common first reason was “vehicle.” The most common second reason was also “vehicle”, as was the most common third reason. Overall, these results point to the “vehicle” cue as being identified in the photographs as an important cue in making decisions on each case.

In order to assess the degree of correspondence between participants' open-ended self-reports of cue importance with that established by their models, for each participant, we compared the most commonly reported first reason (across the 20 cases) with the cue assigned the highest utilization validity in their Matching Heuristic model and the cue with the highest weight in their Franklin's Rule model, respectively. There was correspondence between the open-ended self-reports and the Matching Heuristic regarding the most important cue for 65.00% (95% CI = 50.22–79.78%) of participants. There was agreement between the open-ended self-reports and Franklin's Rule for 57.50% (95% CI = 41.66–72.34%) of participants.

Cue importance over all decisions. Participants' ratings of the importance of the cues in making their decisions over the 20 cases showed that the most highly rated cue across participants was the visibility or not of a

Table 4 Percentage of reasons provided by their order

Reason	Order			
	First	Second	Third	Fourth
Curtains	4.27	6.42	–	–
Door	–	–	5.66	–
Just looks that way	10.29	11.82	9.43	–
Lights	9.28	13.51	5.66	–
Time of day	–	7.77	16.98	–
Vehicle	53.33	27.70	26.42	–
Windows	7.40	17.57	16.98	–
Other	13.43	15.20	18.87	–

Note: Any reason reported by 5% or less of participants across the cases across all the orders (first, second, third, and fourth) was categorized as “other.” The sample sizes for the first, second, and third reasons were 797, 296, and 53, respectively

security system ($M = 5.68$, $SD = 1.91$). This was followed by the presence or absence of a vehicle ($M = 4.98$, $SD = 1.69$), and landscaping ($M = 4.33$, $SD = 1.46$). The cues receiving the lowest ratings of importance across participants were whether or not there was a deadbolt visible ($M = 3.45$, $SD = 2.04$), and whether or not there was an attached garage ($M = 3.50$, $SD = 1.84$).

In order to make the correspondence analysis comparable to that used for the open-ended responses, for each participant, we took the cue with the highest utilization in the Matching Heuristic and the highest weight in Franklin's Rule and determined whether it corresponded with the cue that was given the highest self-rating. (Correspondence was coded for cues with tied ratings/validities/weights if any of them were the same in the comparison.) There was correspondence between the most important cue in self-ratings and the Matching Heuristic models for 40.00% (95% CI = 24.82–55.18%) of participants, and there was correspondence between self-ratings and Franklin's Rule for 35.00% (95% CI = 20.22–49.78%) of participants.

Finally, we also compared the results of the two techniques (i.e., open-ended cue report by each decision versus cue rating over all decisions). There was correspondence between the cue with the highest utilization validity in the Matching Heuristic and the most important cue in the open-ended self-reports for 65% of participants (95% CI = 50.22–79.78%). There was correspondence between the cue with the highest utilization validity in the Matching Heuristic and the most important cue in the self-ratings for 40.00% of participants (95% CI = 24.82–55.18%). Similarly, there was correspondence between the Franklin's Rule models and the open-ended self-reports for 57.50% of participants (95% CI = 41.66–72.34%), and correspondence between Franklin's Rule and self-ratings for 35.00% of participants (95% CI = 20.22–49.78%). In other words,

the open-ended report by each decision technique showed greater correspondence between self-reported and captured cue use than the rating over all decisions technique.

Discussion

This research aimed to further our understanding of burglars' decision making by exploring the types of cognitive processing, in terms of weighting and integration of information that may underlie their residence occupancy decisions. Here, we summarize and discuss the main findings.

Burglars' Residence Occupancy Decision Strategies

Determining whether a residence is occupied is an important precursor to the decision to break-in. We found, as predicted, that the Matching Heuristic was significantly better at capturing burglars' decision policies regarding residence occupancy than Franklin's Rule. Indeed, for those participants whose models differed in predictive accuracy by at least 10% points, the majority were classified by the Matching Heuristic rather than Franklin's Rule. Also as predicted, it was found that participants' Matching Heuristic models included significantly fewer cues than their Franklin's Rule models. While Franklin's Rule included all the eight cues, the Matching Heuristic contained only one cue for the vast majority of burglars. In both models, however, the most important cue was the "vehicle" cue.

