The geography of crime fear: A pilot study exploring event-based perceptions of risk using mobile technology

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ABSTRACT

The current pilot study explores whether mobile technology can be leveraged in survey research to gather meaningful context-dependent data on fear of crime and risk perception formation. A series of Ecological Momentary Assessments (EMAs) were administered to students enrolled at an Australian University (N = 20), using a smartphone application. Analysis of data collected from participants in their everyday activity spaces a) show strong internal consistency among multiple measures of crime fear; b) indicate that perceptual measures of social cohesion are significant predictors of victimisation worry; and c) support most hypothesised associations between concepts contained in contemporary models of crime fear. Unfortunately, some aspects of the pilot study design could not be implemented as planned, which have implications for future research. Specifically, we found that triggering participant’s surveys based on their location (rather than time), produced data that was not conducive to robust place-based analysis. In spite of this limitation, we offer alternative means of measuring the effects of place on fear of crime using mobile devices.

1. Introduction

Public perceptions of crime have an important influence on policy decisions in relation to community safety and the operational activity of law enforcement. Place-based information collected from residents about their perceptions of crime may provide critical information about the state of crime fear within communities, and provide opportunities for managing it more effectively and efficiently. However, most fear of crime research fails to consider the impact that “place” has on fear of crime. Despite recent advancements in geographic technologies, there has been little in the way of methodological improvements to the way we measure fear of crime amongst individuals within their natural environment.

The purpose of this pilot study is to examine whether mobile technology can be leveraged in survey research to gather meaningful context-dependent data on fear of crime and risk perception formation. With exception of recent work by Solymosi, Bowers, and Fujiyama (2015), no known research has examined this important question. We argue that using mobile technology as a tool to collect information about context-dependent perceptions of crime requires a greater recognition of the complexity of fear of crime and its measurement as a social-psychological construct. Furthermore, we argue that a more thorough conceptualisation of “place”—and what it means with respect to an individual’s fear of crime—is long overdue. Finally, we conclude that future work utilising mobile technology to test fear of crime should consider it as a dynamic emotional response to crime and disorder grounded in the everyday experiences of individuals within their proximate environment.

2. Review of literature

2.1. The geography of crime fear

The physical landscape and social geography of “places” affect perceptions of crime, which has been documented in the literature at varying scales. In terms of the physical landscape, macro-level sociological theories have long argued that neighbourhood structural factors can disrupt a community’s ability to self-regulate, which in turn causes crime and delinquency (Park & Burgess, 1925; Shaw & McKay, 1942). Existing contemporary research also
shows that perceptions of neighbourhood disorder and physical decay influence perceptions of crime (Brunton-Smith & Sturgis, 2011). Moreover, extant literature suggests that adverse perceptions of crime can cluster within socially disorganised neighbourhoods, similar to the way that crime patterns form hot spots (Wyant, 2008).

At the micro-level, criminology-of-place scholars argue that crime concentrates and endures in relatively smaller units of geography, including street segments (Weisburd, Benasco, & Bruinsma, 2009; Weisburd & Eck, 2004). Furthermore, these scholars purport that the environmental backcloth is supportive of victim and offending behaviour within these small geographic “places” (Brantingham & Brantingham, 1999), and that the physical characteristics of the environmental backcloth can influence attitudes towards crime, as well as individual responses to it (i.e., constrained behaviours) (Pain, 2000; Warr, 1990).

In terms of social geography, existing research demonstrates a strong correlation between the social meaning of “places” and attitudes towards them, including attitudes towards crime. Research within this field has linked fear of crime, for example, to how people view their quality of life and the urban environment in which they live (Pacione, 2003). This perspective reflects a more humanistic interpretation of place (Tuan, 1977), where “spaces become ‘places’ as they become imbued with meaning through lived experiences” (Stedman, 2003, p. 672). This means that we must better understand the way in which individuals interact with their proximate environment if we are to better understand how their attitudes, such as fear of crime, are affected by it.

With few exceptions (e.g., Solymosi et al., 2015), most studies largely ignore the interaction between people and their proximate environment and how this interaction affects perceptions of crime. This deficiency in the existing empirical scholarship may not be a result of disinterest, but rather shortcomings in the traditional methods used to study fear of crime and the common measures used to assess it. Without new methodological approaches to studying—and innovative ways of measuring—this social issue, our ability to disentangle the role “place” plays in risk perception formation will be stymied.

