



# Influence of environmental variables on fear of crime: Comparing self-report data with physiological measures in an experimental design

Francisco J. Castro-Toledo<sup>1</sup> · Juan O. Perea-García<sup>2</sup> ·  
Rebeca Bautista-Ortuño<sup>1,3</sup> · Panagiotis Mitkidis<sup>2,4,5</sup>

Published online: 13 July 2017

© Springer Science+Business Media B.V. 2017

## 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 was conducted over 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.

---

**Electronic supplementary material** The online version of this article (doi:[10.1007/s11292-017-9295-1](https://doi.org/10.1007/s11292-017-9295-1)) contains supplementary material, which is available to authorized users.

---

✉ Francisco J. Castro-Toledo  
[fj.castro@crimina.es](mailto:fj.castro@crimina.es)

<sup>1</sup> CRÍMINA Center for the Study and Prevention of Crime, Miguel Hernández University, Avda. de la Universidad s/n. Edif Hélike Elche, 03201 Alacant, Spain

<sup>2</sup> Interacting Minds Centre, Aarhus University, Aarhus C, Denmark

<sup>3</sup> Health Psychology Department, Miguel Hernández University, Alacant, Spain

<sup>4</sup> Department of Management, School of Business and Social Science, Aarhus University, Aarhus C, Denmark

<sup>5</sup> Center for Advanced Hindsight, Social Science Research Institute, Duke University, Durham, NC, USA

**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 that subsequent literature will build upon. We propose that traditional methods and new measurements could be combined to advance research in the field by allowing researchers to more unambiguously constrain the interpretation of their data. This becomes particularly relevant in a field like FOC, which 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 et al. 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 et al. 1999), the varying investigations of this phenomenon seem to point at the opposite direction. Decades of research have accumulated an extensive catalog 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 and 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 and Grange 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 and 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 2005). 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 and 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 et al. 2000; Sun et al. 2004; Taylor and Covington 1993; Wilson and 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; Painter 1996; Sun et al. 2004; Taylor and 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) or direct/indirect experiences as a victim (Hanson et al. 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 et al. 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 the 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 and Brantingham 1993), as well as negatively affecting the reputation of the neighborhood or area in question (Koskela and Pain 2000; Markowitz et al. 2001).

## 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; Painter 1996; Sun et al. 2004; Taylor and Covington 1993). We wanted to explore how this would be reflected in physiological measures associated with FOC. This led us to hypothesis (1) *that 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 and Addington 2010; Yang and 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*.

**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 at which the participants reach those points of the stretch

## Methods<sup>1</sup>

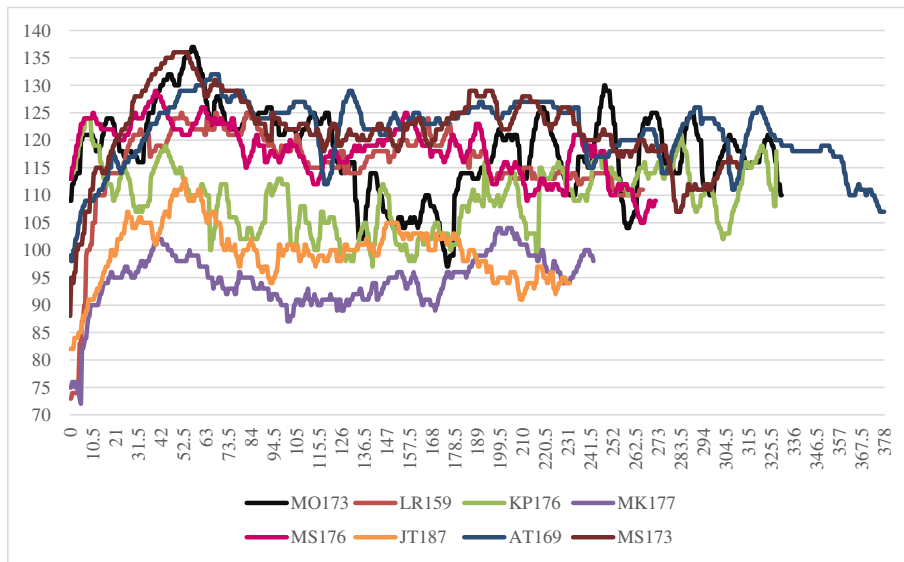
Participants in our experiment had to comply with a naturalistic task in an urban environment during the nighttime, in a between-subjects design. We had a control group in which we had no manipulation of luminosity and an experimental group in which we manipulated luminosity (Table 1). In order to achieve 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 heart rate (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 the baseline for both conditions.

