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Parallel lives: Intergroup contact, threat and the segregation of everyday activity spaces

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Parallel lives: Intergroup contact, threat and the segregation of everyday activity spaces

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Abstract

Although intergroup contact can reduce prejudice, opportunities to experience such contact are often constrained by systems of segregation. Work on this problem has focused on divisions entrenched within institutions of residence, education and employment. Our research employed a complementary approach, which treated segregation as the outcome of individuals' movements over time within everyday life spaces. Taking as a case study Catholics' and Protestants' use of public environments in north Belfast, we used GPS tracking technology, combined with GIS analytics, to explore the time geography of residents' activity space use over a two-week period (Study 1). We also conducted a field survey to explore how psychological factors shaped their willingness to use activity spaces beyond their own communities (Study 2). Analysis based on around 1000 hours of raw movement data revealed that north Belfast is marked by high levels of segregation, expressed via residents' limited use of public spaces, facilities and pathways located in outgroup areas. However, use of shared spaces is also common, with Catholics spending more time in such spaces than Protestants. Structural equation modelling suggested that residents' self-reported willingness to use activity spaces outside their own communities was associated with both negative and positive intergroup contact - relationships partially mediated by realistic threat, symbolic threat, and anxiety over interaction across sectarian lines. Both kinds of contact and realistic threat were also associated with the time residents actually spent in spaces beyond their own communities. Opportunities for integrating psychological and geographic research on contact and segregation are highlighted.

Key words: Segregation, contact, intergroup threat, mobility, GIS, time geography, Northern Ireland

Most research on segregation uses census data to investigate population distributions across residential areas of cities as well as institutions of education and employment. This research has proved valuable in mapping the fundamental characteristics of urban segregation and revealing its often-negative socioeconomic consequences, particularly for historically disadvantaged communities. Residential segregation has been linked, for instance, to the concentration of poverty in cities (Massey & Fischer, 2000), exposure to negative environments and associated health risks (Acevedo, Lochner, Osypuk & Subramanian, 2003), inequalities of access to education and other resources (Orfield & Lee, 2005), and problems of intergroup conflict and prejudice (Pettigrew & Tropp, 2011).

However valuable its contribution, this work has provided an incomplete picture of the nature of segregation (Schnell & Yoav, 2001; Dixon et al., 2008). In their day-to-day lives, people spend a lot of their time outside the home, the workplace or institutions of learning. They use everyday activity spaces such as street corners, parks, markets, sports fields, and leisure spaces, and they travel along public pathways such as roads, footpaths, thoroughfares, and streets. How do such routine behaviours create opportunities for interaction across intergroup barriers or help to sustain isolation? By what social and psychological processes are they shaped? The present research was designed to address these questions.

To do so, we employed a methodological framework that capitalised on the potential to use mobile phone technology for mapping residents' movements in cities (Palmer et al., 2013). Taking as a case study Catholics' and Protestants' use of public environments in the historically divided city of Belfast, Northern Ireland's capital city, Study 1 used tracking with a Global Positioning System (GPS), combined with analytics drawn from a Geographic Information System (i.e. a GIS system for storing, manipulating and visualising geographic data), to explore the 'time-geography' (Miller, 2004) of activity space segregation in Belfast. Study 2 employed a field survey designed to explore how psychological factors may shape residents' willingness to use activity spaces beyond their own communities. Building on research on the 'contact hypothesis' (Allport, 1954), this survey investigated the role of negative and positive intergroup contact experiences, realistic and symbolic threat, and anxiety about interaction across sectarian lines.

The contact hypothesis and the time-geography of segregation

Research on the 'contact hypothesis' offers arguably the strongest psychological evidence for the negative effects of segregation on relations between groups. This research has shown that

segregation tends to increase intergroup hostility and that positive contact between groups may both reduce prejudice and foster positive intergroup emotions (Dovidio, Gaertner & Kawakami, 2003; Pettigrew & Tropp, 2011; Vezzali & Stethi, 2017). Studies conducted in Northern Ireland, for example, have found that positive interactions between Catholics and Protestants are associated with improved sectarian attitudes, forgiveness, and civic engagement (e.g., see Hewstone et al., 2006; McKeown & Taylor, 2017; Paolini, Hewstone, Cairns & Voci, 2004).

Policymakers seeking to create opportunities for positive contact, however, must face an inconvenient truth: even in societies where segregation has been formally dismantled, its influence on social life often lingers. In the US and South Africa, for instance, *de jure* structures of racial segregation have been abolished, yet racial segregation endures in both societies. The imperatives of the apartheid system and Jim Crow racism, which enforced segregation by law, have been replaced by the 'informalities of private preference schemes' (Goldberg, 1993, p.17), often accompanied by new forms of institutional discrimination (Massey & Denton, 1993). Segregation is now driven, at least in part, by individual and collective choices about where to live, work and educate children, even if economic, legislative, and other macro-level factors continue to play a role (e.g., Dawkins, 2004; Quillian, 2002; Charles, 2003). The present research highlights the role of individuals' day-to-day mobility choices in shaping the dynamics of intergroup contact and segregation, whilst acknowledging too that such choices are themselves constrained by broader structural dynamics, such as the organization of institutions of education and residence in divided cities (e.g., see Swyngedouw, 2013).

The role of so-called 'preferential segregation' has, of course, already been illustrated by observational research on the micro-ecological organization of relations between groups (see Dixon et al., 2008; McKeown & Dixon, 2017 for reviews). Such research has revealed how barriers to contact are routinely maintained in everyday life settings, even when members of different groups are physically co-present and have ample opportunities to interact. Studies have shown, for example, how segregation emerges in such varied settings as: (1) school playgrounds, classrooms and cafeterias (e.g., Al Ramiah, Schmid, Hewstone, & Floe, 2015); (2) public seating areas and similar public spaces (e.g., Tredoux et al., 2005); (3) beaches (e.g., Durrheim & Dixon, 2005); (4) university lecture theatres and dining halls (e.g., Schrief et al., 2010); (5) public transport (e.g., Swyngedouw, 2013); and (6) bars and leisure spaces (e.g., Tredoux & Dixon, 2009).

The present research extends work on the micro-ecology of segregation by building on advances in the study of human mobility practices (e.g., see Palmer, 2013; Kwan, 2013; Wang & Chai, 2012). Most previous work has consisted of small-scale observational studies of relations

located in a single context - for example, studies mapping seating arrangements in cafeterias and dining halls (e.g., Schrief et al., 2010) or trains (Swyngedouw, 2013). However, as Study 1 demonstrates, GPS tracking technology, which can be installed on the mobile phones that most city residents routinely carry, opens up opportunities for investigating activity space use in new, more expansive, ways. For example, this technology enables researchers to identify the pathways residents select as they travel the city, the everyday spaces where they spend their time, the spaces they do not frequent, and the destinations where the pathways of different communities bundle together, potentially creating opportunities for intergroup contact. In addition, as Study 2 demonstrates, such methods can be complemented by standard psychological techniques in order to investigate the psychological processes that underpin residents' mobility choices.

