GOING SPATIAL: APPLYING EGOHOODS TO FEAR OF CRIME RESEARCH

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A central theme in criminology is how fear of crime is influenced by the residential context. Most researchers rely on administrative neighbourhoods to define context. These administrative units do not necessarily align with how inhabitants experience their local surroundings. The present study combines administrative neighbourhoods with a more innovative way to measure context. Using geocoded survey data (N = 14.620) in combination with detailed geographic information system data, we construct egohoods with different radii (ranging from 50 to 750 m). We find that crime, ethnic diversity, economic status, disorder and facilities all have an effect on feelings of unsafety. The contextual effects differ in size and are not detected in all spatial contexts, indicating that it matters how and to which scale data are aggregated.

Key Words: fear of crime, egohoods, neighbourhoods, contextual effects

Introduction

From the 1970s on, fear of crime has emerged as a central topic in criminology and is perceived as a pressing issue in a range of countries (Brunton-Smith and Sturgis 2011; Vanderveen 2006). Scholars have examined both the consequences of fear of crime and its underlying causes. Research on the determinants of fear of crime is generally conducted along two lines. The first strand focuses on processes at the individual level and emphasizes, more specifically, the role of vulnerability to understand why certain groups of individuals—females, elderly adults and members of the lower class—report relatively high levels of fear without being victimized more often (Covington and Taylor 1991; Pantazis 2000). The second set of explanations centres on how fear of crime is shaped by the broader residential context in which individuals reside. The current study focuses primarily on these contextual determinants of fear of crime.

Fear of crime studies examining the role of local context almost exclusively use administrative neighbourhoods with fixed boundaries to explore the ways through which context shapes individual-level fear (e.g. Covington and Taylor 1991; Markowitz *et al.* 2001; Scarborough *et al.* 2010; Brunton-Smith and Sturgis 2011). Scholars tend to rely on these 'simple' measures of neighbourhood context mainly for reasons of data availability (Lupton and Kneale 2012: 122). This traditional approach of using neighbourhood units with predefined administrative boundaries is criticized for its limited ability to adequately map the influence of context on individual-level outcomes (Sampson *et al.* 2002; Hipp and Boessen 2013); most importantly, because the boundaries of these

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neighbourhoods are often arbitrary, resulting in areas that fail to reflect how individuals perceive and experience their local living environment (Brunton-Smith *et al.* 2014).

To better capture the role of neighbourhood context in fear of crime, the present study adopts a more sophisticated and spatially informed way of measuring context. More specifically, we will use geographic information system (GIS) to construct so-called 'egohoods': individualized measures of context based on a person's residential location (e.g. Hipp and Boessen 2013). The boundaries of these egohoods are drawn as concentric circles surrounding each individual, and the radii of these circles can be flexibly adjusted. Such approach has become the preferred way to study contextual effects (Sharkey and Faber 2014). This article is the first to apply egohoods to the study of fear of crime. By using these egohoods, we aim to meet the demand for more spatially explicit fear of crime research (Doran and Burgess 2012).

We consider four pathways through which the local context may shape fear of crime. The first pathway considers how crime affects feelings of unsafety. The second pathway focuses on demographic and economic characteristics of the context, such as the level of ethnic diversity, economic disadvantage and residential mobility, which are all believed to increase fear levels. Our third pathway looks at how signs of disorder—or incivilities—trigger feelings of fear. The fourth and last pathway explores the potential fear-reducing impact of having facilities in the local living environment. Drawing on the work of urban sociologist Blokland (2009; 2017), we hypothesize that local facilities promote public familiarity and, as a result, feelings of safety. The societal benefits of local facilities are empirically underexplored in fear of crime research, although scholars have analysed the association with other positive societal outcomes, such as reductions in crime (e.g. Peterson *et al.* 2000; Papachristos *et al.* 2011; Wo 2016) and increased levels of social capital and cohesion (e.g. Völker *et al.* 2007; Van Bergeijk *et al.* 2008; Curley 2010; Corcoran *et al.* 2018).

We analyse the impact of these contextual characteristics on fear of crime in different ways, first using the 'traditional' approach that relies on administrative neighbourhoods and second using the more innovative and exploratory approach of egohoods. These egohoods are constructed based on different radii, ranging from 50 to 750 m. As a result, the present study sheds more light on the role of spatial scale within fear of crime research. Fear of crime patterns will be examined within the municipality of Rotterdam. Rotterdam is the second most populous municipality of the Netherlands and is known for its ethnically diverse population and relatively high unemployment rates. We will use geocoded survey data of the Rotterdam Safety Index 2015 ($N = 14.620$) in combination with geocoded administrative register data. Our contextual measures are, with the exception of disorder and crime, constructed based on individual point data. The disorder and crime measures are based on data aggregated to the administrative neighbourhood.

Linking Context to Fear of Crime

We distinguish four pathways through which context may shape fear of crime. In the first place, fear may be a 'rational' reaction to actual crime incidents. A second pathway is through certain demographic and economic characteristics of the context that ultimately deteriorate inhabitants' sense of control. The third pathway centres on incivilities and their negative effect on feelings of safety. The fourth pathway considers how local facilities

contribute to the development of feelings of familiarity between residents, thereby mitigating feelings of unsafety. We will now elaborate on these pathways separately.