A repeated measures *t*-test revealed no significant differences between the first and second stretches in the control condition ( $t = 1.213$ ,  $p = 0.265$ ) (Fig. 1, Table 2). In contrast, the same test revealed highly significant differences between

<sup>1</sup> All the details pertaining to the task, setting, and sample are included in the online only [Technical appendix](#).



**Fig. 1** Heart rate (HR, beats per minute): control condition

the first and the second stretches in the experimental condition ( $t = -5.033$ ,  $p = 0.002$ ) (Fig. 2).

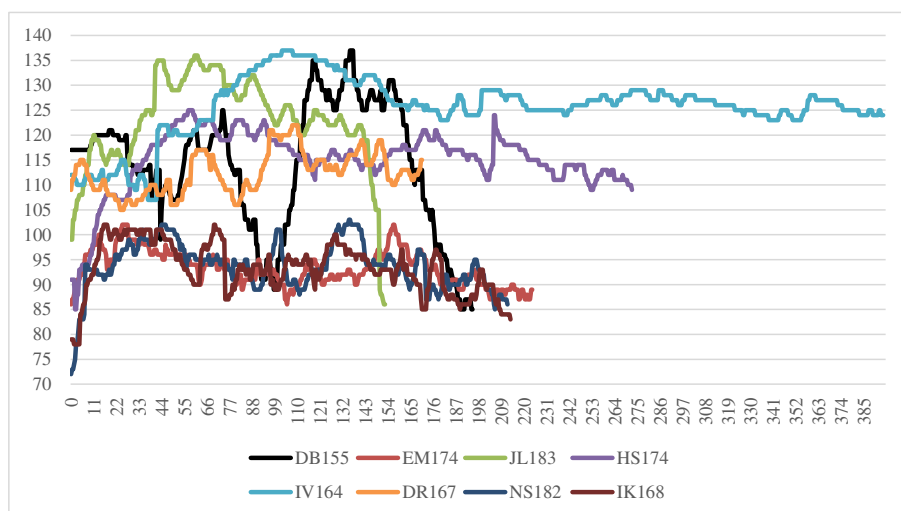
Regarding our second hypothesis, *that the self-reported data (questionnaires) will not be possible to correlate to the results obtained through the physiological measures*, we ran an independent groups  $t$ -test to find no significant differences in the self-report scores across conditions for the three items (fear of being raped,  $t = 0$ ,  $p = 1$ ; fear of being attacked,  $t = 0$ ,  $p = 1$ ; fear of being robbed,  $t = 0.942$ ,  $p = 0.362$ ) (Table 3).

## Discussion and conclusion

Our investigation analyzed the influence of environmental variables in the FOC of participants in a stigmatized urban setting. The 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 (Department for Transport, Urban Planning and the Arts, DTUPA 2002; Nasar and Jones 1997; Newman 1972).

**Table 2** Results from the physiological measurements

Group	Stretch	No.	Mean (SD)	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)		



**Fig. 2** Heart rate (HR, beats per minute): experimental condition

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 HR as an indicator of fear is well grounded in the psychological literature. Kobayashi et al. (2015) observed an increase in the HR of their participants when they were exposed to a forestall setting, which they explained as

**Table 3** Results from the self-report measurements

Crime	Group	No.	Mean (SD)	<i>t</i>	<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

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 (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 et al. (2013) relied 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 (2013), 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 showed 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 calmer 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 et al. 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 that data of different natures can constrain our interpretations of the results. Especially now that inconsistencies between the divergent results stemming from different studies of FOC (see the [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 natures, such as the study by Xygalatas et al. (2013), who found that memories about highly arousing rituals (i.e., fire-walking rituals) responded to pre-existing schemata, rather than actual experiences, leaving HR as the only reliable marker of arousal.