The superiority of the Matching Heuristic over compensatory strategies such as Franklin's Rule is consistent with the past research in the criminal justice domain (Dhami, 2003; Dhami & Ayton, 2001; Snook & Mercer, 2010), and confirms the idea that burglars may use heuristics reported in past ethnographic and interview studies (e.g., Bennett & Wright, 1984; Cromwell et al., 1991, 1993; Nee & Meenaghan, 2006; Rengert & Wasilchick, 2000; Wright & Decker, 1994), as well as Garcia-Retamero and Dhami's (2009) recent study. The importance of the "vehicle" cue is also consistent with earlier research (e.g., Bennett & Wright, 1984; Logie, Wright, & Decker, 1992; Nee & Meenaghan, 2006; Wright & Logie, 1988). For instance, in Bennett and Wright's (1984) study, burglars stated that they would approach the residence if a car was absent, and would change their mind only if other cues pointing toward occupancy emerged as they moved toward the house.

Importantly, this growing body of research on burglars' decision making appears to contradict criminological theories of rational choice that portray offenders as employing compensatory decision strategies that weight and integrate

information (e.g., Becker, 1968; Cornish & Clarke, 1986, Piquero & Tibbetts, 2002). Rather, our findings support the view that criminal decision making is best understood through a limited (or bounded) rationality perspective, where, for instance, offenders make "fast and frugal" decisions using heuristic strategies that are often non-compensatory (e.g., Johnson & Payne, 1986; Tunnell, 2002). As Dhami and Harries (2001) argued, the Matching Heuristic is a psychologically plausible model of how people may make decisions in consequential, real-world decision environments where resources and time are typically limited. Such conditions are likely to be faced by burglars when deciding on residence occupancy.

This study was one of two on the Matching Heuristic that examined the accuracy of individuals' decisions and determined whether the most ecologically valid cue appeared in their models (see also Snook & Mercer, 2010). The burglar's task of deciding occupancy is fraught with considerable uncertainty since the ecological validities of the cues in the environment were fairly low (i.e., on average $r = .10$, where 0 is not at all predictive and 1 is perfectly predictive). Furthermore, the burglar's task is made more difficult by the lack of opportunity for vicarious functioning or inter-substitutability of cues due to the low inter-cue correlations (Brunswik, 1952). Despite this, burglars' accuracy in predicting occupancy was significantly greater than chance levels, thus showing they were not responding randomly. In terms of the effectiveness of their decision policies, burglars' use of the vehicle cue was appropriate given that it was also the cue with the greatest ecological validity (i.e., most strongly associated with actual occupancy). In addition, there was significantly greater correspondence between the cue ecological validities in the environment and both the cue utilization validities in burglars' Matching Heuristic models and the cue weights in their Franklin's Rule models. Given that only a few cues had a reasonable level of ecological validity, searching a limited amount of information is adaptive.

Burglars' Self-Reported Cue Importance

Although a considerable body of literature has compared individuals' self-reported cue importance with that of the compensatory models that capture their decision policies (e.g., Cook & Stewart, 1975; Reilly & Doherty, 1992; Summers et al., 1970), the present study was one of two to conduct this comparison using simple heuristics (see also Dhami & Ayton, 2001). Unlike Dhami and Ayton (2001) who used a cue-ranking technique, we established self-reported cue importance using both a cue-rating task over all decisions and an open-ended task reporting cues by each decision.