2.2. Measures and methods in fear of crime research

Scholars have debated the validity and reliability of traditional measures of fear of crime for many years, especially perceptions of safety questions such as, “How afraid are you of walking alone in your neighbourhood at night” (Farrall, Bannister, Ditton, & Gilchrist, 1997; Jackson, 2005). Results from various national surveys indicate that when asked about perceptions of safety at night in an area, individuals tend to indicate that they are somewhat fearful, with most fearful respondents being women and the elderly (e.g., ABS, 2010). However, scholars have argued that perceptions of safety questions such as these are simply too narrow for measuring complex processes that may be associated with fear of crime, as they tend to disregard physiological and emotional responses to criminal events (Hale, 1996; Jackson, 2005). Additional criticisms of traditional measures of crime fear are that they a) ignore the frequency with which respondents feel fearful of crime; b) fail to identify whether fear varies over time; and c) ignore important features related to risk perception formation such as perceptions of control and consequences of victimisation (Killias, 1990).

In response, more valid and reliable indicators of victimisation worry have been developed. These alternative measures are framed in reference to existing research on risk perception formation (Ferraro, 1995; Killias, 1990) and social-psychological theories of fear, evaluating the physical and social environment, general beliefs about the frequency with which crime occurs, whether an individual can control becoming a victim of crime, and the perceived consequences of victimisation if it were to occur (Jackson, 2004). Furthermore, tests of these alternative indicators of crime fear in robust social-psychological models of victimisation worry (e.g., Jackson, 2004, 2005, 2009; Chataway & Hart, 2016) show that they are valid and reliable measures of this complex, multi-dimensional concept (see Fig. 1).

Although this alternative conceptualisation of crime fear has been validated in many countries, it is yet to be tested with emerging technologies that are designed to gauge fear of crime in real-time/place. Specifically, it is unknown whether the quality of contemporary indicators of victimisation worry can be retained if they are derived from methods other than traditional paper-pencil surveys; and perhaps more importantly, whether alternative methods for collecting these measures can further our empirical understanding of the impact that place has on perceptions of crime, disorder, and victimisation risk.

2.3. Fear of crime research methods

Most of our empirical knowledge about individual’s fear of crime is derived from survey research. Unfortunately, paper-pencil surveys tend to produce data that lack ecologically valid information that is needed to assess fear of crime within a person’s natural environment (Gray, Jackson, & Farrall, 2011; Pain, 2001). It is not clear, for example, whether individuals’ reactions to crime within the environment are stable across time and different “places”, when paper-pencil methods are used (Solymosi et al., 2015). Likewise, most models designed to explain the processes behind crime fear and risk perception formation are tested using cross-sectional survey data—limiting conclusions that can be drawn about the stability of crime fear over time and different places (Jackson, 2005).

One possible way to resolve this issue is to measure fear of crime by conducting Ecological Momentary Assessments (EMAs) (Czikszentmihalyi & Larson, 1992). In the health, medical, and psychological sciences, EMAs are often administered as a Short Message Service (SMS) (i.e., text messages) that are sent to study participants’ mobile devices and designed to illicit feedback/responses while participants are in their natural settings (Raento et al., 2009). Alternatively, EMAs can be delivered to study participants as part of a mobile application. Several commercial applications exist that support EMA research, which are designed to test social behaviour using temporal and spatial sensors already built into smartphones. Because EMAs gather data from individuals while in their natural settings, they are capable of producing data with greater ecological validity, compared to retrospective paper-pencil surveys (Brewer, 2000; Moore, Elkins, McNulty, Kivisto, & Handsel, 2011).

EMA participation and completion rates tend to be relatively high, often ranging between 70% and 90%. These high rates of completion may be due, in part, to EMAs being relatively quick and easy to complete with mobile technology, which can also help reduce respondent fatigue and reactivity effects (Collins, Kashdan, & Gollnisch, 2003; Muesing et al., 2013). Empirical evidence also suggests that measures of concepts delivered through momentary assessments have strong concurrent and construct validity (Serre et al., 2012).

Despite the benefits of EMAs, some evidence suggests that self-selection bias may occur during participant recruitment and when

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1 Here “ecological validity” refers to the extent to which results from surveys can be generalised to everyday life and social actions (Shiffman, Stone, & Hufford, 2007).
respondents receive an EMA signal to record their data (Larson, Moneta, Richards, & Wilson, 2002). Similarly, hard-to-reach populations such as the homeless or those without easy access to—or understanding of—modern technology may be difficult to study. Additional training for participants and/or strategies that allow subjects to choose their preferred means of communication with researchers (e.g., texting versus emailing data) have been used in past research to ameliorate some of the problems associated with using EMAs to study unique populations (Muessig et al., 2013).

With respect to fear of crime research, there has been only one study to our knowledge that has used EMAs to assess reactions to crime and risk within the natural environment. This study was conducted by Solymosi et al. (2015) and consisted of a sample of six London residents. Solymosi and her colleagues developed the Fear of Crime Application (FOCA) and regarded perceptions of crime as an event that was situated in the individual’s immediate environment and personal activity space.