Conceptually, our research proceeded from the assumption that the opportunity to experience intergroup contact is shaped by factors located across a range of socio-spatial scales (cf. Tredoux & Dixon, 2009) and, more specifically, by the dynamics of human mobility practices in everyday life spaces. Whereas most social science research has focused on the relatively stable, macro-level factors that shape segregation - as established, for example, within the global institutions of housing, education and employment - the present research proposed that segregation can also be treated as a micro-level process that is enacted via individuals' use of public activity spaces over time. Indeed, to adapt Alan Pred's (1977) elegant phrase, our overall aim was to investigate how, why and when segregation is reproduced within the 'choreography of existence' in historically divided cities.

In developing this kind of approach, some researchers have drawn productively on concepts based within the field of time geography (e.g., see Aksyonov, 2011; Kwan, 2013; Palmer, 2012). This theoretical tradition analyses individuals' movements by employing concepts such as *space-time paths* (the spatial trajectories that individuals trace via their movements over time) and *bundles* (the recurrent grouping together of such individual paths to accomplish, for example, shared activities). Of particular interest here is the question of how individuals' movements over time are constrained as they go about their daily activities and how, by implication, this may shape their opportunities to share social spaces with others.

Three kinds of constraints are generally emphasized in classic work on time geography (see Hägerstrand, 1970; Miller, 2004). Capability constraints limit behaviour as a result of individuals' biological capacities or the mobility resources that they can marshal. For example, if people are trapped in their own community due to physical infirmity or lack of access to transport, then this may affect their capacity to interact with members of another community. *Coupling constraints* may limit behaviour due to the necessity of individuals spending time at particular locations with other

individuals. For example, if a mother must take her child to a local creche three times a week at a given time, populated mainly by members of her own community, then this may limit the opportunities that either she or her child have to meet mothers and children from another community, elsewhere, at those same times. *Authority constraints* determine how access to everyday spaces over time is subject to external control. For example, if an external authority regulates access to a given space by age, gender or social class, then this may reproduce social divisions.

Shaped by capability, coupling and authority constraints, the time-geographic organization of everyday life may thus perpetuate segregation in ways that have seldom been considered by social psychologists. Coupling constraints, for example, help us to understand when and how the organization of individuals' space-time paths may regulate their opportunities to experience the kinds of intergroup interactions prioritized by work on the contact hypothesis. By the same token, however, we want to argue that activity space segregation is also shaped by social psychological processes that are typically not fully captured by the time-geographic work on 'constraint'. Recognition of this fact opens up possibilities for developing a rich, interdisciplinary framework. Use of everyday activity spaces, we hold, entails decisions that are (often) are not fully determined by factors such as the physical limitations of human movement or the forms of control exercised by external authorities. Indeed, we argue that such use is shaped by psychological processes every bit as powerful as the factors emphasized by time-geographers.

Intergroup contact, threat and activity space use

Intergroup threat

The present research aimed to explore the relationship between activity space use and three kinds of perceived threat, namely anxiety about interacting with members of other communities, realistic threat, and symbolic threat. It thus sought to integrate research on the time geography of activity space use with research on the social psychology of intergroup threat (Stephan, Ybarra & Morrison, 2009; Riek, Mania & Gaertner, 2006).

The role of *intergroup anxiety* (Stephan & Stephan, 1985) in maintaining practices of segregation has been underlined by several researchers. For example, in an experimental study conducted in South Africa, Finchilescu (2010) found that anxiety over racial contact was predicted by negative meta-stereotypes – the perception that one's 'race' group is perceived unfavourably by members of another group - and argued that this was in turn a powerful barrier to mixing across racial lines. In their longitudinal study of seating arrangements in a university dining hall, Schrieff

and colleagues (2010) likewise highlighted the importance of same-race 'comfort zones' in maintaining segregation over time. Their diners preferred eating in situations where interactions were not rendered awkward by the prospect of racial mixing. Building on this kind of evidence, we hypothesized that anxiety about having intergroup interactions with the 'other' community might also shape sectarian segregation in the everyday spaces of Belfast.

The potential for broader forms of realistic and symbolic threat to shape such segregation is also supported by research evidence. *Realistic threat* designates threats to an individual or group's power, economic prosperity, or general welfare, including threats to their safety (Stephan, Ybarra & Morrison, 2009). Based on local research, we predicted that the latter would be particularly salient to the use of activity space in Belfast. Bairner and Shirlow (2003), for instance, demonstrated how the use of facilities designed to benefit the whole community may be limited by fears about *where* they are located in Belfast. Their interview study suggested that concerns over personal safety made Catholic and Protestant residents reluctant to use leisure facilities located near the other community's areas, confirming Roche's (2008, p.36) claim that Belfast residents have "… a genuine fear of travelling into areas associated with the other community, and often, a fear of the other community".

Symbolic threat designates threats to individual or collective systems of values, beliefs, traditions, and worldviews (Stephan et al., 2009). Based on local research, we again hypothesized that this form of threat would shape activity space segregation in Belfast. After all, Belfast is a place where symbolic divisions between Catholic and Protestant communities are expressed within everyday landscapes in the form of interface barriers[1], wall murals, kerb paintings, flags, and other ethno-political symbols (e.g., Jarman, 2012; Bryan & Stevenson, 2009). Such symbols signify to residents 'who belongs where' as they move through the city's public spaces, whilst also affirming the competing ideologies of Irish Nationalism (mainly in Catholic areas) and Unionism (mainly in Protestant areas).

Negative and positive contact

If intergroup threat is associated with activity space segregation, then understanding the factors that shape such threat becomes theoretically and practically significant. The present research focused on the role of positive and negative contact experiences.

Positive contact has been found both to reduce individuals' perceptions of intergroup threat and, perhaps closely related, to decrease their propensity to act in ways that reproduce segregation. The relationship between positive contact and threat reduction – particularly the reduction of social

anxiety about intergroup encounters - has been evidenced in many studies, some conducted in Northern Ireland (e.g., Paolini et al., 2004; McKeown & Taylor, 2017). Indeed, for this reason, positive contact is now incorporated within general models of intergroup threat such as the influential Integrated Threat Model developed by Stephan and colleagues (Stephan et al., 2009). Positive contact has also been found to reduce attitudes and behaviours that may maintain segregation. Several classic studies demonstrated, for instance, that positive interaction with others increases participants' support for institutional desegregation, including the desegregation of housing, employment, schooling, and the military (e.g., Star, Williams and Stouffler, 1949/1958; Johada & West, 1951). Similarly, Braddock (1980) and Braddock and McPartland (1989) found that positive interracial contact between children in schools increased their likelihood of having such contacts in later life and in other contexts (e.g., employment). Extending this more general work on the interrelations between contact, threat and segregation, we predicted that positive contact would shape activity space segregation in Belfast via its effects on intergroup anxiety, symbolic threat and realistic threat.