Crime

The first pathway relates fear to crime. Crime is perhaps the most likely underlying cause of feelings of unsafety. Researchers, however, often find a mismatch between fear and the actual crime rates: high levels of crime are reported not only in areas with high rates of crime, but also in those with lower rates (Covington and Taylor 1991; Doran and Burgess 2012). Scholars have pointed to methodological imprecisions, which may underlie the weak and inconsistent findings regarding the 'crime–fear linkage' (Ferraro and LaGrange 1987; Rountree 1998). There are two sources of imprecision. First, the variety of ways fear of crime has been defined and measured. An extensive discussion on this matter is beyond the scope of the present article (for more elaborate discussions, see Ferraro and LaGrange 1987; Skogan 1996). Second, the lack of differentiation between different sorts of crime: researchers have argued that more insight into the crime–fear relationship could be gained by distinguishing between different sorts of crime and acknowledging their potentially unique effects on feelings of unsafety (Rountree 1998). For instance, violent crime incidents arguably have a stronger impact on residents' feelings of safety than property crimes (Ferraro and LaGrange 1987; Hooghe and De Vroome 2016).

The outcome that fear levels do not consistently reflect local crime figures also led to the suggestion that people behave 'irrationally', reporting 'inappropriately' high levels of fear (Doran and Burgess 2012). Other scholars have argued that rather than dismissing such feelings as irrational—based on what official crime statistics (do not) tell—fear of crime should in itself be treated as a serious social problem, existing independently of actual victimization or crime rates (Ferraro 1995; Lupton and Tulloch 1999). To better understand the underlying causes of fear of crime, researchers should instead consider how people's fear is shaped by the wider environmental context (Jackson 2004; Scarborough et al. 2010; Brunton-Smith and Sturgis 2011). We, therefore, examine to which extent certain contextual characteristics relate to feelings of unsafety.

Ethnic diversity, economic deprivation and residential instability

The second pathway considers how economic and demographic characteristics of the context increase fear. More specifically, researchers have related fear of crime to economic deprivation, ethnic heterogeneity and residential mobility. These aspects were already identified in the seminal work of Shaw and McKay (1942), who aimed to explain spatial concentrations of crime by pointing to the role of 'social disorganization'. In socially disorganized communities, inhabitants struggle to realize common values and to maintain effective social control over deviant and other forms of unwanted behaviour (Sampson and Groves 1989). Shaw and Mckay observed that low-income areas—which often happen to be ethnically diverse and residentially unstable—lack the capacity to maintain social order and are in particular conducive to disorganization and, consequently, crime. As such, social disorganization in a community may be understood as the product of inhabitants' diminished feelings of self-efficacy combined with their difficulty to understand

and interpret each other's behaviour. More recent formulations of social disorganization theory have introduced the concept of collective efficacy in order to improve our understanding of why crime rates vary within cities. Collective efficacy refers to the process of activating or converting social ties among residents in order to achieve collective goals such as control over crime (Sampson 2010). Reduced collective efficacy may also be related to feelings of unsafety; as social organization deteriorates, or inhabitants perceive it as such, fear of crime may increase as well (Greenberg 1986).

According to this line of reasoning, fear of crime encompasses more than anxiety about crime or victimization alone. These feelings instead reflect a broader set of concerns about the breakdown of the local community. Environments that are judged as unpredictable, unfamiliar and beyond the control of oneself or the community may generate a sense of disquiet and, ultimately, of unsafety caused by the feeling that 'anything could happen' (Jackson 2009: 12). It follows that deprivation, diversity and instability may influence fear of crime both directly and indirectly. Brunton-Smith and Sturgis (2011) express this as follows: 'neighbourhood social-structural characteristics are thought […] to affect fear of crime both indirectly through their influence on criminality and disorder in the neighbourhood and directly as signifiers of deficient mechanisms of social control and weak or fragile feelings of efficacy within the local community' (336).

A range of studies empirically examines the link between economic disadvantage, ethnic diversity and residential instability on the one hand and fear of crime on the other hand. Research into these factors is primarily conducted in the context of American cities and, to a lesser extent, in the British context (see for exceptions Hanslmaier 2013; Hooghe and De Vroome 2016). More fear of crime is found in neighbourhood contexts with more economic disadvantage (Scarborough et al. 2010; Brunton-Smith and Sturgis 2011; Hanslmaier 2013) and more diversity (Moeller 1989; Covington and Taylor 1991; Chiricos et al. 1997; Pickett et al. 2012). In the specific context of Dutch neighbourhoods, Oppelaar and Wittebrood (2006) found significant associations between the level of economic disadvantage and diversity on the one hand and feelings of unsafety on the other hand. The association between residential mobility and fear of crime has been less frequently examined; residential instability is more often considered a relevant predictor for crime (Sampson et al. 1997; Boggess and Hipp 2010; but see Brunton-Smith and Sturgis 2011).

Incivilities

A third pathway connects disorder on the street to feelings of unsafety. Hunter (1978) was the first to address how manifestations of disorder—or incivilities—provoke feelings of fear. These incivilities, defined by LaGrange et al. (1992) as low-level breaches of community standards, do not necessarily trigger fear themselves. It is rather their 'signal' that conventionally accepted norms and values are eroding and social control is lacking (LaGrange et al. 1992). As such, residents perceive incivilities as symbolic cues to an increased possibility to become a victim of crime. Incivilities may thus be a better predictor of fear of crime than crime itself because incivilities are more visible and present in public space (Hunter 1978; Wyant 2008). Signs of disorder may either be social, such as public drinking, drug use and fighting, or physical, such as litter, graffiti and vandalism (Covington and Taylor 1991). Over the years, various scholars

have further refined and redeveloped the incivilities thesis (see Taylor 2001). Kelling and Wilson's (1982) broken window theory, on how persistent incivilities may eventually cause higher neighbourhood crime rates, is especially considered as influential (Robinson *et al.* 2003). The relationship between incivilities and fear of crime appears to be well established, both theoretically and empirically (LaGrange *et al.* 1992). An effect of neighbourhood-level disorder on fear of crime is observed in a range of studies (e.g. Covington and Taylor 1991; Rountree and Land 1996; Markowitz *et al.* 2001; Scarborough *et al.* 2010; Brunton-Smith and Sturgis 2011).

