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Influence of Environmental Variables on Fear of Crime: comparing self-report data with physiological measures in an experimental design

Abstract

Objectives

Self-reports and questionnaires have been the preferred research methods in the criminological field of Fear of Crime (FOC) since its rise in the 1960s. Our study had two main goals: 1) to measure the physiological indicators of fear in real time, and 2) to compare these data with those obtained through self-reports, designed also to measure the emotion of fear.

Methods

An experimental study conducted in the course of a week during late February 2016 in Aarhus (Denmark), in which the focus was on traditional environmental variables in the field of FOC (i.e., poor lighting conditions).

Results

Our results support the ideas that 1) the absence of good luminosity in an open public space in an urban setting elicits physiological reactions of arousal that can be taken as indicators of experiences of fear, and 2) heart rate appears to capture aspects of the emotion of fear that are not reflected in data obtained through self-report questionnaires.

Conclusions

This study, introducing a pioneering approach to the study of FOC, presents great potentials in complementing traditional methods in the crime sciences. The many challenges we faced are significant and reported with the hope the subsequent literature to build on. We propose that traditional methods and new measurements could be combined to advance the research in the field by allowing researchers to more unambiguously constrain the interpretation from their data. This becomes particularly relevant in a field like FOC, that has long suffered from irreconcilable results stemming from different investigations.

Keywords: fear of crime, perception of security, self-report, physiological measures, environmental variables.

Introduction

The concept of “fear of crime” (FOC) has occupied much of the criminological literature since the 1960s (Farrall, Jackson & Gray, 2009). The relevance of the concept is made manifest when confronted with the apparent functional disconnection of this phenomenon with real, or “objective” crime. That is, against the classically held view that the occurrence of crime causes, in turn, a corresponding fear of crime (Schweitzer, Kim & Mackin, 1999), the varying investigations of this phenomenon seem to point at the opposite direction. Decades of research have accumulated an extensive catalogue of variables involved in criminal opportunity, or the victimization processes, of demographic, societal, ecological or environmental nature, explaining the dissonance between “objective” prevalence of criminal activity and emotions that are linked with it (Lee & Farrall, 2008). Despite half a century of research and speculation on possible definitions, the phenomenon has resisted any attempts at its reduction, conceptualization, or operationalization that could be said to enjoy an ample consensus (Ferraro, 1995).

Whereas the methods that we present in this paper represent an innovation in the field of criminology, the critical perspective of the precision and validity of previous investigations of FOC on which we build refers back to the foundational work of Ferraro (1995) and Warr (2000) who stated that most of the confusion in the discussion was due to a confusion between the *emotion* (what we feel, or experience) and the *cognition* (what we think) of FOC. Therefore, the concept of FOC is likely to bear different conclusions depending on whether the approach focuses on emotional or cognitive levels (Ferraro & Lagrange, 1987, Hale, 1996). Our approach conceives the emotion of fear as a distinctive mental state which includes physical responses that prompt or restrain motivated behavior (Carlson & Hatfield, 1992). That is, exploring fear as a strictly emotional phenomenon, even if it might be processed as a part of mental dynamics of a cognitive nature. Besides, exploring the emotional aspects of fear allows us to reliably measure the physiological correlates of fear that have heretofore been identified, like the activation of the autonomous nervous system or a disturbance in the digestive, respiratory or cardiovascular apparatus (Plamper, 2015; Damasio, 2006). In this vein, we understand FOC as the emotion of fear arising in a specific moment and place upon the possibility of perceiving oneself as the victim of a crime.

As such, we can distinguish two groups of variables related to FOC - exogenous, and endogenous variables. In line with classic human ecology (Park & Burgess, 1921), our study

primarily aims to test the influence of exogenous or environmental variables of ecological and environmental nature in the perception of a place as "dangerous" or "threatening". Some researchers (Bursik, 1988, Cochran, Bromley & Branch, 2000; Sun, Triplett & Gainey 2004; Taylor & Covington, 1993; Wilson & Kelling, 1982) have established a positive correlation between the perceived absence of social control in certain urban environments and the FOC of citizens in that environment. Besides, as the literature suggests (Cochran et al., 2000; Sun et al., 2004; Painter, 1996; Taylor & Covington, 1993) this correlation is not limited to clear elements indicating crime or the absence of social control; rather, the notion also includes physical and social elements that, without a necessarily direct link with crime, increase or diminish the experiences of FOC.