We hypothesised that the relationship between segregation and experiences of *negative contact* would work in the opposite direction. Perhaps surprisingly, the study of negative contact is in its infancy. However, emerging work has established that negative contact, though occurring less frequently than positive contact, sometimes exerts the more powerful effects on intergroup relations (Barlow et al., 2012; Graf, Paolini & Rubin, 2014). Such effects may encompass activity space segregation. In line with this hypothesis, Mealeady & Forder (2018) found that negative contact experiences reduced respondents' future intentions to interact not only with members of a 'primary' outgroup, but also with related 'secondary' outgroups, via a process that they labelled the 'avoidance generalization effect'. Along similar lines, Barlow et al. (2012) reported that negative contact was associated with self-reported avoidance of interracial contact on relevant questionnaire items, including the item "I would rather study for an exam than talk to a Black stranger on the street". Likewise, Hayward (2016) reported that negative contact was a stronger predictor of intergroup avoidance than positive contact, an outcome mediated by both intergroup anger and anxiety. The latter finding supports the hypothesis that the relationship between contact and activity space avoidance may be mediated by discomfort about interacting with members of other communities. By extension, it is plausible that negative intergroup encounters may raise concerns about personal safety in everyday spaces (realistic threat) or acceptance of identity-relevant values in such spaces (symbolic threat), thereby again triggering behavioural practices of avoidance.

The present research, then, tested the psychological model represented in Figure 1 below. This proposed that both negative and positive contact experiences would shape Belfast residents' willingness to use activity spaces beyond their own ethno-political communities and that this process would be partially mediated by realistic threat, symbolic threat and anxiety about cross-community contact. Given that, to our knowledge, this is the first study to investigate the specific pattern of relationships proposed in Figure 1, we left open finer-grained questions about how specific pathways might vary across Protestant and Catholic communities. However, given that men have suffered disproportionately from sectarian violence in Belfast (McKittrick, Kelters, Feeney & Thornton, 2001) and that qualitative evidence suggests women accordingly may feel more able to 'cross borders' to use activity spaces beyond their own communities (Dowler, 2007), we conjectured that the interrelations between contact, threat and activity space segregation would be shaped by gender. Specifically, based on interview evidence that women feel more comfortable than men about entering outgroup residential areas and leisure spaces (e.g., Dowler, 2001; Bairner & Shirlow, 2003), we predicted that this would be reflected in their self-reported mobility practices.
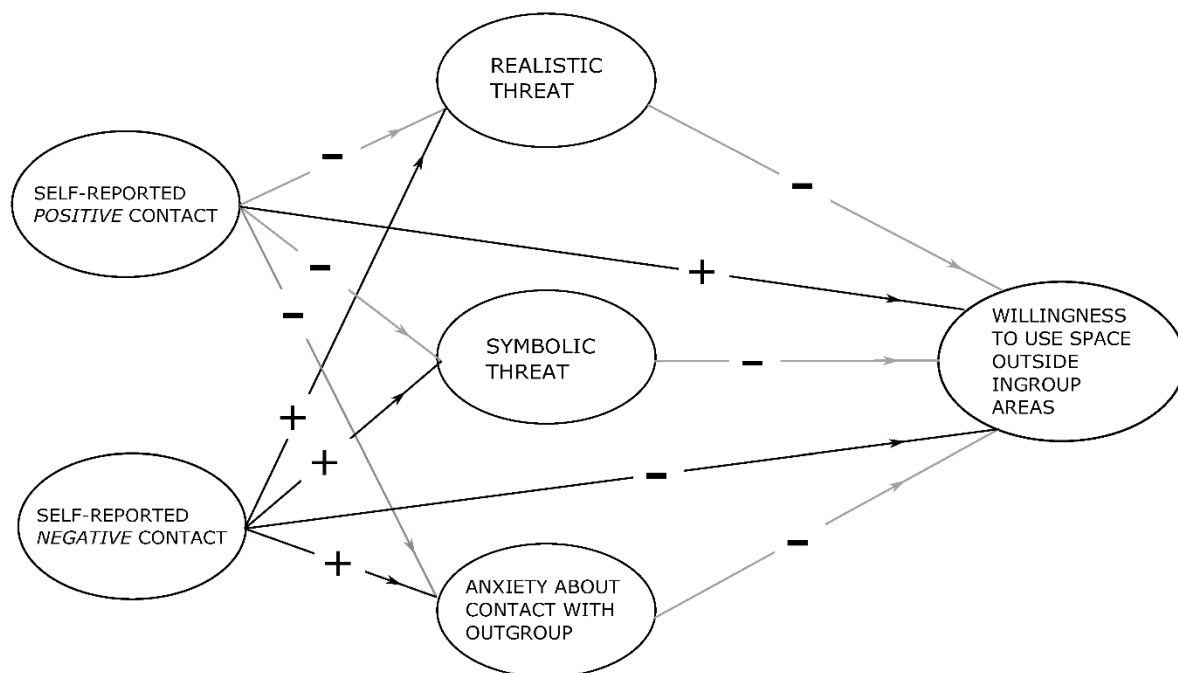

Figure 1. Proposed SEM model of relations between contact, threat and activity space segregation

Note: to simplify presentation, the measurement model is not shown. Paths predicted to be positive are annotated with + signs and are a dark gray, whereas paths predicted to be negative are annotated with - signs and are a light gray.

The present research

In sum, our research attempted to develop a novel approach to evidencing and explaining segregation, focusing on everyday activity space use over time in the historically divided city of Belfast. Our overall objective was not simply to provide new empirical data on relations in Belfast. More broadly, we aimed to develop and apply an interdisciplinary framework that might inform wider research on segregation, drawing on concepts and methodological tools rooted in both human geography and social psychology.

Study 1 used a bespoke mobile phone app to collect mobility data from residents of north Belfast, which were then captured and analysed using a combination of Geographic Information System (GIS) analytics and multivariate statistics. The study's design enabled descriptive exploration not only of global sectarian patterns of activity space use, but also of more subtle variations (e.g., across time, community membership, and gender). Study 2 comprised a field survey designed to explore some social psychological factors associated with Belfast residents' willingness to use spaces beyond their own community areas. Specifically, it tested a psychological model of the potential role of contact experiences and intergroup threat in shaping self-reported activity space segregation (see Figure 1).