Facilities and familiarity

Our fourth and final pathway proposes that facilities may decrease fear levels by facilitating familiarity. Based on a systematic review of qualitative studies, criminologists suggest that familiarity with the living environment is key to reducing the fear-inducing impact of contextual features (Lorenc *et al.* 2013). Public familiarity is a relevant concept in this regard; it refers to a feeling of familiarity that emerges through running into the same people regularly (Blokland 2009; 2017). By having trivial and superficial forms of interaction, inhabitants are better able to 'place' each other in public space and to estimate whether other residents can (not) be trusted: 'public familiarity makes the social clear, and can make us feel safe for that reason' (Blokland 2017: 127).

The opportunity to meet and familiarize lies in the presence of facilities in the local environment (Van Bergeijk *et al.* 2008; Van Eijk and Engbersen 2011). Facilities function as an everyday meeting place (Blokland 2009). Oldenburg (1989) refers to these encounter opportunities as 'third places': public spaces that host regular, voluntary, informal and happily anticipated gatherings of individuals beyond the realms of home or work. Having nearby facilities may create 'a casual social environment' for local residents. These facilities include not only shops and recreation facilities, but also schools, churches, community centres and so forth. Only one study has researched the association between facilities and fear of crime in the context of US cities; it was shown that the use of local facilities was unrelated to fear levels (Riger *et al.* 1981). The role of local facilities is more frequently examined in relation to other societal outcomes such as increases in cohesion (or social capital) or declining crime rates. Quantitative analyses conducted in the Dutch context demonstrate that the presence or use of facilities is associated with more contact and friends in the neighbourhood (Van Bergeijk *et al.* 2008) and with an improved ability to realize shared goals in the neighbourhood (Völker *et al.* 2007). Besides, two other studies showed that the presence of facilities is related to an improved access to social capital (Curley 2010) and to higher levels of collective efficacy and civic engagement (Corcoran *et al.* 2017).

Studies on crime have analysed which local facilities reduce crime rates in the context of American neighbourhoods. Facilities are expected to lower crime levels by stimulating social organization or collective efficacy (Wo 2016). The evidence is, however, somewhat mixed. Certain facilities, such as recreation centres, religious facilities and other third places, are associated with lower crime rates (Peterson *et al.* 2000; Beyerlein and Hipp 2005; Wo 2016). Facilities may also elevate crime rates; studies show that schools (Slocum *et al.* 2013) and bars and banking establishments (Wo 2016) are associated with higher crime rates.

Negative effects of facilities are also examined within the literature on (non-residential) land use. These effects include increased levels of crime (e.g. Wilcox *et al.* 2005; Lockwood 2007; Stucky and Ottensmann 2009) and incivilities (e.g. Taylor *et al.* 1995; Sampson and Raudenbush 1999; McCord *et al.* 2007). An explanation suggests that non-residential land use blocks social control, thereby giving rise to uncontrolled deviant behaviour. The reason is two-fold: first, having more non-residential buildings implies having fewer inhabitants who may take care of the neighbourhood and, second, non-residential land use draws outsiders to these areas, decreasing the familiarity within an area (Taylor *et al.* 1995).

Defining and Measuring Local Context

Although 'the neighbourhood' is often perceived as the main contextual unit of interest in fear of crime research, the conceptualization and measurement of this unit generally lacks theoretical justification. Most existing research is instead driven and constrained by considerations of data availability. Consequently, neighbourhoods are often pragmatically defined as fixed entities with predefined administrative boundaries (Brunton-Smith and Jackson 2012; Van Ham *et al.* 2013). Using fixed and administratively defined neighbourhoods to detect contextual-level effects is considered problematic for at least two reasons. First, these rather simple measures of the neighbourhood generally lack meaningful boundaries. This is in particular the case from the perspective of the inhabitants and especially for those who live near an administrative neighbourhood boundary. In the Dutch case, neighbourhoods are defined by the municipality and aimed at creating units with a homogenous planning structure and boundaries that follow natural demarcations (e.g. rivers, railway lines) (Statistics Netherlands 2018). Resulting neighbourhoods, however, do not necessarily align with how inhabitants define their neighbourhood. Perceptions of the neighbourhood are structured not only by physical characteristics, but also by activity patterns and symbolic boundaries (Van Gent *et al.* 2016). In addition, researchers found that the Dutch administrative neighbourhood is in general much larger in size than how residents experience their neighbourhood (Wassenberg *et al.* 2006).

The second drawback of using administrative neighbourhoods lies in the inflexibility of the approach: relying on fixed neighbourhood boundaries limits the ability to explore patterns on a smaller scale. If inhabitants respond to their direct environment rather than the broader neighbourhood, researchers who rely on administrative neighbourhoods will miss out such effects because the unit of aggregation is too large (Hipp 2010). The lack of meaningful boundaries and inaccurate measurement of the local environment may in part explain why the empirical evidence for neighbourhood-level influences on fear of crime is 'surprisingly thin and inconsistent' (Brunton-Smith and Sturgis 2011: 331).

Because of the pitfalls of using administrative neighbourhoods, Hipp and Boessen (2013) proposed a new strategy for measuring context which they call egohoods.[1] As mentioned earlier, egohoods are concentric circles with a certain radius surrounding each inhabitant, providing each person with an individualized measure of neighbourhood context. It is argued and expected that egohoods better align with the behaviours and perceptions of inhabitants than the 'traditional' administrative neighbourhood. Research demonstrated that persons tend to travel in their neighbourhood area in concentric circles and do not

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[1] Dinesen and Sønderskov (2015) introduced a similar approach in their article on ethnic diversity and social trust.

necessarily stay within their own neighbourhood. In addition, inhabitants who are asked to define their neighbourhood often place themselves in the centre (Hipp and Boessen 2013).