Apart from exogenous variables, we can find two groups of theories that aim to explain FOC, depending on whether they focus on perception of vulnerability (Warr, 2000), and direct/indirect experiences as a victim (Hanson, Smith, Kilpatrick, & Freedy, 2000). That is, variables that are endogenous to the subjects. Building on these theories, our study secondarily considers the influence of endogenous or cognitive variables, by controlling for the prior perception that participants had of the area in which the task took place. This is in line with the interpersonal communication approach to studying FOC (Mawby, Brunt, & Hambly, 2000). The assumption underlying this approach is that information regarding criminality in a specific place, when obtained from interpersonal communication, modulates the risk perception of said place, biasing subjects towards feeling less safe (Hale, 1996), affecting their routines for avoidance of given spaces that are perceived as presenting a greater potential for victimization (Brantingham & Brantingham, 1993), as well as negatively affecting the reputation of the neighborhood or area in question (Koskela & Pain, 2000).

Complementing self-reports with physiological measures of FOC

The absence of proper lighting is one of the classic environmental variables associated with FOC (Cochran et al., 2000; Sun et al., 2004; Painter, 1996; Taylor & Covington, 1993). We wanted to explore how this would be reflected in physiological measures associated with FOC. This led us to hypothesis, that (1). *Participants would show greater physiological responses associated with fear when fulfilling the same task in conditions of poor luminosity than participants fulfilling the task in conditions of better luminosity.* We suspected that the perception of the area in which the naturalistic task took place would affect how participants felt when completing it.

Given the aforementioned disparity between the results obtained when enquiring about more emotional or cognitive dimensions of FOC, and given the evidence in the literature regarding the limitations of measuring emotions through self-reports or interviews (Lynch & Addintong, 2010; Yang & Wyckoff, 2010), we formulated our second hypothesis (2). *that the self-reported data (questionnaires) will not be possible to correlate to the results obtained through the physiological measures.*

Methods¹

Participants in our experiment had to comply with a naturalistic task in an urban environment during the nighttime, in a between-subjects design. We had a control group in which we had no manipulation of luminosity, and an experimental group in which we manipulated luminosity. In order to achieve poor conditions of luminosity for the experimental condition, streetlights in the last third of the path were covered with opaque textiles.

Results

We compared the HR data (in beats per minute) across conditions to test our first hypothesis, that *participants will show greater physiological responses associated with fear when fulfilling the same task in conditions of poor luminosity than participants in better conditions of luminosity.* Stretch A, before the independent variable (poor luminosity) was introduced, served as baseline for both conditions.

¹ All the details pertaining to the task, setting, and sample are included in the *Technical Appendix*, published online with this article.

Table 1

Summary of participants' data

ID code	Start (B) Stretch	End point	Condition
MO173	155,5	330,5	Control
LR159	174,5	266	Control
KP176	217,5	328	Control
MK177	123,5	243	Control
MS176	176	272	Control
JT187	142,5	232	Control
AT169	263,5	378	Control
MS173	203,5	310	Control
DB155	118,5	195	Experimental
EM174	142,5	224	Experimental
JL183	121,5	152,5	Experimental
HS174	181,5	272,5	Experimental
IV164	263,5	394,5	Experimental
DR167	75,5	170,5	Experimental
NS182	124	212	Experimental
IK168	119	213,5	Experimental

The columns "Start (B) Stretch" and "End point" are expressed in seconds and indicate the moment in which the participants reach those points of the stretch.

Figure 2. HR. Experimental Condition (BPM)

A repeated measures T-test revealed no significant differences between the first and second stretch in the control condition ($T = 1.213$, $p = 0.265$). In contrast, the same test revealed highly significant differences between the first and the second stretch in the experimental condition ($T = -5.033$, $p = 0.002$).

Table 2

Results from physiological measurements

Group	Stretch	N	Mean (ST)	T	P/r
Control	A	8	112,95 (11,89)	1,213	0,265
	B	8	111,07 (8,82)		
Experimental	A	8	94,99 (14,39)	-5,033	0,002/0,89
	B	8	111,35 (15,65)		

Regarding our second hypothesis, - *that the self-reported data (questionnaires) will not be possible to correlate to the results obtained through the physiological measures* - we ran an independent groups T-test to find no significant differences in the self-report scores across conditions for the three items (fear of being raped, $T = 0$, $p = 1$; fear of being attacked, $T = 0$, $p = 1$; fear of being robbed, $T = 0.942$, $p = 0.362$).

Tabla 3

Results from self-report measurements.