Research Context

The human geography of Belfast has inspired a long tradition of research, stretching from the classic work of Boal and others on sectarian divisions during 'the troubles' (e.g., Boal, 1969; Doherty & Poole, 1997) to more recent work mapping the changing face of the 'post-conflict' city (e.g., Murtagh, 2012; Leonard, 2017). Much of this work has examined residential polarization. Our research extended this literature by exploring emerging patterns of segregation and mixing in everyday activity spaces in north Belfast. Whereas West Belfast is predominantly Catholic and East Belfast predominantly Protestant, North Belfast is home to roughly equal numbers of Catholic and Protestant residents, with an estimated total population of just over 102000 (Northern Irish Assembly, 2013). Historically, members of the local Catholic community have suffered in particular from sectarian discrimination in terms of access to resources such as housing, employment and education. However, it is important to note that this area of the city has also been subject to widespread patterns of economic deprivation and sectarian violence in which members of *all*

communities have suffered, both before and after the 1998 peace agreement (e.g., see Jarman, 2006; McKittrick et al., 2001).
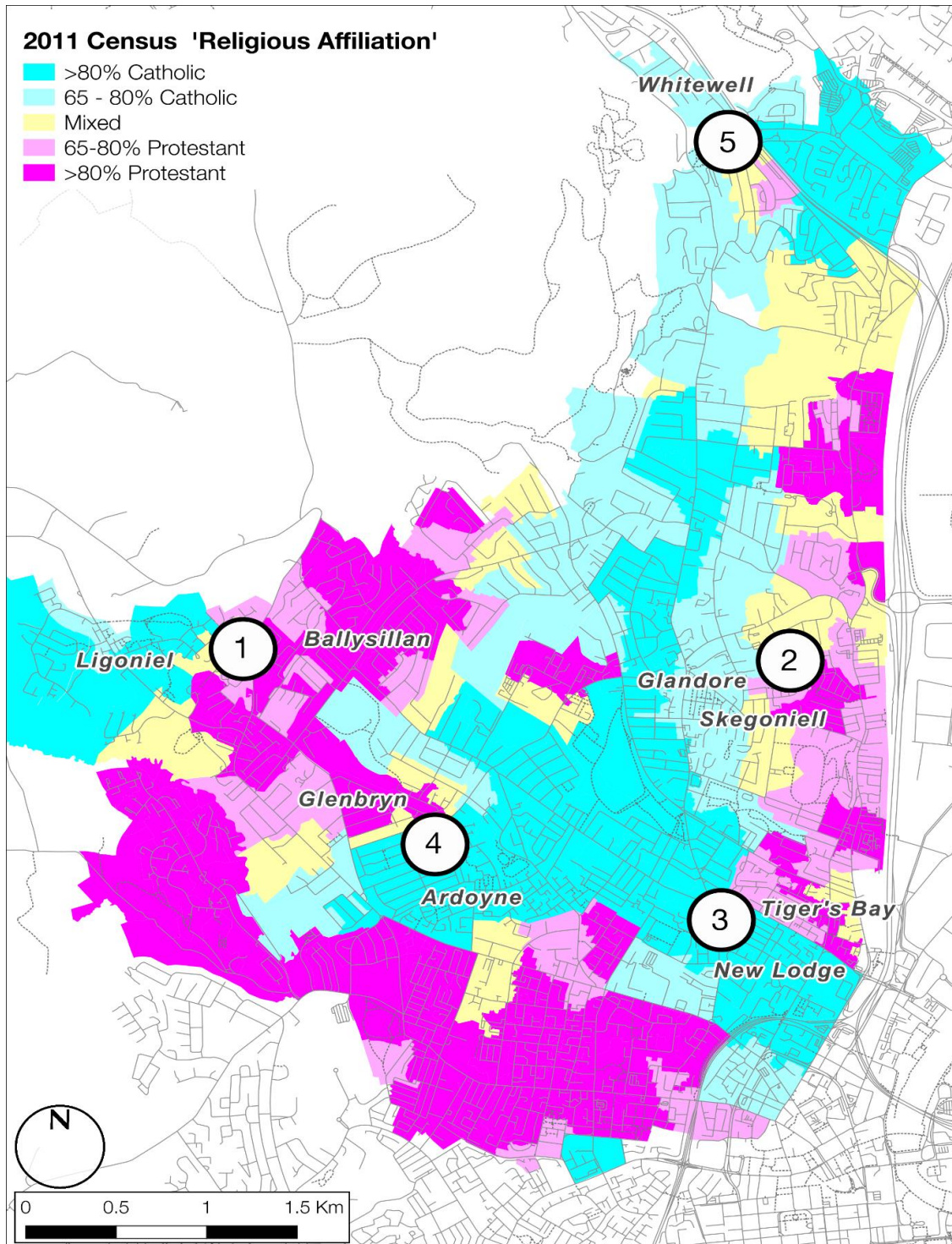

Figure 2. The religious demography of greater north Belfast

Note: The five sites from which participants in the present research were drawn are indicated, namely (1) Ballysillan/Ligoniel, (2) Glandore/Skegoneill, (3) Tiger's Bay/New Lodge, (4) Ardoyne/Glenbryn, and (5) Greater Whitewell

Residential segregation in north Belfast assumes a distinctive 'checkerboard' pattern in which Catholic and Protestant areas exist in close proximity. In the five areas from which our samples for studies 1 and 2 were drawn (see Figure 2 above), for example, Catholic and Protestant residents live in intimately adjacent neighbourhoods, but remain divided by material and symbolic barriers (e.g., peace walls) and other institutional structures (e.g., the segregation of local schools). Perhaps for this reason, the management of daily activities and routines of movement is highly salient for local residents, making north Belfast an apt context in which to explore activity space segregation.

Yet Belfast is also a city in transformation. In the decades since the 1998 Good Friday peace agreement, which brought armed conflict to an end, numerous interventions have sought to reduce segregation in Northern Ireland and promote social justice. The local Catholic community, who have historically been disadvantaged, have made considerable advances in terms of key indicators such as political representation, social welfare, housing and participation in institutions of justice and policing. Moreover, local government is actively promoting new, more inclusive spaces of civic life whose effects on residents' behaviour are still emerging (e.g., see the Northern Ireland Executive office, 2013). In order to explore activity space use in north Belfast, we employed a novel methodological framework.

Study 1

Method

Participants

We used a door-to-door sampling method to recruit 233 participants in five neighbourhoods in north Belfast (see Figure 2 above). Each neighbourhood comprised Catholic and Protestant housing estates whose residents live close to one another but are divided by both material and symbolic boundaries. Eleven participants did not identify as either Catholic or Protestant and their data were excluded from the present analysis. We also excluded a further 41 participants who did not supply sufficient and reliable data to permit meaningful analysis (because of technical problems with interface between our tracking application and their mobile phones). The final sample of 181 participants consisted of 90 Catholics and 91 Protestants ($M_{Age} = 40.8$ years), of whom 113 were women.