In addition to creating more meaningful boundaries, another advantage of the ego-hood approach is its flexibility. The radius size of each egohood can be flexibly adjusted, enabling the construction of multi-scale egohoods. Accordingly, we can assess which spatial scale is most relevant to research contextual influences and whether this implies zooming in (on the 'micro-context') or zooming out (on the broader environment). Egohoods with small radii produce arguably more statistical power to detect contextual effects due to increased levels of spatial homogeneity, resulting in more accurate measures of the contextual characteristics (Hipp 2007; Oberwittler and Wikström 2009). Other fear of crime researchers have advocated the need to zoom out in order to capture possible 'geographical spillover effects' of the broader environment (Brunton-Smith and Jackson 2012). In any case, we assume that the egohood approach provides a more precise and hence relevant means of measuring context. We, therefore, expect that the contextual effects are stronger when the analyses are based on egohoods rather than administrative neighbourhoods. We do not have specific expectations regarding the egohoods.

Data and Methods

Data

Our analyses draw on a combination of survey data and administrative and register data. Survey data are obtained from the Rotterdam Safety Index 2016, a biennial survey on crime-related feelings of unsafety and victimization. The survey was conducted in 2015 among a subset of Rotterdam's population (aged 15 years or older). The sample of the survey was drawn from the municipality population register. In total, 14.620 respondents filled in the questionnaire, either online or through a written questionnaire. The net response rate was 23.6%. We only select those respondents whose residential location (in latitude and longitude) is known (N = 14.170).

To construct the contextual measures, we use data provided by the municipality of Rotterdam and Statistics Netherlands. Our measure of disorder is based on the perceptions of the respondents and is aggregated to the administrative neighbourhood level. Besides, the research department of the Rotterdam municipality (Research and Business Intelligence, OBI) granted us access to the Personal Records Database (PRD, in Dutch: *Basisregistratie Personen*). The PRD contains very detailed (anonymized) information about all individuals legally residing in Rotterdam, including their country of birth, parents' country of birth, geographic location of residence (in latitude and longitude) and the length of residence on the current address. Based on this information, the measures of ethnic diversity and residential mobility are calculated. OBI also provided data on housing values (in Dutch: *WOZ-waarde*) and the locations of facilities. All data supplied by OBI are geocoded, meaning that longitude and latitude coordinates are attached to each data point (which represents respondents, inhabitants, housing units or facilities). For the remaining contextual variable—crime—we rely on publicly available data from Statistics Netherlands.[2] The crime statistics are only available at the aggregated level of administrative neighbourhoods.

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[2] We use the file *Geregistreerde criminaliteit per gemeente, wijk en buurt, 2010–2015* (retrieved at www.cbs.nl/nl-nl/maat-werk/2016/45/geregistreerde-criminaliteit-per-gemeente-wijk-en-buurt-2010-2015). Accessed 28 January 2019.

Operationalizations

Our outcome variable—fear of crime—is measured through a set of three items. Respondents were asked how often they feel unsafe in the neighbourhood; how often they do not open the door during the evening or at night because they feel unsafe and how often they avoid certain areas in their neighbourhood because they feel unsafe (answer categories: never, occasionally, frequently). It should be noted that our measurement of fear refers to how often respondents feel unsafe or take certain actions rather than the intensity. Asking respondents about the frequency of crime fears is considered methodological and empirically more meaningful than posing questions about the overall intensity of crime-related worries (Farrall and Gadd 2004; Gray *et al.* 2008). Our three items measuring fear appear to form a unidimensional scale, accounting for 66% of the variance. The scale is based on the average of at least two valid answers and is internally consistent with a Cronbach's α of 0.73. A higher score (on the four-point scale) indicates more fear.

We distinguish between five contextual variables. To capture crime, we include police-recorded crime statistics and differentiate between the incidence of violent crimes (crimes such as sexual assault, homicide, stalking and human trafficking) and of burglaries. For both crime types, the relative incidence per 1,000 inhabitants is calculated. Ethnic diversity is measured by the percentage of non-Western minorities.[3] For economic status, we include the natural logarithm of the average housing value. Obviously, a higher average housing value indicates less economic disadvantage. The degree of residential mobility is calculated as the average length of residence. For our measure of incivilities, we rely on the perceptions of respondents. The respondents were asked about physical incivilities in their neighbourhood and, more specifically, about how often there is litter on the street; garbage outside of containers; graffiti on walls or buildings; and vandalism of street furniture (answer categories: (almost) never, sometimes and frequently). These items were combined into one scale with a Cronbach's α of 0.79. For the last contextual variable—facilities—we include the total number of facilities, including daily grocery shops; schools; healthcare facilities; religious facilities; community centres; restaurants, cafes and bars; and libraries. This variable is transformed by taking the square root of it.

We also take into account several control variables at the individual level. These variables and their descriptive statistics are depicted in Table 1. Aside from the variables gender and ethnicity, all the variables are based on self-reported answers. Missing values are either included as dummies or deleted list-wise. Descriptive statistics for the contextual variables are summarized in Appendix Table A1.

Measuring context

We employ two ways of measuring context. The first approach relies on administrative neighbourhoods and the second approach relies on egohoods. Depending on the approach, we include and aggregate contextual data at the level of administrative neighbourhoods or level of the egohood. The calculations were carried out by

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[3] Non-Western minorities are defined as those who are born in or who have at least one parent who was born in Africa, Latin America or Asia (including Turkey). Instead of the share of non-Western minorities, researchers often use the Herfindahl–Hirschman Index to measure ethnic diversity. These measures, however, tend to correlate strongly with each other.