Crime	Group	N	Mean (SD)	T	<i>p</i>
Sexually assaulted	Experimental	8	1,13 (0,35)	0	1
	Control	8	1,13(0,35)		
Attacked	Experimental	8	1,38 (0,74)	0	1
	Control	8	1,38 (0,74)		
Robbed	Experimental	8	1,5 (1,07)	0,942	0,362
	Control	8	1,13 (0,35)		
Global FOC*	Experimental	8	1,33 (0,64)	0,444	0,664
	Control	8	1,21 (0,47)		

*Average score of all the other items

Discussion and Conclusion

Our investigation analyzed the influence of environmental variables in the FOC of participants in a stigmatized urban setting. Results support the idea that the lack of luminosity in public spaces could trigger experiences of FOC. These results are in accordance with previous research within the frame of the theories of safe and dangerous places that propose this same idea (DTUPA, 2002, Nasar & Jones, 1997; Newman, 1972). Importantly, these theories do not claim that the lack of luminosity causes the FOC but, rather, the interpretation that people make in terms of indicated neglect from authorities, or the activity of unlawful agents. Namely, previous research on the effects of poor luminosity in the perception of security has associated it with making natural observation more difficult, the space of opportunity for criminals to carry out their activities, or the absence of the so-called “eyes on the street” (Jacobs, 1961, Painter, 1996). Others have linked the experience of FOC with the time of the day, with this being greater during times when it is dark (Painter, 1996). However, we can also find conflicting evidence in the literature, such as the study conducted by Nair and colleagues (1993) in which the FOC of citizens walking through a public park in Glasgow (Scotland) did not improve after refurbishment - including an improvement in conditions of luminosity.

Furthermore, our choice of heart rate as an indicator of fear is well-grounded in the psychological literature. Kobayashi and colleagues (2015) observed an increase in HR of their participants when they were exposed to a forestall setting, which they explained as being caused by biophobia. However, as already remarked in classical discussions, and reflected in the theory of the two paths to fear by Joseph Ledoux (1996), a higher HR is not

necessarily always an indicator of stress or fear, so it cannot be univocally interpreted as indicating fear. Feinstein (2013) relies on HR, together with respiratory frequency and galvanic skin response, to study fear and panic in humans. A good example of such innovations can be found in the research conducted by Torrent-Rodas and colleagues (2012), who use reflexes and galvanic skin response as markers of affective processing in the learning of fear and anxiety. As such, prospective investigations of FOC would greatly benefit from using other markers of fearful experiences. Regarding our results, it should be noted that both study groups show an almost identical average HR in stretch B, where the manipulation was introduced, so that the difference is due to a lower average in the experimental study group in stretch A. As we allocated our participants randomly, we can only attribute this difference in the baseline to random factors that could contribute to a different HR in a resting state across groups. Despite our efforts to stabilize our participants' HR upon arrival to the experimental site, it is important to note that our small sample size could have contributed to a skewed distribution of participants - either because the participants in our experimental group arrived in a significantly more calm state, or because the participants in our control condition arrived in a significantly more aroused state.

Regarding the introduction of physiological indicators of fear to measure the real time experience, this is the first time that, to our knowledge, they are introduced in a criminological study of FOC - though subjective indicators of fear in real time have been previously used through a phone app (Solymosi, Bowers & Fujiyama, 2015). We trust that the reader will be convinced of their combined potential, all the more given the demonstration of a significant divergence between the self-report and the physiological data. However, research on human emotions as bodily changes has often led to researchers focusing *only* on that dimension, partly because these responses accompany subjective experiences that are not easily described, but that are similar across cultures (Plamper, 2015). Our proposal is rather to combine physiological and self-report data in future investigations so data of different nature can constrain our interpretations of the results. Especially now that inconsistencies between the divergent results stemming from different studies of FOC (see *introduction*) are being addressed (Collins, 2016), this would be a step back, rather than forward. We can find studies from other fields that do explore this discrepancy between measurements of different nature, such as the study by Xygalatas and colleagues (2013), who found that memories about highly arousing rituals (ie. fire-walking rituals) responded to pre-existing schemata, rather than actual experiences, leaving HR as the only reliable marker of

arousal.

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Influence of Environmental Variables on Fear of Crime: comparing self-report data with physiological measures in an experimental design

TECHNICAL APPENDIX

1. Procedure

Participants were prescreened with a test specifically designed for this purpose (adapted *Fear of Crime in America Survey*) to control for their perception of security in a map dividing the city of Aarhus and its immediate surroundings in five areas (see figure 1). This pre-screening was to confirm that our choice of area would evoke a uniformed impression in participants (see *setting* below for more details). The results of our pre-screening test confirmed that area D (where we chose to conduct the experiment) was perceived as the least safe in two out of three items (“being sexually assaulted” and “being attacked by someone”). It was only second to area E in one of the items (“being robbed”). The results are summarized in table 1.