Measures

The measures used in this study sought to capture: (1) the amount of time participants spent in different kinds of activity spaces (ingroup, outgroup and shared; variable name Group_Space in the analyses presented below) and (2) the number of locations they visited in each kind of space (ingroup, outgroup and shared). The aim here was to quantify such spatial patterns and explore how they might be shaped by factors such as community identity (Protestant and Catholic; variable name: Community), gender (male and female; variable name: Gender) and time of day (morning, afternoon and evening; variable name: Day_Section).

To do so, we constructed a GIS in which different areas in north Belfast were defined as: (1) predominantly Protestant; (2) predominantly Catholic, or (3) shared. Here, we relied on evidence from the 2011 census, which classifies census output areas of north Belfast in terms of their local demography, defining an area or facility as Protestant if the surrounding local population is more than 65% Protestant and as Catholic if that population is more than 65% Catholic. In effect, as Figure 2 above indicates, many such areas have a higher proportion of a given community, and often they have long established sectarian boundaries. We defined as shared areas where neither community was numerically predominant (i.e. >65%) or where the area or facility in question was designed or located, in principle, to be shared. The latter included some parks and other public spaces, the city centre, major arterial roads, natural landscapes, large retail outlets on the outskirts of north Belfast, industrial areas, and several supermarkets. In defining a space as Protestant, Catholic or shared we also took into account established local knowledge. For example, in some areas, even ostensibly public spaces have longstanding sectarian boundaries. Alexandra Park in the heart of north Belfast, for instance, is notoriously divided into Catholic and Protestant sections by a three-meter-high peace wall, with the two sections being linked by gate that is open during daytime.

Procedure

Participants downloaded a bespoke GPS tracking application, the 'Belfast Pathways' app, onto their mobile smart phones. Devised by co-author Huck, this app operated in the background of their device's functioning and was self-launching, ensuring that it would continue to track movements even if the device was rebooted. It included a pause function that allowed participants to discontinue tracking at any time.

The Belfast Pathways app collected GPS data points at 4-second intervals for a period of up to two weeks when participants moved outdoors beyond their home spaces (tracking when

participants entered buildings was unreliable and was not a focus of our analysis). The fields registered in each data point were: latitude, longitude, timestamp and accuracy. The latitude and longitude fields recorded the geographic position of a given GPS receiver (a participant's mobile phone) in the form of x,y spatial coordinates. The timestamp field recorded the date and time at which a data point was captured. The accuracy field provided a measure of the likely degree of error for the geographic location of any given data point, expressed in terms of an estimated radius around that point. When this potential error radius was larger than 20 metres, the data point in question was deemed too inaccurate to feature in our analysis (Davies et al., 2017).

Data were stored temporarily on the mobile device and then uploaded onto a central server when the mobile device was next in contact with Wi-Fi (this ensured that participants were not charged for data uploads). At the end of the two-week period, participants were contacted and reminded to delete the Belfast Pathways app from their mobile phones.

The amount of usable data collected from each participant varied widely. Some registered relatively few GPS data points, others many thousands of points. Some participants rarely left their homes or, if they did, stayed outside for a brief period of time within a restricted radius; others roamed longer and more widely. In addition, some data were excluded because participants left our defined study area of North Belfast and the city centre (i.e. 586 trips were to destinations located out of town) or because they were part of a truncated route (i.e. 215 false 'destinations' were excluded as they were recorded at our two-week cut off point when participants were mid-journey rather than stopped at an actual destination). As noted above in our participants section, data collection was also hampered by technical problems on several mobile devices, which limited the number of usable tracking points gathered.

Notwithstanding these challenges, our tracking methodology generated a raw data corpus of just under 1000 hours on participants' outdoor movements in north Belfast and the city centre, also including usable data on 4791 out of a possible total of 5592 destinations. Derived from over 24 million GPS tracking points, these data were 'cleaned' (see below) and then integrated into a Geographic Information System (GIS) for further analysis. Figure 3 provides an example of pilot tracks in the Tigers Bay and New Lodge neighbourhoods of north Belfast, illustrating how movements in one of our selected areas were captured and represented in our initial GIS.
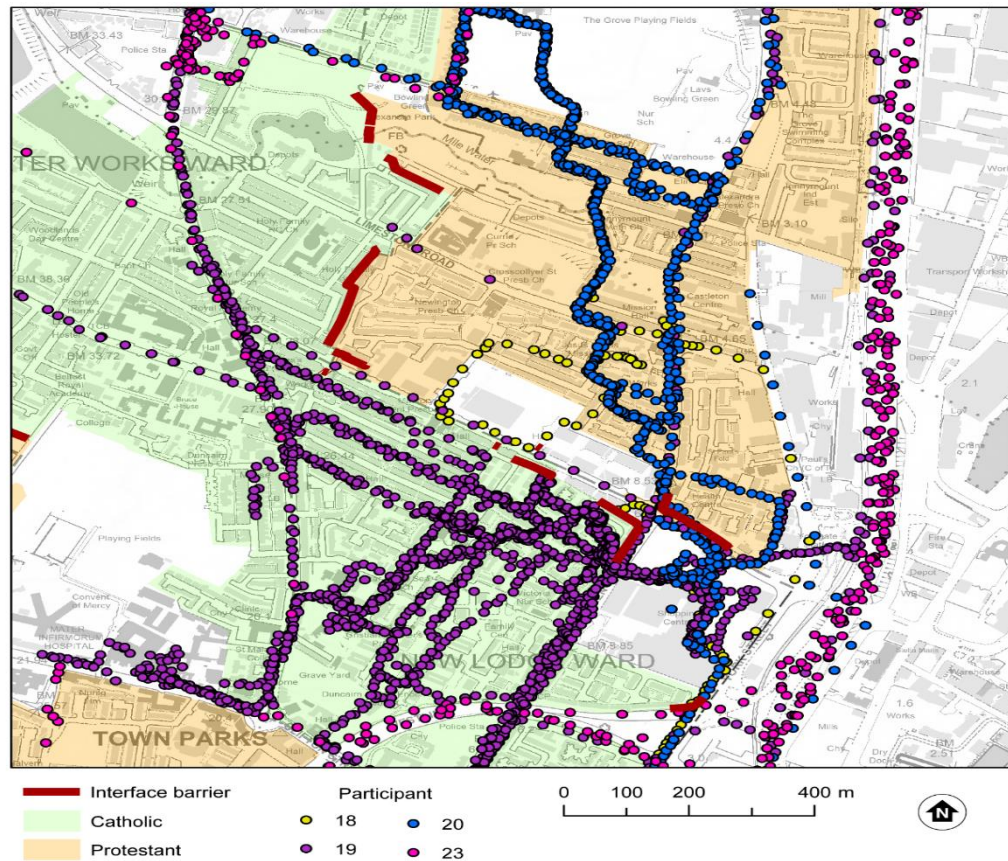
Figure 3. Pilot tracks of four participants in and around the Tigers Bay (Protestant) and New Lodge (Catholic) neighbourhoods

Results

Data preparation and GIS construction

First, raw GPS data were cleaned to remove tracking points that were redundant (e.g., multiple points in close proximity) or fell beneath our accuracy threshold (e.g., through 'scatter' created when tracking continued indoors). Track destinations were then marked as polygons using information derived from various sources, notably Ordnance Survey Northern Ireland maps, Google Street View, and local knowledge. Individual pathways, stops and home spaces were derived using procedures developed by Bohte and Maat (2009) and refined by members of our research team (see Davies et al., 2017 for a detailed description of the technical steps in our data cleaning process, available at: http://huckg.is/gisruk2017/GISRUK_2017_paper_43.pdf).