FOCA used temporal triggering logic to “push” surveys to participant’s mobile phones, during peak transportation times, in London. Using a single-item measure of “fear,” participants were asked how worried they were about crime in the present moment. If respondents indicated they were worried, they were asked to describe what type of crime they were worried about and to identify where they were worried by dropping a digital pin on a digital map. Results of this study suggest that fear of crime can be potentially mapped as a dynamic mode of perception and that worry about criminal victimisation changes as a function of time and place.

Although Solymosi et al. (2015) demonstrated that mobile devices can be used to test fear of crime within transportation journeys, important questions about the use of mobile technology to study fear of crime and risk perception remain, including a) the long-term feasibility of this approach, b) its application to an individual’s regular day-to-day movements, c) whether more sophisticated measures of victimisation worry can be delivered as part of momentary assessments, d) whether using additional built-in sensors to ping participants a survey (e.g., GPS) can produce reliable and valid spatial data about fear of crime within local areas, and e) whether these data fit contemporary models of victimisation worry.

We argue that moving away from traditional measures of crime fear and paper-pencil survey methods may offer an improved understanding of the spatial and temporal factors that may affect risk/threat perception and fear of crime. However, to date, there remains little insight into the benefits and possible unintended consequences of using mobile technology to measure fear of crime and perceptions of risk across movements in time and place. Guided by the extensive body of literature on mobile EMAs in the health, medical, and psychological sciences, Solymosi et al. (2015) have provided a useful mechanism for answering these shortcomings in relation to measuring context-dependent fear of crime—mobile apps. However, there remains limited insight into whether more ambitious retrospective measures of worry and risk can be administered using mobile technology.

3. Current study

Using mobile technology to deliver EMA’s of crime fear and risk perception, the present investigation begins to fill existing gaps in our knowledge about attitudes towards crime, with particular focus on the measurement of key constructs in real time and place. Specifically, this pilot study aims to examine whether mobile devices can be used to collect meaningful data about the spatio-temporal context of fear of crime and risk, by using alternative retrospective measures.

4. Data and method

A convenience sample of students (N = 20) enrolled at an Australian university and who lived on the Gold Coast of Queensland volunteered for the pilot study designed to measure

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2 The Gold Coast is located in Southeast Queensland, Australia. It is the second most populous city in the state, with approximately 537,844 residents (ABS, 2011). The Gold Coast covers about 1,379 km².
perceptions of crime in real time/place, using EMAs. Information about the study, how to download the smartphone app, and activate the EMAs was provided to each volunteer. Volunteers were required to use their own smartphone device and data plan; and were not incentivized to participate.

The app used GPS sensors built into participants’ smartphones to trigger the EMAs, based on their movements within the study area. A total of 10 locations were geofenced, representing various parts of the study area that participants were likely to travel (e.g., shopping centres, central business district, local beaches, etc.) during the three-month data collection period. Images of the mobile interface of the app are displayed in Fig. 2. Participants were allowed to skip questions delivered during the EMA; and at the end of the data collection period, a total of 50 EMAs were submitted. Four were excluded from analysis due to a large number of incomplete responses.

The smartphone app contained two data collection instruments. First, a pre-experiment demographic questionnaire was provided to volunteers once they activated the app on their smartphone. Second, a fear of crime instrument that included Jackson’s (2005) questions relating to perceptions of worry, likelihood of victimisation experience, consequences of victimisation, perceived control over crime, beliefs about the incidence of crime, and perceptions of the social and physical environment (incivility and social cohesion) was delivered as an EMA, when triggered by a participant entering a geofenced location.

Frequency of worry about personal victimisation was measured using a 4-item response set, where 1 indicates “Not once in the last month” and 4 corresponds to “Everyday” (M = 1.57; SD = 0.60). Likelihood of personal victimisation was measured on a 7-point scale, where only the endpoints were labeled: 1 = “Definitely not going to happen” and 7 = “Certain to happen” (M = 3.04; SD = 0.96). Attitudes about the consequences of personal victimisation were also measured on a 7-point scale, with only the endpoints labeled: 1 = “Not at all” and 7 = “To a very great extent” (M = 4.70; SD = 1.66). Using the same 7-point scale, participants’ were asked about the extent to which they had control over becoming a victim of a personal crime (M = 3.42; SD = 1.52). Finally, participants were asked how often they believed that crime would occur in the area during the next month (i.e., belief). A 4-point scale that ranges from 1 “Never in the next month” to 4 “Every day in the next week” was used to measure this dimension of fear (M = 1.89; SD = 0.68).