**Acknowledgments** Thanks to Aarhus Kommune for their help throughout the preparations and the Danish police for their permission to conduct the study. Also, thanks to the people who contributed to this study with their precious time, energy, and skills: Agos, Ale, Jan, Marlene, Natalia, and Tobi.

**Compliance with ethical standards**

**Conflict of interest** The authors declare no conflict of interest.

## References

- Brantingham, P. L., & Brantingham, P. J. (1993). Nodes, paths and edges: Considerations on the complexity of crime and the physical environment. *Journal of Environmental Psychology*, 13(1), 3–28.
- Bursik, R. J. (1988). Social disorganization and theories of crime and delinquency: Problems and prospects. *Criminology*, 26, 519–552.
- Carlson, J. G., & Hatfield, E. (1992). *Psychology of emotion*. Fort Worth, TX: Harcourt Brace Jovanovich College Publishers.
- Cochran, J. K., Bromley, M. L., & Branch, K. A. (2000). Victimization and fear of crime in an entertainment district crime “hot spot:” A test of structural-choice theory. *American Journal of Criminal Justice*, 24(2), 189–201.
- Collins, R. E. (2016). Addressing the inconsistencies in fear of crime research: A meta-analytic review. *Journal of Criminal Justice*, 47, 21–31.
- Damasio, A. (2005). *Descartes' error: Emotion, reason and the human brain*. New York: Penguin Books.
- Department for Transport, Urban Planning and the Arts (DTUPA) (2002). *Crime prevention through environmental design and urban design: Design Issues for safe neighbourhoods*. Adelaide.
- Farrall, S. D., Jackson, J., & Gray, E. (2009). *Social order and the fear of crime in contemporary times*. Oxford: Oxford University Press.
- Feinstein, J. S., Buzza, C., Hurlmann, R., Follmer, R. L., Dahdaleh, N. S., Coryell, W. H., Welsh, M. J., Tranel, D., & Wemmie, J. A. (2013). Fear and panic in humans with bilateral amygdala damage. *Nature Neuroscience*, 16(3), 270–272.
- Ferraro, K. F. (1995). *Fear of crime: Interpreting victimization risk*. Albany, NY: State University of New York Press.
- Ferraro, K. F., & Grange, R. L. (1987). The measurement of fear of crime. *Sociological Inquiry*, 57, 70–97.
- Hale, C. (1996). Fear of crime: A review of the literature. *International Review of Victimology*, 4, 79–150.
- Hanson, R. F., Smith, D. W., Kilpatrick, D. G., & Freedy, J. R. (2000). Crime-related fears and demographic diversity in Los Angeles County after the 1992 civil disturbances. *Journal of Community Psychology*, 28, 607–623.
- Jacobs, J. (1961). *The death and life of great American cities*. New York: Vintage Books.
- Kobayashi, H., Song, C., Ikei, H., Kagawa, T., & Miyazaki, Y. (2015). Analysis of individual variations in autonomic responses to urban and forest environments. *Evidence-Based Complementary and Alternative Medicine*. doi:10.1155/2015/671094.
- Koskela, H., & Pain, R. (2000). Revisiting fear and place: women's fear of attack and the built environment. *Geoforum*, 31(2), 269–280.
- Lab, S. P. (2014). *Crime prevention: Approaches, practices and evaluations*. Waltham: Elsevier.
- LeDoux, J. E. (1996). *The emotional brain*. New York: Simon and Schuster.
- Lee, M., & Farrall, S. (2008). *Fear of crime: Critical voices in an age of anxiety*. Abingdon: Routledge-Cavendish.
- Lynch, J. P., & Addington, L. A. (2010). Identifying and addressing response errors in self-report surveys. In A. R. Piquero & D. Weisburd (Eds.), *Handbook of quantitative criminology* (pp. 251–272). New York: Springer.
- Markowitz, F. E., Bellair, P. E., Liska, A. E., & Liu, J. (2001). Extending social disorganization theory: Modeling the relationships between cohesion, disorder, and fear. *Criminology*, 39(2), 293–319.
- Mawby, R. I., Brunt, P., & Hambly, Z. (2000). Fear of crime among British holidaymakers. *The British Journal of Criminology*, 40(3), 468–479.
- Nair, G., Ditton, J., & Phillips, S. (1993). Environmental improvements and the fear of crime: the sad case of the ‘Pond’ area in Glasgow. *The British Journal of Criminology*, 33(4), 555–561.
- Nasar, J. L., & Jones, K. M. (1997). Landscapes of fear and stress. *Environment and Behavior*, 29(3), 291–323.
- Newman, O. (1972). *Defensible space: Crime prevention through urban design*. New York: Macmillan.
- Painter, K. (1996). The influence of street lighting improvements on crime, fear and pedestrian street use, after dark. *Landscape and Urban Planning*, 35(2–3), 193–201.
- Park, R., & Burgess, E. (1921). *Introduction to the science of sociology*. Chicago: University of Chicago Press.
- Plamper, J. (2015). *The history of emotions: An introduction*. Oxford: Oxford University Press.
- Schweitzer, J. H., Kim, J. W., & Mackin, J. R. (1999). The impact of the built environment on crime and fear of crime in urban neighborhoods. *Journal of Urban Technology*, 6, 59–73.
- Solymosi, R., Bowers, K., & Fujiyama, T. (2015). Mapping fear of crime as a context-dependent everyday experience that varies in space and time. *Legal and Criminological Psychology*, 20, 193–211.