Our analysis then sought to identify segregated and shared spaces via statistical estimates of: (1) time spent in ingroup, outgroup and shared spaces; (2) the geographic locations of participant destinations over time; and (3) the impact of gender, community identity, and time of day in shaping

both time spent and destination patterns. As a descriptive starting point, however, we constructed a GIS representation of the overall spatial morphology of activity space use in our study area.

The spatial morphology of activity space use in north Belfast

Figure 4 is of heuristic value in capturing the global patterning of activity space use amongst our sample of Protestant and Catholic residents. The figure employs a simple colour blending technique to depict varying levels of sharing and segregation across our study area. It has been derived by aggregating and then visualising our complete GPS tracking data set. As the use of a given space or pathway approaches 100% Protestant, then it is represented as increasingly pink; as it approaches 100% Catholic, it is represented as increasingly turquoise; and as use approaches an even 50/50 split between both communities, it is represented as increasingly dark blue. Shades between indicate varying degrees of sharing.

In effect, Figure 4 visualises the spatial morphology of activity space segregation in north Belfast, illustrating where and, to some extent how, it is reproduced through residents' patterns of movement. Specifically, this figure suggests that residential street networks - and associated facilities based across several neighbourhoods - are used almost exclusively by one community only (e.g., see the mobility patterns depicted in and around the Tigers Bay/New Lodge and the Ardoyne/Glenbryn) areas. Consisting of interlinked systems of tertiary streets, these networks enable Catholic and Protestant communities living at close quarters to sustain segregation at the level of everyday life, notably by sticking to pathways and destinations located within their own spatially-bounded communities, whilst avoiding those located in the other community.

At the same time, Figure 4 illustrates the existence of potentially shared pathways and destinations. Indicated in dark blue, the pathways are mainly large arterial routes that connect north Belfast to other parts of the city, as well as to outlying destinations such as shopping centres, retail parks and industrial areas. Both the pathways and some of the outlying facilities are used by members of both communities and may thus represent activity spaces where Catholic and Protestant residents are co-present and in potential contact. The pathways include the Crumlin and the Shankill roads, for instance, which are major arterial routes into the city centre. The facilities include larger retail stores and supermarkets indicated in Figure 4, such as the Abbey Retail Centre, the Cityside Retail Park and the Tesco, ASDA and Lidl supermarkets, as well as the city centre basin.
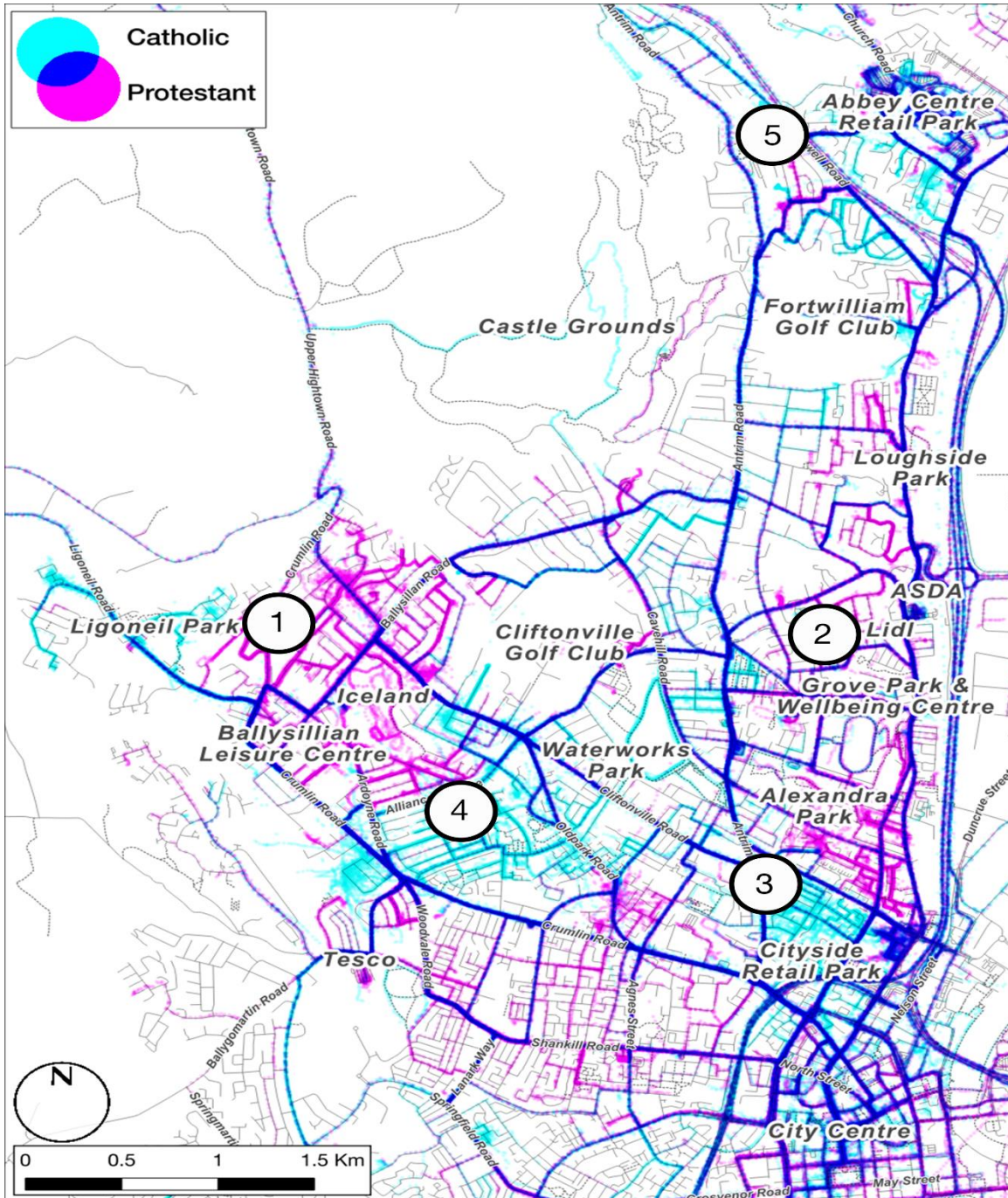
Figure 4. GPS tracks by community affiliation