Figure 1. The map participants had to look at in order to fill the items in our adapted version of the “Fear of Crime in America” survey. Participants were asked to rate their fear (1 = not afraid at all; 10 = very afraid) of being: a) sexually assaulted, b) attacked by someone and c) robbed (Lab, 2014).

Table 1

Summary of the average scores for each of the areas in the different items.

FOC items and urban areas	N	Mean (SD)
Robbed A	16	4 (2,58)
Robbed B	16	3,38 (2,31)
Robbed C	16	3,38 (2,22)
Robbed D	16	4,75 (3,37)
Robbed E	16	5,13 (3,54)
Sexually Assaulted A	16	3,06 (2,69)
Sexually Assaulted B	16	2,88 (2,39)
Sexually Assaulted C	16	2,38 (1,63)
Sexually Assaulted D	16	3,31 (2,98)
Sexually Assaulted E	16	3,13 (2,92)
Attacked A	16	3,19 (2,29)
Attacked B	16	3,06 (2,62)

Attacked C	16	2,88 (2,61)
Attacked D	16	4,75 (3,51)
Attacked E	16	3,13 (3)

Once participants arrived at the site of the presential task, they were equipped with gear to measure their heart rate (*Polar* belt and ActiLife hand wrist sensors to store the data). After being equipped, participants were instructed to comply with a recall task that required them to walk along a path (see figure 2 - they were asked to count empty bottles and beer cans, that they would have to report at the end of the task as part of the recall task that also served as distractor, since the experiment was presented as investigating the influence of environmental cues in memory processes. For participants in the “low luminosity” condition, we manipulated lighting conditions so that roughly the last third of the path was dark. After the walking task, all participants filled out a questionnaire with items assessing their FOC during the task. Participants were also questioned about the instructions that they were administered at the beginning of the task, as well as about a salient aspect of the researcher’s outfit that introduced them to the task (who was at that point absent). Whereas participants had been instructed to count empty bottles and beer cans, they had not been told to retain information about the researcher’s outfit, or about the precise instructions that they were administered.

Figure 2. Picture of the stimuli used during the experiment. As part of the presential task, participants were required

to comply with a recall task. The choice of such stimuli is motivated by their significance in terms of lack of social control. All of them had LED lights so that the lack of luminosity would not be a problem.

2. Setting

A naturalistic, urban setting (see Fig. 3) during the night time. We chose an area that had strong significance in terms of criminality as confirmed by our pre-screening test. Participants were required to walk from one point to the other as part of the experimental task. The second stretch began at the point where the variables were introduced, which corresponded to the 11th street light. A researcher noted down the time when participants got to the second stretch so that we could associate their HR with the corresponding stretch. The first stimulus in this stretch was a bottle of wine with a flashing light. The rest of the stimuli consisted of five beer cans. The second and fourth cans after this bottle had flashing lights. The rest of the lights were constantly on. The path had 18 street lights in total.

Figure 3. This is the path that participants had to walk by as part of the presential task. The figure shows where the lights were covered in the experimental condition, as well as the rest of street lights in the path. The path is situated in area D (see figure 1).

3. Participants

Twenty five participants (18 females, mean age = 23.96, $SD = 3.31$) took part in the experiment in return for a bottle of wine, and the chance to win a cinema ticket. Of these, we could only obtain 16 sets of heart rate (HR) data (9 females, mean age = 24, $SD = 2.73$) because of data loss having

to do with a faulty contact between the sensors in the belt and the skin of our participants. Participants were recruited through the participant pool from the CFIN (<http://cfin.au.dk/>) SONA subject pool and gave informed written consent following the guidelines of the local research ethical committee. We pre-screened participants to make sure that they had been living in Aarhus for at least six months. We did this so that they had the chance to become acquainted with the local connotations of the area in which we chose to conduct the experiment.

4. Limitations and Prospects

Whereas we are convinced that the incorporation of physiological measurements in field experiments holds great promise for the sciences of crime, we also faced considerable obstacles in conducting the present study. We had to obstruct a stretch of ca. 800 meters in order to carry out the task. For this we needed a special permit from the Kommune (Municipality), and approval by the police. The electricity company in charge of the area where we conducted the experiment failed to provide us with the required services (turning the lights off/on), so we had to recur to covering the lights with opaque textile (see figure 4).