In the open-ended task, most participants provided only one reason for the decision in all or the majority of the cases. A comparison between participants' open-ended self-reports and the Matching Heuristic models suggested that burglars appear to be using a very limited amount of information. The most common reason that was provided by participants across the 20 cases in the open-ended task referred to the presence or absence of a "vehicle." By contrast, in participants' *ratings* of cue importance, the vehicle cue was the second most important, after the visibility or not of a security system. Overall, however, there was no significant difference in the proportion of participants who showed correspondence between the most important cue according to their self reports (using either the open-ended or rating techniques) and their Matching Heuristic and Franklin's Rule models.

Getting burglars to recognize the most important cue for each decision revealed significantly greater levels of correspondence than requiring burglars to recall the cue to which has been attached the most importance across all decisions. This finding is consistent with Reilly and Doherty's (1992) claim that insight into, or awareness of, decision policies are best examined using recognition rather than recall-based techniques (although they asked participants to recognize their models rather than the cues used for each decision). Indeed, research suggests that burglars are particularly good at recognizing cues in their environment (Logie et al., 1992). It would thus be beneficial for future research to use the open-ended technique to get individuals to report cue importance for each decision.

Limitations

This research attempted to overcome the limitations of some past study by using representative stimuli from the participants' environment. However, the use of photographs as experimental stimuli may have omitted other cues that are available to burglars such as auditory cues to occupancy. Furthermore, viewing the photographs did not allow burglars to get closer to the residences or take actions such as knocking on the door to determine whether the residences were occupied. Nevertheless, we believe that photographic stimuli are an improvement over the paper-pencil descriptions often presented in research on decision policy capturing (Dhami et al., 2004) and simple heuristics in particular. Furthermore, the photographic stimuli contained most of the cues considered important to occupancy as reported in past research (e.g., Bennett & Wright, 1984; Rengert & Wasilchick, 2000), and the eight cues observed and coded by researchers in the photographs were also

those reported by participants in the open-ended task. However, we look forward to research using alternative technologies, such as interactive videos, which can potentially facilitate improved approximations of burglars' decision processes.

One could argue that the generalizability of the findings is limited because the sample comprised incarcerated offenders (with at least one previous conviction for burglary), who may not be as proficient as unconvicted offenders when making occupancy decisions. In particular, convicted burglars may have relied on different (less predictively valid) cues than their unconvicted counterparts. However, many burglars are caught because of factors other than poor judgment in occupancy decisions and consequent target selection (e.g., CCTV; Coupe & Kaur, 2005). Furthermore, we know of no theoretical reason to believe that the decision strategy (i.e., way in which information is used rather than what information is used) of the unconvicted burglars would differ from that of the convicted ones. We also do not consider the focus on a convicted sample to be a limitation because burglars typically commit larger number of crimes than they are caught for (e.g., Pare, Felson, & Ouimet, 2007). The burglars in the studied sample reported committing twice as many crimes as they had been convicted of. Indeed, even in studies involving burglars who are not incarcerated, some of the participants have prior convictions for burglary (e.g., Wright & Decker, 1994). Finally, beyond the practical issues of recruiting unconvicted burglars that often leads to small, non-random samples (e.g., Rengert & Wasilchick, 1989), ethical issues are involved in studying "active" offenders. It is no surprise that much of the research on understanding crime (and even crime statistics) is based on the arrested and convicted offenders (see Bartol & Bartol, 2007), and this research contributes to this large body of literature.

Implications

There are several avenues for future research, which stem from the present finding that offenders may use simple heuristics or non-compensatory decision strategies. First, researchers may wish to explore the precise cognitive strategies that are used by other groups of offenders to highlight the similarities and differences between different populations, and the cognitive-skills based intervention programs that may be useful during their incarceration. Second, researchers ought to consider the extent to which decision making at various stages of an offender's criminal career (from initial involvement, through specific criminal events, to desistance) is characterized by non-compensatory strategies. Third, given that simple heuristics embody

separate principles for information search, stop, and decision making, researchers could explore the validity of different heuristics in describing burglars' decision making by seeing how well they describe search and stop as well as decision making (see Dhimi & Harries, 2009). Finally, researchers could examine how burglars learn to use specific types of decision strategies. This might involve both studies of expert–novice differences (see Shanteau, 1988) as well as studies of multiple-cue probability learning (see Hammond & Summers, 1965).