In order to assess perceptions of the participants’ proximate environment, seven questions were used to measure attitudes towards both physical and social incivility. Participants were asked how much of a problem they felt the following conditions were in the immediate area: (a) vandalism/graffiti; (b) rubbish in the streets; (c) dogs out of control/creating a mess; (d) drug-taking in the open; (e) drinking in the street; (f) teenagers hanging around; and (g) not enough things for young people to do. On average, study participants rated the areas around them 2.49 out of 4.00 (SD = 0.52), where 1 indicates incivilities are “Not a problem at all” and 4 indicates that they are “A very big problem”.

Seven questions were also used to measure informal social control and social capital (i.e., social cohesion). Participants were asked how much they agreed with the following statements: (a) the people who live here can be relied upon to call the police if someone is acting suspiciously; (b) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (c) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (d) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (e) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (f) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; and (g) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously. Participants were asked how much they agreed with the following statements: (a) the people who live here can be relied upon to call the police if someone is acting suspiciously; (b) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (c) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (d) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (e) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; (f) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously; and (g) if any of the children or young people who live here can be relied upon to call the police if someone is acting suspiciously.

In contrast to Jackson’s (2005) original questionnaire, retrospective questions were framed in relation to the participant’s geofenced location, rather than their neighbourhood. Furthermore, we chose to only examine fear of personal crime within reference to the participant’s location at the time of the survey. Specifically, three indicators of personal victimisation were examined: a) being attacked in the area; b) being robbed or mugged in the area; and c) being harassed, threatened, or verbally abused in the area.
off; (c) if I sensed trouble whilst in this area, I could raise attention from people who live here for help; (d) this area has a close, tight-knit community; (e) this area is a friendly place to live; (f) this area is a place where local people look after each other; and (g) most people who live in this area trust one another. Using a 5-point Likert scale, where 1 corresponds to “Very strongly disagree” and 5 corresponds to “Very strongly agree,” on average, participants indicated that the area around them was somewhat socially cohesive (M = 3.18; SD = 0.93).

### 4.1. Analyses

In Jackson’s (2005) original study, scaling properties of his social-psychological process model of victimisation worry were assessed using Confirmatory Factor Analysis. Due to the sample size constraints in the current study, we were unable to estimate the full structural models of victimisation worry using this statistical technique. Instead, we produced reliability coefficients (Cronbach’s Alpha) to test the internal consistency of all scales used in the piloted mobile instrument. Cronbach’s Alpha is appropriate to use for small samples as it is calculated from the average correlation and the number of items included in the potential scale (Carmine & Zeller, 1979).

In addition to these reliability assessments, logistic regression models were estimated, to assess a) the effect that perceptions of the physical and social environment had on the probability of worrying about personal crime; and b) the hypothesised relationships between perceptions of threat (i.e., the likelihood, consequences, and control constructs) and their impact on the probability of worrying about three types of personal victimisation considered in the current study (i.e., being attacked, robbed/mugged, and harassed).6

Binary logistic regression was used due to sampling constraints. Preferred statistical tests, such as ordinal regression, were not possible given the sample size and the skewed distribution of some variables (i.e., worry about crime). To assist with interpretation of the first logistic regression model, semi-standardized beta coefficients were calculated using predicted probabilities as a reference point. These coefficients allow for an assessment of the relative strengths of relationships involving variables measured in different metrics (see King, 2007). For the second model, our interpretation of findings is based on the odds ratios produced by the logistic regression model, as additional interpretation of semi-standardized beta coefficients with only dichotomous predictor variables cannot provide meaningful information about the relative strengths of relationships within the model (Menard, 2011).

In the first model, individuals’ perceptions of incivility and social cohesion within their immediate area were averaged by calculating the mean of all response alternatives for incivility and social cohesion, respectively. For perceptions of incivility, the higher the average score, the more perceived incivility within the participant’s immediate area. For perceptions of cohesion, the lower the average score, the less perceived cohesion within the participant’s immediate area.

In the second model the five key dimensions of Jackson’s measures of victimisation worry were recoded into dichotomous variables by splitting the original scale for each dimension of the model at their mid-points (refer to Table 1 for coding labels).7 For example, the response alternatives for the likelihood of becoming the victim of a personal attack were recoded so that participants who perceived an attack as 1 = Definitely not going to happen, through to a 3 on the scale were recoded into a 0 = Not Likely to be Victimised. In contrast, participants who responded with a 4 through to a 7 = Definitely going to happen were recoded into a 1 – Likely to be Victimised.