TABLE 1 *Descriptive statistics of individual variables*

	Minimum	Maximum	Mean	*SD*
Fear of crime	1	4	1.79	0.85
Age	14	98	48.96	17.81
Gender (ref. = male)	0	1	0.55	
Ethnicity (ref. = Dutch)	0	1	0.54	
Moroccan	0	1	0.04	
Turkish	0	1	0.06	
Surinam	0	1	0.12	
Other non-Western	0	1	0.11	
Western	0	1	0.12	
Level of education (ref. = low)	0	1	0.10	
Middle low	0	1	0.17	
Middle	0	1	0.31	
High	0	1	0.36	
Tenure (ref. = renter)	0	1	0.48	
Employment status (ref. = unemployed)	0	1	0.54	
Children in household (ref. = none)	0	1	0.38	
Victim of burglary (ref. = not)	0	1	0.18	

using ArcGIS Pro. Most contextual variables are calculated by averaging or adding the value of the data points that lie within a specific neighbourhood or egohood.

The construction of the individualized measures of crime and incivilities followed a different procedure, either because the underlying data is only available at the level of administrative neighbourhoods (crime statistics) or because there are too few data points to construct a reliable measure (incivilities). To calculate the individualized measures of crime, we determined the (proportions of) administrative neighbourhoods that are located within an egohood and, next, calculated the average level of burglary or violent crime using weights according to the proportion of the given neighbourhood(s) within the egohood and their values. We followed a two-step procedure to calculate our incivilities measure. First, the respondents' responses were aggregated to the administrative neighbourhood level. This resulted in an aggregated measure of incivilities based on an average of 226 observations (minimum: 2, maximum: 499). The second step is similar to how the individualized crime variable was constructed. We first determined which proportion of the administrative neighbourhood(s) falls within each egohood and next calculated an average level of disorder using weights according to the proportion of the given neighbourhood(s) that lies within a specific egohood. We constructed in total six different-sized egohoods with radii ranging from 50 to 750 m. The smallest egohood covers an area of 0.8 ha and has on average 130 inhabitants (median: 118). In contrast, the largest egohood with a 750 m radius encompasses an area of approximately 177 ha and has on average 12,305 inhabitants (median: 10,250). The size of a 750-m-radius egohood corresponds closely to an average-sized Rotterdam administrative neighbourhood, which is approximately 187 ha (median: 120 ha). The average population size of an administrative neighbourhood is 7,889 (median: 7,760).

We should note that we only use data on Rotterdam. This may be problematic for respondents who live near the boundary of Rotterdam and, as a result, end up with 'incomplete' egohoods if their egohood crosses the municipal boundary. We calculated that between 0.5 per cent (for a 50-m egohood) and 22 per cent (for a 750-m egohood)

of the respondents have an egohood that does not entirely fall within the boundaries. These areas that cross the boundary are, however, relatively small. We ran our analyses based on both the full (i.e. all respondents) and the reduced samples (i.e. respondents with a 'complete' egohood). No large differences were observed. We, therefore, decided to report the results based on the full sample. The other results are available upon request.

Methods

For the regression analyses based on administrative neighbourhoods, we apply two-level linear multilevel models in order to take into account the nested structure of the data (respondents nested in neighbourhoods). The contextual effects were assumed to be fixed. Before estimating the full model, we calculated the intraclass correlation (ICC) based on the intercept-only model. The ICC indicates the proportion of variance in respondents' answers that can be attributed to the administrative neighbourhood level. The null model results in an ICC of 0.06. Ordinary least squares regression models are estimated for the analyses based on egohoods.[4]

Results

We first report the results of the multilevel regression analysis with contextual variables measured at the administrative neighbourhood level (see Table 2). Next, we display the contextual effects of this model in Figure 1. Figure 1 also includes the contextual effects estimated based on the egohoods of different radii. All findings reported below are based on regression models in which all individual control variables are included.

The results of the multilevel model shown in Table 2 indicate that fear is significantly higher among elderly adults, women and unemployed respondents. These findings are in line with the vulnerability hypothesis: fear is more widespread among people who perceive themselves as physically or socially vulnerable because they either see themselves as physically unable to resist to potential attacks (e.g. females and older inhabitants) or lack the resources to take actions to prevent victimization (e.g. the unemployed) (Covington and Taylor 1991; Eitle and Taylor 2008). Level of education and ethnicity are unrelated to feelings of unsafety, with the exception of middle-educated respondents and those with a Turkish background. These specific groups report higher levels of fear. Victimization experiences are also related to increased fear levels. In contrast, homeowners and respondents with children in their household report less fear.

As for the contextual variables at the neighbourhood level, we only observe significant effects of ethnic diversity and the two crime rates. The diversity and crime effects are in line with our expectations: residents living in ethnically diverse neighbourhoods express greater fear of crime. More specifically, an increase of 10 per cent points in diversity increases fear of crime with 0.03 ($b = 0.003 \times 0.10$) on a scale ranging from 1 to 4. In addition, higher levels of fear are observed in neighbourhoods where burglaries and violent crimes are relatively more prevalent. In neighbourhoods where burglaries

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[4] Because of potential spatial autocorrelation, we also estimated spatial error models in GeoDa with distance-based neighbours; the distance is based on the radius of the egohood (e.g. Tolsma and Van der Meer 2017). These models produced results that are virtually the same. The results of the spatial error models are available upon request.

TABLE 2   *Multilevel analysis of fear of crime*

	B (SE)
Individual level	
Age	0.001 (0.000)*
Gender (ref. = male)	0.326 (0.014)***
Ethnicity (ref. = Dutch)	
Moroccan	0.071 (0.038)
Turkish	0.178 (0.031)***
Surinamese	−0.031 (0.023)
Other non-Western	0.018 (0.024)
Western	0.014 (0.021)
Level of education (ref. = low)	
Middle low	0.037 (0.027)
Middle	0.058 (0.025)*
High	−0.002 (0.027)
Tenure (ref. = renter)	−0.088 (0.016)***
Employment status (ref. = unemployed)	−0.075 (0.017)***
Children in household (ref. = none)	−0.033 (0.018)*
Victim of burglary (ref. = not)	0.396 (0.016)***
Administrative neighbourhood level	
Ethnic diversity	0.003 (0.000)***
Residential mobility	−0.000 (0.000)
Economic status	−0.096 (0.051)
Burglaries	0.009 (0.002)***
Violent crime	0.002 (0.001)*
Incivilities	0.169 (0.122)
Facilities	0.003 (0.004)
N	13.503

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

and violent crimes are most prevalent, inhabitants report, respectively, 0.389 point ($b = 0.009 \times 43$) and 0.529 point ($b = 0.002 \times 256$) higher on the fear of crime scale. The remaining contextual variables—housing values, residential mobility, facilities and incivilities—are unrelated to individual fear levels. These findings indicate that the administrative neighbourhood is not necessarily a relevant spatial unit to detect contextual effects on fear of crime, with the exception of the diversity and crime effects.