- Sun, I. Y., Triplett, R., & Gainey, R. R. (2004). Neighborhood characteristics and crime: A test of Sampson and Groves' model of social disorganization. *Western Criminology Review*, 5(1), 1–16.
- Taylor, R. B., & Covington, J. (1993). Community structural change and fear of crime. *Social Problems*, 40(3), 374–397.
- Torrents-Rodas, D., Fullana, M. A., Bonillo, A., Caseras, X., Andión, O., & Torrubia, R. (2013). No effect of trait anxiety on differential fear conditioning or fear generalization. *Biological Psychology*, 92(2), 185–190.
- Warr, M. (2000). Fear of crime in the United States: Avenues for research and policy. *Criminal Justice*, 4, 451–489.
- Wilson, J. Q., & Kelling, G. L. (1982). The police and neighborhood safety: Broken windows. *The Atlantic Monthly*, 249(3), 29–38.
- Xygalatas, D., Schjoedt, U., Bulbulia, J., Konvalinka, I., Jegindø, E. M., Reddish, P., Geertz, A. W., Roepstoft, A. (2013). Autobiographical memory in a fire-walking ritual. *Journal of Cognition and Culture*, 13(1–2), 1–16.
- Yang, S. M., & Wyckoff, L. A. (2010). Perceptions of safety and victimization: Does survey construction affect perceptions? *Journal of Experimental Criminology*, 6(3), 293–323.

**Francisco Javier Castro Toledo** is currently a PhD student and researcher at the CRÍMINA Center for the study and prevention of crime at the Miguel Hernández University in Elche. His research interests are wide, but at the moment he is focused in the application of experimental designs in phenomena of the criminology, the moral philosophy and the criminal law.

**Juan Olvido Perea García** is currently enrolled as a PhD student at the Department of Biological Sciences in the National University of Singapore. Generally interested in the relationship between anatomy and mental processes, with a focus on scleral and iridal color in great apes (including humans) and their role in social interaction. His current PhD project focuses on comparative perspectives on the evolutionary origins of depigmented sclerata in Sumatran orangutans. His research interests are wide, including evolutionary psychology, empirical methods in the social sciences, and feminism among others.

**Rebeca Bautista** is currently assistant professor at the Department of Health Psychology of Miguel Hernández University and teach in the disciplines of Psychology of learning and Methodology of the Behavioral Sciences. She is also researcher at CRÍMINA, a center for the study and prevention of crime, in a wide range of topics, with special interest in compliance applied to physical and cyber space.

**Panos (Panagiotis) Mitkidis** is currently an Associate Professor of Behavioral Economics and Decision Making at the Department of Management at Aarhus University, Denmark and a Visitor Associate Professor at the Center for Advanced Hindsight at Duke University, NC, USA. Panos' research spans a wide range of disciplines, from Moral and Organisational Psychology to Anthropology, with special interests on donation strategies, motivating healthy behavior, and the psychophysiological underpinnings of morality.