The dependent variable for both estimated models is frequency of worry. For the three personal crime indicators of worry about: being attacked, being robbed/mugged, and being harassed/threatened in the area, response alternatives were dichotomised so that any occurrence/event of worry about the different types of victimisation over the period of one month were recoded as a 1 = Worried about victimisation. Remaining participants who had not worried about being attacked, being robbed/mugged, and being harassed/threatened in the area were coded as a 0 = Not worried about victimisation. Table 1 displays the labels for the binary variables used in the current study.

### 5. Results

The reliability of Jackson’s (2005) measures was assessed using Cronbach’s Alpha to determine whether data measuring these dimensions are reliable when collected from participants using EMAs delivered on mobile technology. Table 2 presents the reliability coefficients, which indicate how closely related the set of items are as a group, for each dimension of Jackson’s model. Coefficients are produced for each of the three indicators of personal crime.

As shown in Table 2, all dimensions of the social psychological model have good internal consistency/reliability (α > 0.75). In addition, measures used to gauge perceptions of the physical and social environment also have good-to-excellent internal consistency when delivered across multiple environments (e.g., incivility, α = 0.73 and social cohesion α = 0.91). Collectively, scaling properties of each measure of victimisation worry represented in Jackson’s model have good reliability, based on data collected using mobile EMAs.

Next, the hypothesised association between disorder, social cohesion, and worry about crime was tested using logistic regression.8 Table 3 provides results of logistic regressions examining the association between disorder and social cohesion on each indicator of personal victimisation worry.

As seen in Table 3, perceptions of incivility within the immediate area did not predict worry about any type of personal victimisation. Additionally, the odds ratios did not appear to be in the

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Binary recoding of dimensions of victimisation worry for logistic regression models.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Dimensions</td>
<td>Label</td>
</tr>
<tr>
<td>Frequency of Worry(^D)</td>
<td>0 – Not Worried About Being Victimised</td>
</tr>
<tr>
<td>Likelihood of Victimisation</td>
<td>0 – Not Likely to be Victimised</td>
</tr>
<tr>
<td>Consequences of Victimisation</td>
<td>0 – Not Affected by Being Victimised</td>
</tr>
<tr>
<td>Control Over Victimisation</td>
<td>0 – Cannot Control Being Victimised</td>
</tr>
<tr>
<td>1 – Affected by Being Victimised</td>
<td></td>
</tr>
<tr>
<td>1 – Can Control Being Victimised</td>
<td></td>
</tr>
</tbody>
</table>

\(^D\) = Dependent Variable.
hypothesised directions of the model provided in Fig. 1. For example, a one-unit increase in perceived incivility actually decreased the likelihood of worrying about being attacked over the period of one month by 16%. Similarly, a one-unit increase in perceived incivility decreased the odds of worrying about being robbed/mugged over the period of one month by 40%. Finally, a one-unit increase in perceived incivility decreased the odds of worrying about being harassed, threatened or verbally abused over the period of one month by 43%.

In contrast, perceptions of social cohesion within participants' immediate surroundings predicted worry about all types of personal victimisation that were measured—and odds ratios were in the expected directions. Additional inspection of semi-standardized coefficients in Table 3, indicate that perceptions of social cohesion—in comparison to incivility perceptions, are a stronger predictor of worry about personal victimisation. Specifically, a one-unit increase in perceived cohesion decreased the odds of worrying about being attacked in the area by 70%. Moreover, a one-unit increase in perceived cohesion decreased the odds of worrying about being robbed/mugged in the area by 81%. Finally, a one-unit increase in perceived cohesion decreased the odds of worrying about being harassed, threatened, or verbally abused by 72%.

Finally, the hypothesised associations between perceptions of vulnerability/appraisal of threat and frequency of worry about personal crime within the proximate environment were assessed. Table 4 provides results of the logistic regressions used to test the association between perceptions of vulnerability/threat and worry about crime for each indicator of personal victimisation.

As seen in Table 4, all but two of the dimensions significantly predicted the probability of being worried about a particular type of personal victimisation at the $\alpha < 0.10$ level, with exception to the likelihood of victimisation predicting whether participants reportedly worry about being attacked and the consequences of victimisation predicting whether participants reportedly worry about being robbed or mugged ($b = 0.77$, $p = 0.180$; $b = 0.73$, $p = 0.197$, respectively).

When looking at individual dimensions of risk perception and vulnerability and their effect on worry about specific types of personal crime in the immediate area, it can be seen in Table 4 that those who believed that harassment was likely in an area had an increased likelihood of being worried about harassment over a period of one month ($OR = 6.81$). Similarly, those who believed that they would be affected by harassment in the immediate location had an increased likelihood of being worried about this type of victimisation over a period of one month ($OR = 2.80$). However, inconsistent with Jackson (2005), those who perceived they had control over becoming the victim of harassment within the area had a higher likelihood of being worried about harassment over a period of one month ($OR = 4.33$). Results of all remaining logistic regression models for worry about personal attack and worry about robbery are provided in Table 4.