The administrative neighbourhood and egohoods

We now will compare the impact of our seven contextual variables on fear of crime across the different spatial units and elaborate on differences and similarities. Figure 1 presents an overview of the estimated effects. It should be noted that the results of residential mobility are not displayed. This variable is not included because no significant associations between residential mobility and fear of crime were found. Overall, our research provides no evidence that inhabitants feel more unsafe in places where the average length of residence is low(er).

Figure 1a shows that the occurrence of burglaries is a significant predictor of fear in all contexts. The impact of this predictor varies only slightly between the aggregation scales. The effects at the four smallest egohood levels and administrative neighbourhood level are in particular similar in size. Besides, we observe somewhat of an upward pattern regarding the two largest egohoods, which have radii of 500 and 750 m. The
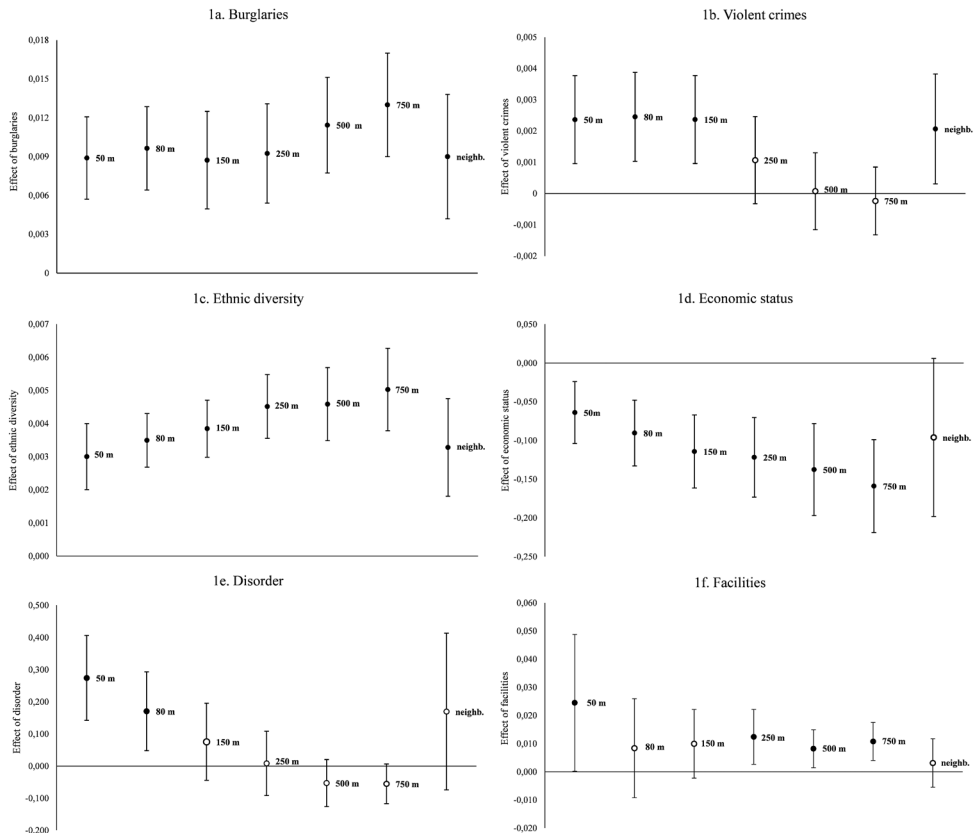
FIG. 1 The impact of contextual variables estimated at different contextual units and sizes with 95% confidence intervals. Significant *b* estimates are filled ($p < 0.05$), and non-significant *b* estimates are only outlined. $N = 13.503$.

effect on fear of crime is strongest when the burglary rates are measured at the largest egohood level. In contrast to burglaries, violent crimes (see Figure 1b) are only significant predictors of fear of crime in the three smallest egohoods and within administrative neighbourhoods. The sizes of the significant effects are, again, very similar. These similarities in effect sizes are perhaps not very surprising: if egohoods are located in just one administrative neighbourhood—which is more likely in the case of the smaller egohoods—these egohoods obtain a similar score as a result of how our measurement is constructed. The same holds for our burglaries measure.

The level of ethnic diversity (Figure 1c) is a significant predictor of fear of crime within all spatial units, including the administrative neighbourhood. Overall, the effects indicate that more fear of crime is reported in areas with higher levels of diversity. We observe a consistent pattern regarding the egohoods: the diversity effects become somewhat more prevalent when diversity is aggregated to egohoods with a larger radius. These findings confirm that the strongest effects of diversity are not necessarily found within the smallest contexts (cf. Tolsma and Van der Meer 2017). In their

study on trust in neighbours, Tolsma and Van der Meer (2017) also found stronger diversity effects on larger spatial scales. Our results indicate that the effect of ethnic diversity on fear of crime is less detrimental in smaller contexts. This may be because inhabitants of smaller areas are more familiar with each other as a result of physical proximity. Research showed that residents are most likely to interact with those who live closest to them (Hipp and Perrin 2009). Increased familiarity and a better ability to 'place' each other in public space may lessen the negative impact of diversity on fear. This mechanism is less likely to operate in larger contexts. As the scale expands, familiarity between residents decreases and the diversity effect becomes more prevalent.