Figure 4. A researcher covers one of the street lights prior to the experimental session with a plastic material that prevented light from illuminating the street.

We also required tight coordination with the participants, since the study was out-of-the-lab. Meeting points were set at nearby bus stops, with two research assistants in charge of picking up participants and bringing them to the start point. We also operated within a very limited time window (from approximately 18:00 to 21:00 PM), after the sunset and before it was unreasonably late for participants to come to the field.

The considerable complexity of the experimental design - including an online pre-monitoring questionnaire, a presential task in the outer limits of the city, and a last online follow up questionnaire - negatively affected the size of our sample, so that only 25 participants took part in the last two stages, out of 75 who signed up for the experiment and took the pre-monitoring questionnaire online. Of these 25 participants, we could only collect HR data from a total of 18, which further affected the sample size. The issue with sample size was particularly relevant for our memory task (see *methods* section) - we are not confident that the results from said task are interpretable, given the nature of the measurements, and the low amount of data points.

Lastly, the ethical advisory group at the Cognition and Behavior Lab strongly encouraged us to find a clinical psychologist in case we triggered an anxiety experience in a participant with post-traumatic stress disorder. The inclusion of yet another professional made the design even more demanding. The warning from the advisory group also made us tone down the interaction with participants, and we strived to make them feel comfortable and safe. This, as later debriefings with the participants would confirm, made them feel safe all throughout the task. This might have had a mediating effect, eventually minimizing the effects of the independent variable.

Thus, given the already mentioned prospect that this experimental paradigm opens up the possibility to combine traditional environmental variables together with more precise physiological measurements, we would like to discuss some notes for studies that will follow up on this first attempt to incorporate physiological measurements in the sciences of crime. First, the issue with lighting - obstructing light in a way that appears natural within the context of urban settings, rather than using opaque textiles - should be resolved, as this might have contributed to the perception of participants that they were under control circumstances, and might have further guided their inferences as to what the experiment was about. Second, informing participants in as much detail as possible as to their options of transportation was extremely time consuming. Ideally, they should be transported to the desired spot by a vehicle specially designated for this purpose throughout the duration of the experiment. We suspect that the complexity of the design in terms of a location in the outer limits of the city might have had to do with the considerable drop ratio from the first stage to the second, and third stages. Lastly, we would advise subsequent investigations to try to account for the mediating effects of participants being aware of being in a highly controlled situation, as we suspect that the low scores in risk perception (see *results*) could have been negatively influenced by it. Additionally, as pointed out in the *discussion* section, we would encourage subsequent physiological investigations into the topic of FOC to incorporate more measurements such as could constrain the interpretation of data more univocally - for example, by including galvanic skin response, or analysis of facial micro expressions.

5. Post-Task Questionnaire

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***Required**

You will now answer a series of question related to your experience during the task.

Answer "yes" or "no" to the following questions, depending on your own experience and impressions. *

	Yes	No
When you were instructed to walk along the path, were you asked to do it "at your own pace"?	☐	☐
Was the researcher who gave you the instructions wearing glasses?	☐	☐

Please enter one response per row

What type of object (with LED lights) have you seen most often towards the beginning of the path? *

This is a required question

How sure do you feel about your response? *

1	2	3	4	5
Not sure at all	☐	☐	☐	Totally sure

This is a required question

What type of object (with LED lights) have you seen most often towards the end of the path? *

This is a required question

How sure do you feel about your response? *

1	2	3	4	5
Not sure at all	☐	☐	☐	Totally sure

This is a required question

Figure 5. Post-Task Questionnaire (part I)

How many beer cans have you seen throughout the whole path? *

This is a required question

How sure do you feel about your response? *

1	2	3	4	5
Not sure at all ☐ ☐ ☐ ☐ ☐ Totally sure				

This is a required question

How many wine bottles have you seen throughout the whole path? *

This is a required question

How sure do you feel about your response? *

1	2	3	4	5
Not sure at all ☐ ☐ ☐ ☐ ☐ Totally sure				

This is a required question

How many of the LED lights were flashing intermittently (on and off)? *

This is a required question

How sure do you feel about your response? *

1	2	3	4	5
Not sure at all ☐ ☐ ☐ ☐ ☐ Totally sure				

This is a required question

During the task, rate your fear of: *

(1 = not afraid at all; 10 = very afraid)

	1	2	3	4	5	6	7	8	9	10
Being raped or sexually assaulted	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Being robbed	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Being attacked by someone	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please enter one response per row

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75% completed

Figure 6. Post-Task Questionnaire (part II)