5.1. Placing fear of crime

Rather than triggering surveys at time points, the current study set out to use mobile GPS sensors to trigger surveys to participants when they entered a specific location or area. Unfortunately, this alternative method for collecting spatial information about fear of crime and disorder patterns was not feasible. There were two noteworthy reasons for our inability to execute this aspect of our study design. First, our sample size was not sufficient to conduct spatial analyses on fear of crime, given the number of completed and returned EMAs.

Second, we were unable to group all respondents who were pinged as a result of entering the geofenced locations into one group, in order to represent one unique “place”. Theoretically, this

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Table 2
Descriptive statistics and Cronbach’s alpha coefficients for personal crime model ($N = 46$).

<table>
<thead>
<tr>
<th>Scale/Dimension</th>
<th>Min</th>
<th>Max</th>
<th>M</th>
<th>SD</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worry</td>
<td>1</td>
<td>3</td>
<td>1.57</td>
<td>0.60</td>
<td>0.78</td>
</tr>
<tr>
<td>Likelihood</td>
<td>1</td>
<td>5</td>
<td>3.04</td>
<td>0.96</td>
<td>0.87</td>
</tr>
<tr>
<td>Consequences</td>
<td>1</td>
<td>7</td>
<td>4.70</td>
<td>1.66</td>
<td>0.89</td>
</tr>
<tr>
<td>Control</td>
<td>1</td>
<td>6</td>
<td>3.42</td>
<td>1.52</td>
<td>0.99</td>
</tr>
<tr>
<td>Belief</td>
<td>1</td>
<td>3</td>
<td>1.89</td>
<td>0.68</td>
<td>0.84</td>
</tr>
<tr>
<td>Incivility</td>
<td>1</td>
<td>3</td>
<td>2.49</td>
<td>0.52</td>
<td>0.73</td>
</tr>
<tr>
<td>Social Cohesion</td>
<td>1</td>
<td>5</td>
<td>3.18</td>
<td>0.93</td>
<td>0.91</td>
</tr>
</tbody>
</table>

Note. $N = 46$ reflects the number of location based surveys completed by respondents.

Table 3
Logistic regression results of incivility/cohesion and frequency of worry about personal crime ($N = 46$).

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>$b$</th>
<th>SE$^a$</th>
<th>$\beta$</th>
<th>OR</th>
<th>Wald</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worry About Attack$^d$</td>
<td>-0.18</td>
<td>0.70</td>
<td>-0.02</td>
<td>0.84</td>
<td>0.07</td>
<td>0.399</td>
</tr>
<tr>
<td>Incivility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Cohesion</td>
<td>-1.22</td>
<td>0.42</td>
<td>-0.27</td>
<td>0.30</td>
<td>8.50</td>
<td>0.002</td>
</tr>
<tr>
<td>Constant</td>
<td>4.08</td>
<td>2.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worry About Robbery/Mugging$^b$</td>
<td>-0.92</td>
<td>0.77</td>
<td>-0.12</td>
<td>0.40</td>
<td>1.43</td>
<td>0.116</td>
</tr>
<tr>
<td>Incivility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Cohesion</td>
<td>-1.67</td>
<td>0.50</td>
<td>-0.36</td>
<td>0.19</td>
<td>11.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Constant</td>
<td>7.00</td>
<td>2.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worry About Harrassment$^c$</td>
<td>-0.57</td>
<td>0.71</td>
<td>-0.07</td>
<td>0.57</td>
<td>0.63</td>
<td>0.215</td>
</tr>
<tr>
<td>Incivility</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Social Cohesion</td>
<td>-1.28</td>
<td>0.42</td>
<td>-0.29</td>
<td>0.28</td>
<td>9.08</td>
<td>0.003</td>
</tr>
<tr>
<td>Constant</td>
<td>5.44</td>
<td>2.47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\beta$ = semi-standardized beta weight using the mean predicted probability of each DV outcome as a reference value.

$^a$ Nagelkerke $R^2 = 0.283$.

$^b$ Nagelkerke $R^2 = 0.405$.

$^c$ Nagelkerke $R^2 = 0.304$.

$^d$ Nagelkerke $R^2 = 0.301$.

$^e$ Nagelkerke $R^2 = 0.308$.

$^f$ Nagelkerke $R^2 = 0.279$.

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Table 4
Logistic regression results of vulnerability model and frequency of worry about personal crime ($N = 46$).