This research has shown that burglars are effective, adaptive, and self-aware decision makers who use simple heuristics to decide on residence occupancy. Defensible space theory states that characteristics of the environment associated with a residence can inhibit crime by creating the appearance and feeling of a space that is defended by its occupants, for example, by being occupied (Newman, 1972). Accordingly, manipulation of the cues found to be important for burglars' occupancy decisions in this study could reduce the likelihood of a residence being burglarized. We found that the majority of residential

burglars used the presence or absence of a vehicle in the photograph as their primary indicator as to whether the home was occupied or unoccupied. Therefore, keeping a vehicle in view when possible may inhibit burglars from selecting a particular residence. Unlike other cues to occupancy such as noise from within the property, the presence of a vehicle can be known by a prospective burglar from a distance rather than during the process of burglary, which may additionally reduce the chances of a residence being burgled.

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Appendix

Tables 5 and 6.

Table 5 Calculation of the Matching Heuristic

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- Step 1. A *critical value* indicating a focal decision on a cue is the value of a cue that was most frequently assigned the focal decision in the cases in the modeling set. For example, the critical value for the vehicle cue is “absent”, if more houses with absent vehicles than present vehicles were judged as unoccupied (where unoccupied is the focal decision) (e.g., out of 20 cases, 14 houses with absent vehicles were judged to be unoccupied compared to six houses with present vehicles). (Where the absolute frequencies are equal the cue value with the lowest absolute frequency assigned the non-focal* decision is selected as the critical value, and where this is also equal a critical value is selected randomly.)
- Step 2. Cues are rank ordered according to their *utilization validity* which is defined as the proportion of cases in the modeling set with the critical value that were assigned the focal decision. For example, the validity of the vehicle cue would be the proportion of houses with absent vehicles judged as unoccupied (e.g., 14 houses with absent vehicles were judged to be unoccupied out of 20 is .70). A rank of 1 is assigned to the cue with the largest validity. (Cues with tied ranks are placed in order of their presentation.)
- Step 3. Finally, the maximum number of cues the heuristic searches (i.e., K) is determined by systematically testing the heuristic's ability to correctly predict decisions (or criterion) in the modeling set where $K = N$ cues, $K = N - 1$ cues, $K = N - 2$ cues, etc. The model where K yields the greatest percentage of correct predictions is then selected as the final model. (In the case of a tie between models, the most parsimonious model is selected.)
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Note: We have corrected the typo in Dhimi and Harries (2009) which states “focal” instead of “non-focal”

Table 6 Calculation of Franklin's Rule

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- Step 1. Cue values are coded. For example, for the vehicle cue, houses with present vehicles could be coded as 0 and with absent vehicles as 1
- Step 2. Cue weights are determined by calculating the proportion of each cue value, for a cue, that was judged as unoccupied in the modeling set, and then taking the greater proportion as the weight for the whole cue. For example, if the proportion of houses with a vehicle absent judged as unoccupied is .71 (i.e., 5 houses judged as unoccupied out of 7) and the proportion of houses with a vehicle present judged as unoccupied is .46 (i.e., 6 house judged as unoccupied out of 13), the weight for the vehicle cue would be .71
- Step 3. A threshold value for predicting an unoccupied decision is established across the cases in the modeling set, by taking the sum of each case, totalling these sums, and dividing this total by the number of cases in the modeling set. For example, imagine that the sum of case 1 for burglar 1 was $2.17 = \text{vehicle}(0)(.72) + \text{security system}(1)(.67) + \text{windows above ground}(0)(.67) + \text{curtains above ground}(1)(.78) + \text{curtains at ground}(1)(.72) + \text{landscaping to hide behind}(0)(.73) + \text{deadbolt}(0)(.78) + \text{attached garage}(0)(.67)$. The sum across 20 cases for this burglar might then be 57.40. This would be divided by 20 (cases) to yield a threshold value of 2.87
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