Note: Points 1 to 5 indicate the locations of the communities from which participants were sampled, namely (1) Ballysillan/Ligoniel, (2) Glandore/Skegoneill, (3) Tiger's Bay/New Lodge, (4) Ardoyne/Glenbryn, and (5) Greater Whitewell

Activity space use in the city centre is especially important as it has been targeted for numerous government interventions to promote shared civic spaces in Belfast. The visualisation of the pathways and patterns of movement that our participants used when visiting the city centre are

further illustrated by Figure 5, which is derived from a total of 402 trips (241 by Catholic and 161 by Protestant residents), representing just under 9% of the total number of shared destinations visited by our participants. In stark contrast to the highly segregated use of activity spaces in the residential areas of North Belfast, Catholic and Protestant residents' movements here suggest that many pathways and activity spaces are commonly used by both communities, opening up the possibility of contact across sectarian lines.
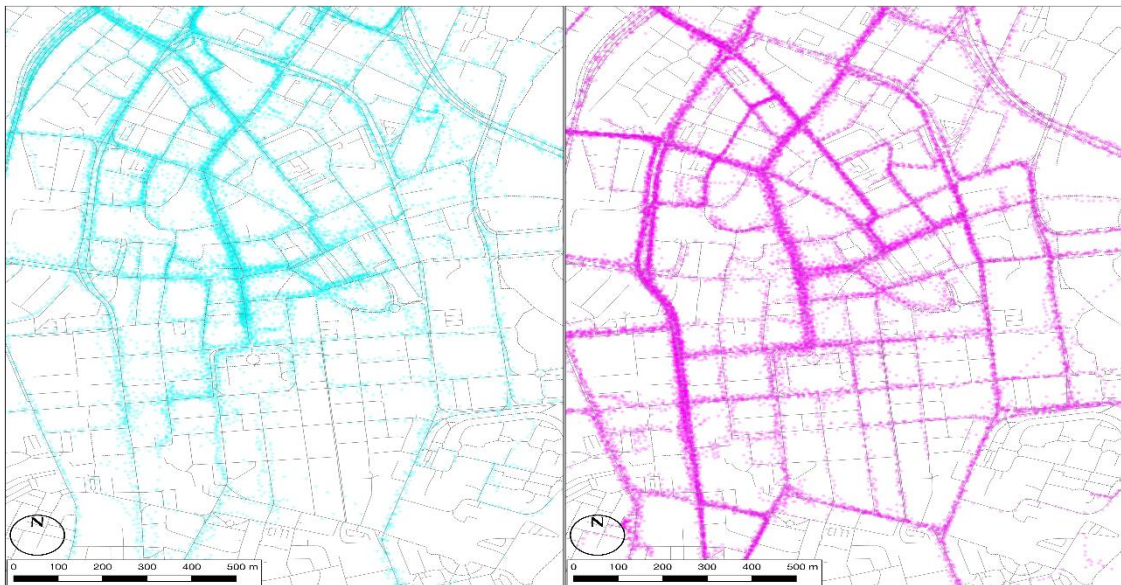
Figure 5. Mapping Protestant and Catholic pathways in Belfast city centre
Note: The left panel indicates Catholic tracks, the right panel Protestant tracks

Quantifying activity space segregation and mixing using data on time spent and destinations visited

Time spent in different kinds of activity spaces

As Figures 6 and 7 illustrate, many participants spent little time in outgroup areas; indeed, the modal time in minutes spent in such areas by members of both Catholic and Protestant communities was zero. Figure 7 also indicates why our movement data posed significant problems for additional multivariate analysis, precisely because of the high proportion of zero scores. We dealt with this by focusing multivariate analysis on the set of scores > 30 seconds, using a linear mixed model and the statistical programming language R (R Core Team, 2017) and the mixed linear models package NLME (Pinheiro, Bates, DebRoy, Sarkar, & Core R Team, 2017)[2].

Figure 6. Mean time spent in ingroup, outgroup and shared activity spaces

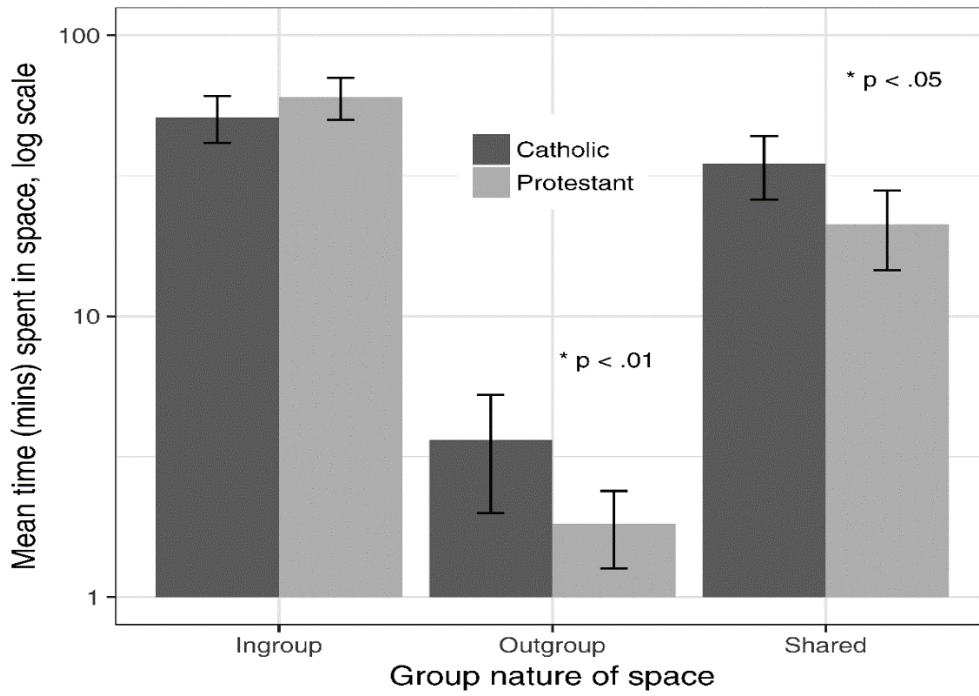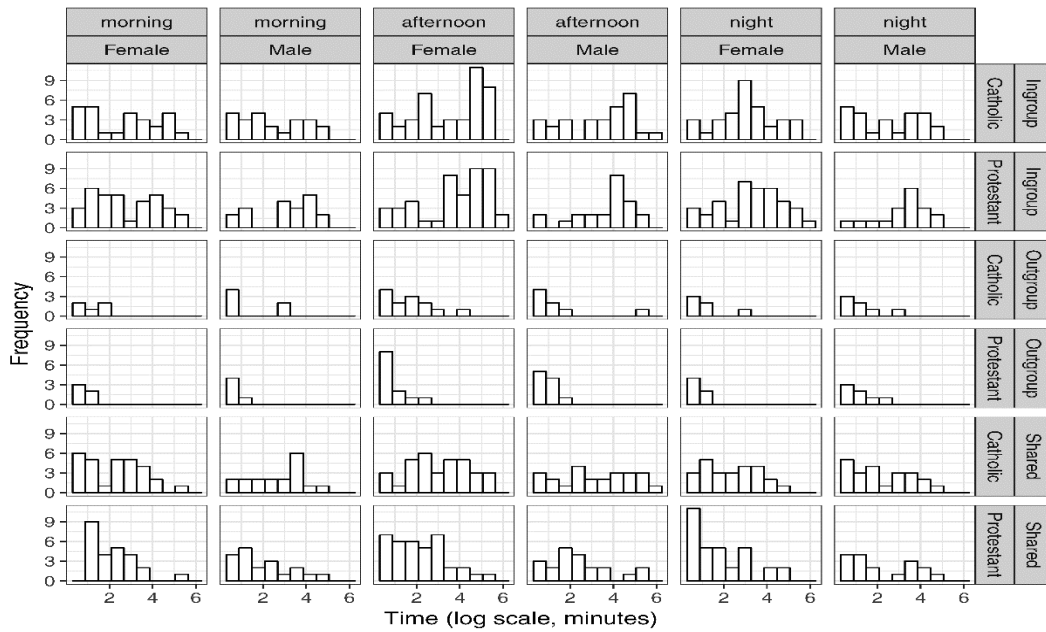Figure 7. Distribution of time (log minutes) spent in group areas by community membership, gender and time of day