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>$b$</th>
<th>SE$^a$</th>
<th>$\beta$</th>
<th>OR</th>
<th>Wald</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worry About Attack$^d$</td>
<td>0.73</td>
<td>0.80</td>
<td>0.09</td>
<td>2.08</td>
<td>0.04</td>
<td>0.180</td>
</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consequences</td>
<td>2.01</td>
<td>0.77</td>
<td>0.13</td>
<td>2.91</td>
<td>2.23</td>
<td>0.068</td>
</tr>
<tr>
<td>Control</td>
<td>1.07</td>
<td>0.72</td>
<td>0.12</td>
<td>2.91</td>
<td>2.23</td>
<td>0.068</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.27</td>
<td>0.83</td>
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<tr>
<td>Worry About Robbery/Mugging$^b$</td>
<td>1.80</td>
<td>0.95</td>
<td>0.21</td>
<td>6.03</td>
<td>3.58</td>
<td>0.029</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Consequences</td>
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<td>0.90</td>
<td>0.09</td>
<td>2.15</td>
<td>0.73</td>
<td>0.197</td>
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<td>Control</td>
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<td>0.86</td>
<td>0.26</td>
<td>8.83</td>
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<tr>
<td>Worry About Harrassment$^c$</td>
<td>1.92</td>
<td>0.85</td>
<td>0.24</td>
<td>6.81</td>
<td>5.04</td>
<td>0.013</td>
</tr>
<tr>
<td>Likelihood</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consequences</td>
<td>1.03</td>
<td>0.79</td>
<td>0.13</td>
<td>2.80</td>
<td>1.69</td>
<td>0.097</td>
</tr>
<tr>
<td>Control</td>
<td>1.56</td>
<td>0.76</td>
<td>0.20</td>
<td>4.77</td>
<td>4.22</td>
<td>0.020</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.44</td>
<td>0.97</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\beta$ = semi-standardized beta weight using the mean predicted probability of each DV outcome as a reference value.

$^a$ Nagelkerke $R^2 = 0.283$.

$^b$ Nagelkerke $R^2 = 0.405$.

$^c$ Nagelkerke $R^2 = 0.304$.

$^d$ Nagelkerke $R^2 = 0.301$.

$^e$ Nagelkerke $R^2 = 0.308$.

$^f$ Nagelkerke $R^2 = 0.279$.

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The control-worry relationship was in the opposite direction to the hypothesised model for all indicators of personal victimisation. We explore possibilities for this finding in the discussion section.
is important because in the current study "place" is defined by a physical location within a pre-defined area—however, there may be significant spatial and temporal variability between participants who submit a survey within the same pre-defined area. Thus, participants who responded to the EMAs in the same location may have had contrasting opinions of the environment they were in (i.e., an individual may perceive the location as their neighbourhood, and another as a less familiar public space), and this may have subsequently affected their perceptions of crime and other local problems within that area. We discuss alternative avenues for exploring place and its potential relationship with fear of crime using mobile technology in the discussion section below, based on our findings, and existing research on the geography of place.

6. Discussion

This pilot study explored the feasibility of using mobile devices to collect information about context-specific fear of crime. Results of our pilot investigation indicate that some dimensions of victimisation worry are significant predictors of worry about personal crime, while others are not. Further confirmatory studies are needed to explore the associations between dimensions of the model that are not consistent with how these associations have been documented in past studies (Chataway & Hart, 2016; Jackson, 2005).

First, we found that retrospective measures of worry are reliable when delivered on smartphones. Our results indicate that the five dimensions of victimisation worry, as well as indicators of incivility and social cohesion within a particular area, have good internal consistency and reliability. This mirrors previous work by Chataway and Hart (2016), who found strong support for the reliability of Jackson's (2005) model of victimisation worry when tested using paper-pencil survey methods in Australia.

Second, the current results suggest that risk perception formation and appraisal of threat in reference to personal crime victimisation is represented by the combination of two unique factors of the social-psychological model of victimisation worry—the likelihood of victimisation and the consequences of victimisation. Although the strength and significance of these two factors (likelihood and consequences) on worry about crime varies depending on the type of personal crime measured, our findings are somewhat consistent with previous work by Jackson (2009), who has tested the underlying features of risk perception formation.