A similar mechanism may underlie the pattern of economic status, which is illustrated in Figure 1d. Significant associations between economic status and fear of crime are observed for all egohoods. More specifically, it is shown that a higher economic status is related to less fear. It also appears that, similar to ethnic diversity, the impact of economic status is slightly stronger in egohoods with a larger radius. The notions of physical proximity and familiarity may, again, explain why weaker effects are found in smaller contexts. It could be that in these contexts the impact of economic status is minimized by a sense of familiarity that residents share. Overall, the results suggest that it is not only, and especially, characteristics of smaller local contexts that play a role in generating fear. We already observed that economic status measured at the level of the administrative neighbourhood is unrelated to fear levels.

Disorder (Figure 1e) aggregated to the administrative neighbourhood is also not significantly related to fear levels. Figure 1e shows furthermore that our measure of disorder is only significantly associated with more fear in the two smallest egohoods, which have radii of 50 and 80 m. The strongest disorder effect is found within the smallest egohood. Besides, Figure 1e demonstrates that the amount of disorder in larger egohood contexts is not related to fear of crime. In contrast to the effects of diversity and economic status, the effects of incivilities seem to be 'localized' (Hipp 2007). This means that disorder only affects the perceptions of residents who live close by, probably because inhabitants tend to be more aware of disorderly things happening in their immediate surroundings than those located further away (Hinkle and Weisburd 2008).

Last, we consider whether and how the number of facilities in the residential environment affects feelings of unsafety. These facilities include both commercial venues and non-commercial settings. The effects are displayed in Figure 1f. Significant associations are reported in egohoods with a 50, 250, 500 and 750 m radius. Contrary to our expectations, more facilities are in these contexts associated with higher levels of fear. It seems that facilities in the micro-context and in larger egohoods are fear generating. A clear pattern regarding the effect sizes is absent. The largest effect is found within 50-m egohoods, with a p-value just below 0.05. The significant effects detected in the larger egohoods are similar in size. Rather than facilitating familiarity and subsequently increasing feelings of safety, we provide tentative evidence that facilities may in contrast increase fear levels.

Overall, our findings suggest that fear levels are affected by the residential context a person lives in. More specifically, we found that crime, ethnic diversity, economic status, disorder and facilities all have an effect on feelings of unsafety. These contextual effects differ, however, in size and are not detected in all spatial contexts, indicating that it matters how and to which scale data are aggregated (see

Table 3 for an overview). This is a familiar issue in spatial statistics, known as the modifiable areal unit problem (MAUP). Central to the MAUP is the notion that analytical results are sensitive to the way spatial units are defined (Fotheringham and Wong 1991).

Discussion and Conclusion

Whether and how the residential context shapes fear of crime has become a central theme in criminological research. Scholars studying the contextual determinants of fear of crime almost always rely on administrative neighbourhoods to define the residential context (e.g. Covington and Taylor 1991; Chiricos *et al.* 1997; Brunton-Smith and Sturgis 2011; Pickett *et al.* 2012). The present study combines this traditional neighbourhood approach with a more innovative way to measure the residential context. Using very detailed GIS data, we constructed egohoods with radii ranging from 50 to 750 m. These egohoods enable us to study fear of crime in a more spatially informed way.

Our analyses show that individuals' feelings of unsafety are affected by the residential context they live in. With the exception of residential mobility, all our included contextual variables are to some extent related to fear of crime. More importantly, however, we found that not every contextual characteristic is relevant at every spatial scale. The 'appropriate' spatial level seems to differ per characteristic. Our results suggest that the effects of context operate at different levels (cf. Hipp 2007). The strength of these relationships also depends on the spatial scale at which the contextual effects are assessed. In the case of ethnic diversity and economic status, stronger effects on fear of crime are observed in larger egohoods. As for disorder, the opposite holds true. The tendencies in the effect sizes of crime and facilities show less clear patterns.

Another notable result of the present study is that the administrative neighbourhood proved to be the least relevant spatial context to detect significant contextual effects. It suggests that administratively defined areas do not necessarily align with how inhabitants experience their unsafety, thereby questioning the use of administrative units in fear of crime research. This is consistent with outcomes of previous European studies, which also used administrative units to define context and examined fear patterns in Belgium and Germany. These studies offer only limited support for the impact of

TABLE 3   *Schematic overview of results. Fear of crime and contextual effects*

	50-m egohood	80-m egohood	150-m egohood	250-m egohood	500-m egohood	750-m egohood	Neighbourhood
Burglaries	***	***	***	***	***	***	***
Violent crimes	**	**	**	×	×	×	*
Ethnic diversity	***	***	***	***	***	***	***
Economic status	*	*	***	***	***	**	×
Residential mobility	×	×	×	×	×	×	×
Disorder	***	**	×	×	×	×	×
Facilities	*	×	×	*	*	**	×

× indicates no significant effect on fear. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

context on fear (Hanslmaier 2013; Hooghe and De Vroome 2016). In contrast, research conducted by Brunton-Smith and Sturgis (2011) and Brunton-Smith *et al.* (2014) provides stronger evidence that characteristics of the local level have a direct influence on fear among UK residents. An explanation for these diverging results is the measurement of context, and whether the resulting spatial units align with how individuals experience their local surroundings. Either way, it urges us to think about whether 'the neighbourhood' is still the most appropriate concept to adopt. We agree with Sharkey and Faber (2014) that the terms residential context and residential environment are more useful when studying how context shapes individual-level outcomes. Instead of asking 'do neighbourhoods generate fear of crime?' (Brunton-Smith and Sturgis 2011), we should examine how the residential environment influences feelings of unsafety.