However, our logistic regression models indicate that the relationship between perceived control over crime and frequency of worry is in the opposite direction to what has been hypothesised in Jackson's (2005) model. That is, the odds of being worried about personal crime within an area were found to be higher for those who perceived they had control over personal victimisation. This may be a consequence of the EMA approach, given that paper-pencil surveys using Jackson's measures in the Australian context have supported the hypothesised direction of the control-worry relationship (see Chataway & Hart, 2016). These disparate findings may be due to the paper-pencil approach being cross-sectional in nature, and restricted to the participant's own neighbourhood. Thus, we may find that when asked about control over victimisation across a number of places people may respond differently than when asked to generalize such perceived experiences within their own neighbourhood. However, further confirmatory studies are needed to explore the control-worry relationship with larger samples using the EMA approach.

Third, results of the current study suggest that indicators of incivility do not appear to significantly influence worry about different types of personal crime, but perceptions of social cohesion in an area do. This finding is somewhat inconsistent with the literature on fear of crime; and more specifically, the strong positive associations that have been noted between highly disordered environments and fear of crime in past empirical investigations (Brunton-Smith & Sturgis, 2011). Due to the small sample size in the current study, we caution this finding and suggest once again that larger confirmatory studies using the EMA approach are needed to test this hypothesised relationship between incivility and worry about crime.

6.1. Limitations

The current study demonstrated that retrospective measures of victimisation worry could be administered using mobile devices; however, a number of challenges were identified. First, we found that triggering participant's surveys based on their location (rather than time), produced data that was not conducive to robust spatial analysis. Therefore, we argue that researchers interested in using mobile devices to measure fear of crime in the natural environment rethink what is meant by the term "place". As Solymosi et al. (2015) argues, "it is important to consider fear of crime events at the smallest possible scale to be able to un-erroneously associate them with elements of the environmental backcloth such as incivilities, crime, and disorder" (p.198).

One way to "tease out" the effect place may have on fear of crime, is to ask respondent's questions about the "place" in which they are currently located, in addition to estimating the specific geographical coordinates of that particular place. Specifically, questions might ask how familiar participants are with the current location (i.e., their awareness space) (Brantingham & Brantingham, 1999), do they feel generally anxious within this location, and how often do they frequent this place.

For example, an individual may feel quite comfortable in a semi-private place that is not necessarily their home, but has meaningful significance to them such as their place of work. Thus, they may be more likely to notice small irregularities/peculiarities (i.e., a person or object that looks out of place) within this familiar environment—in turn this may affect their concerns for safety and levels of perceived risk posed by crime (Innes, 2004). Future work could collect this more detailed EMA data on perceptions of place to explore a) how fear of crime differs among perceived places (i.e., home, school, work, and public spaces); and b) how familiarity/attachment with these places affects fear of crime and other related constructs (i.e., disorder and place-dependent anxiety) (10).

Second, although we found that retrospective measures of victimisation worry could be administered using mobile devices, the sample size in the current study did not allow us to accurately examine the stability of the various dimensions of worry over the course of time. Thus, larger confirmatory studies are needed to investigate possible temporal features of victimisation worry. More importantly, despite finding that retrospective indicators of victimisation worry used in the current study have good reliability and internal consistency, we support Solymosi et al. (2015) assertions that retrospective questions provide a static picture of an event that has occurred in the past, and that future work might consider adopting momentary measures of fear of crime and risk.

We hope the current study will lead to future research exploring place-based perceptions, and more specifically research that expands original process models of victimisation worry (i.e., Jackson's 2005 model) to a momentary approach. This is especially

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(10) Another avenue of future research may be to test the effect psychological distance has on context dependent fear of crime, specifically the dimensions of temporal and spatial distance, which can be easily captured with EMA techniques (Gouseti & Jackson, 2015).
important, considering the relationships found between risk perception (likelihood of victimisation and consequences of victimisation) and context dependent worry about crime in the current study, and other research (Jackson, 2009). Adapting these process models of victimisation worry to a momentary event-related model of fear of crime may provide a clearer picture of the underlying psychological processes behind fear of crime and risk when it is experienced within the proximate environment.

7. Conclusion

The current pilot study aimed to advance our existing understanding of the relationship between place and fear of crime, by testing alternative measures of crime fear using mobile technology. We argue that criminologists and researchers alike need to move away from traditional measures of fear of crime (i.e., perceptions of safety questions, and single item measures), that are collected using paper-pencil surveys, so that a better insight into the spatial and temporal factors that may affect risk perception formation and fear of crime within the proximate environment can be established. Our pilot study confirms that mobile devices may be a reliable alternative to measuring fear of crime, and some aspects of retrospective worry about crime in particular—within the immediate environment. It is suggested that researchers should make use of this relatively cost effective, and reliable data collection tool for measuring complex social phenomena, such as fear of crime, and disorder perceptions. The more that we know about fear of crime events, and how the environmental backdrop interacts with an individual's specific movements within time and place, the better informed our interventions will be that are designed to reduce the prevalence of fear of crime in the community.

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References