This study explored the ways the residential environment impacts fear of crime. More specifically, we distinguished four pathways and hypothesized that fear of crime may be affected through (1) crime; (2) demographic and economic characteristics of the context (i.e. ethnic diversity, economic disadvantage and residential mobility); (3) incivilities and (4) facilities that promote familiarity. The analyses support the first pathway: it is shown that more burglaries and violent crimes are indeed related to higher fear levels, indicating that fear of crime is at least to some degree related to objective crime. This result is in line with other Europeans studies (Brunton-Smith and Sturgis 2011, but see Hooghe and De Vroome 2016). We find mixed evidence for the second pathway. More fear of crime is observed in ethnically diverse areas with a lower economic status. The degree of residential mobility is, however, not associated with fear. The latter finding is in particular insightful: although residential instability is often linked to the breakdown of social control, the association with fear of crime has not been explored extensively (for an exception see Brunton-Smith and Sturgis 2011). The third pathway, which centres on the role of incivilities, is partially supported. We found an effect on fear, but only in the smallest egohoods. The link between incivilities and fear was already well established in previous research (e.g. Covington and Taylor 1991; Rountree and Land 1996; Markowitz *et al.* 2001). We add to this literature by showing that incivilities especially matter to those inhabitants who live in nearby areas that are perceived as disorderly. The findings regarding the fourth and last pathway were not in line with our expectations. Based on earlier research, we predicted lower levels of fear in areas with more facilities. The analyses showed that the opposite is the case. Rather than creating feelings of public familiarity and decreasing fear levels, the findings indicate that facilities may instead lower feelings of familiarity and safety. We should, however, note that we did not examine whether inhabitants actually use facilities, nor did we directly test the relationship between facilities and feelings of familiarity. Actual use is considered key to understanding the development of public familiarity (Blokland and Nast 2014).

We should also consider other limitations of our study. For our measures of crime and disorder, we had to rely on data that were only available at the aggregated level of administrative neighbourhoods. Our individualized measures of crime and disorder are, therefore, prone to measurement error since we implicitly assumed that the administrative neighbourhoods are homogeneous in their disorder and crime scores. If this assumption is invalid, measurement errors are likely to occur, especially in the case of the smaller egohoods. This may result in biased results and an underestimation of the disorder and crime effects at smaller scales (Sluiter *et al.* 2015). More accurate estimations of these effects require access to more detailed data. Another limitation is

the use of cross-sectional data, inhibiting us from controlling for selective residential mobility. Consequently, a causal effect of context on fear of crime cannot be assumed. Longitudinal data are needed to overcome this limitation.

Overall, our study shows that it is important to consider the role of spatial scale when studying the contextual determinants of fear of crime. We outline two directions for future research. A first direction is constructing more sophisticated egohoods based on the road network and other natural demarcations, resulting in areas that better align with how residents experience their local environment. Another direction is examining to which extent the impact of the contextual factors depends on individual-level characteristics. It may be that the effects of the contextual characteristics are different for different groups of individuals.

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APPENDIX
TABLE A1
Descriptive statistics of contextual variables

	Minimum	Maximum	Mean	*SD*
Administrative neighbourhood				
Burglaries	0	43	7.31	4
Violent crimes	0	256	9.51	9.99
Ethnic diversity	0	80.18	36.22	19.03
Economic status	11.22	12.98	11.83	0.33
Residential mobility	38	235	111.25	24.68
Disorder	1.33	2.30	1.89	0.15
Facilities	0	14.32	6.41	2.36
Egohood 50 m				
Burglaries	0	42.99	7.67	4.86
Violent crimes	0	256	9.65	10.03
Ethnic diversity	0	97.81	34.81	25.37
Economic status	10.78	15.67	11.88	0.48
Residential mobility	4.86	666	115.39	45.40
Disorder	1.17	2.30	1.89	0.15
Facilities	0	5.29	0.29	0.58
Egohood 80 m				
Burglaries	0	43	7.67	4.79
Violent crimes	0	256	9.71	10
Ethnic diversity	0	94.48	35.44	23.88
Economic status	10.76	14.98	11.87	0.45
Residential mobility	4.75	666	114.04	40.35
Disorder	0.75	2.30	1.88	0.16
Facilities	0	6.16	0.59	0.83
Egohood 150 m				
Burglaries	0	43	7.67	4.65
Violent crimes	0	256	9.94	10.18
Ethnic diversity	0	89.97	36.04	22.29
Economic status	11.02	14.08	11.86	0.41
Residential mobility	11	500	112.6	34.06
Disorder	0.48	2.19	1.88	0.17
Facilities	0	6.86	1.43	1.25
Egohood 250 m				
Burglaries	0	43	7.31	4.17
Violent crimes	0	256.01	10.08	10.60
Ethnic diversity	0	86.24	36.33	20.79
Economic status	11.08	14.03	11.84	0.37
Residential mobility	15.05	500	111.89	30.04
Disorder	0.37	2.19	1.86	0.19
Facilities	0	9.43	2.60	1.70
Egohood 500 m				
Burglaries	0	38.69	7.67	4.49
Violent crimes	0.13	251.62	11.42	11.98
Ethnic diversity	0	81.49	36.93	18.89
Economic status	11.19	13.56	11.82	0.32
Residential mobility	30.3	302.17	111.24	25.36
Disorder	0.33	2.14	1.80	0.24
Facilities	0	14.70	5.49	2.76
Egohood 750 m				
Burglaries	0	31.08	7.62	4.47
Violent crimes	0.46	218.13	12.65	13.51
Ethnic diversity	0	75.09	37.50	17.51
Economic status	11.22	13.12	11.81	0.30
Residential mobility	32.41	342.20	111.22	22.64
Disorder	0.28	2.09	1.74	0.29
Facilities	0	14.83	5.64	2.73