Note: Time of day is defined as: (1) morning (7am to 12pm); afternoon (between 12pm to 6pm) and evening (between 6pm and 7am)

Upon preliminary exploration of the data, we decided to employ a mixed linear model with random intercepts for participants, with analysis including the variables: (1) group_space (ingroup, outgroup and shared), (2) day_section (morning, afternoon and evening), (3) gender (Male and Female), and (4) community (Catholic and Protestant). This reflects the dependency in the data set introduced by collecting multiple measures from the same participants.

We opted for a top down approach to building this model[3]. Proceeding in this way, we found no significant four-way or three-way interactions (see Table 1). The model containing all the two-way interactions, however, fitted better than the model containing only main effects (L. Ratio = 28.22, df = 13, p < .009), indicating the need to incorporate two-way interactions in the model. Within the model containing all two-way interactions, only the interaction between community and group area was significant (χ^2= 18.86, df = 2, p < 0.001). In addition, the main effects for group space and time of day (day_section) were significant.

Visual inspection of model residuals suggested some heteroscedasticity. We adjusted the model to incorporate a variance structure across group space to deal with this issue. We also removed three outlying values, as these had high normalized model residual values (> 2.8), and re-ran the model, trimming non-significant interactions. Model residuals were improved, and the model was acceptable on conventional tests. Table 2 summarises effects in the model.

Table 1. Model comparisons, top-down model building process - time spent

Model	df	AIC	Log Likelihood	Test	L. Ratio	p <
4 way	38	2826.979	-1375.49			
3 way	34	2821.574	-1376.79	4 way vs 3 way	2.59	.630
2 way	22	2802.562	-1379.28	3 way vs 2 way	4.99	.960
1 way	9	2804.779	-1393.39	2 way vs 1 way	28.22	.008

Table 2. ANOVA table for model containing two-way interactions - time spent

	df1	df2	F	p <
Intercept	1	564	1182.04	0.001
Day_section	2	564	14.35	0.001
Group_space	2	564	106.61	0.001
Gender	1	161	0.03	0.867
Community	1	161	0.67	0.415
Day_section x Group_space	4	564	1.18	0.319
Day_section x Gender	2	564	0.19	0.828
Group_space x Gender	2	564	1.16	0.313
Day_section x Community	2	564	0.78	0.460
Group_space x Community	2	564	9.06	0.001
Gender x Community	1	161	0.89	0.347

Notes: *Variables*: Gender: male-female; Community: Catholic-Protestant; Group Space: ingroup, outgroup and shared; Day section: morning, afternoon and evening

Reference Condition. Group space: reference condition is ingroup space. Day section: reference condition is morning. Community: reference group is Catholic. Gender: reference group is Female. All tests are of the stated effect against the reference group.

Table 3. *Effect analysis for model containing two way interactions - time spent*

	B	SE	dF	t-value	p <
Intercept	2.52	0.17	564.00	14.95	0.001
Day_section_afternoon	0.68	0.13	564.00	5.27	0.001
Day_section_night	0.12	0.14	564.00	0.86	0.393
Group_space_neutral	-0.36	0.18	564.00	-2.07	0.039
Group_space_outgroup	-2.35	0.20	564.00	-11.98	0.001
Community_protestant	0.39	0.19	160.00	2.08	0.039
Gender_male	-0.06	0.13	160.00	-0.45	0.654
Group_space_neutral: community_Protestant	-0.99	0.25	564.00	-4.02	0.001
Group_space_outgroup: community_Protestant	-0.73	0.27	564.00	-2.69	0.007

Notes: Variables: Gender: male-female; Community: Catholic-Protestant; Group Space: ingroup, outgroup and shared; Day section: morning, afternoon and evening

Reference Condition. Group space: reference condition is ingroup space. Day section: reference condition is morning. Community: reference group is Catholic. Gender: reference group is Female. All tests are of the stated effect against the reference group.

Follow up tests were conducted using the R package 'Multcomp' (Hothorn, Bretz, & Westfall, 2008), which takes mixed linear model structures into account (see Table 3). Differences across day section were statistically significant (i.e., morning = night < afternoon). Tests of simple effects at each level of the Group Space factor (i.e., differences between communities at each level of Group Space) showed significant differences between communities on shared and outgroup spaces ($Z = 2.44$, p < .044, and $Z = 3.06$, p < .007, respectively; see also Figure 6). Members of the Catholic community spent more time in these spaces than members of the Protestant community.

Destinations visited in outgroup, ingroup, and shared spaces

We also tracked the destinations that participants visited and again classified those destinations as being located within ingroup, outgroup or shared areas. We could thus explore both the potentially sectarian organization of destination choices and how such choices were affected by time of day, gender and community membership. Preliminary inspection of the data revealed that of a total of 4791 destinations captured, 2375 were to ingroup destinations (49.6%), 2242 to shared destinations (46.7%) and only 174 (3.7%) to outgroup destinations.

Preliminary inspection of destinations also revealed a very high incidence of zero frequencies, particularly for destinations located within outgroup spaces. This again complicated follow up multivariate analysis. To deal with zero inflation, we focused our statistical modelling on cases with non-zero frequencies of destinations visited.[4] Figure 8 captures the mean numbers of destinations visited by type of activity space, while Figure 9 shows the (log-scaled) distribution of number of destinations visited across group space, gender, and day section. In both figures, zero frequencies have been removed.
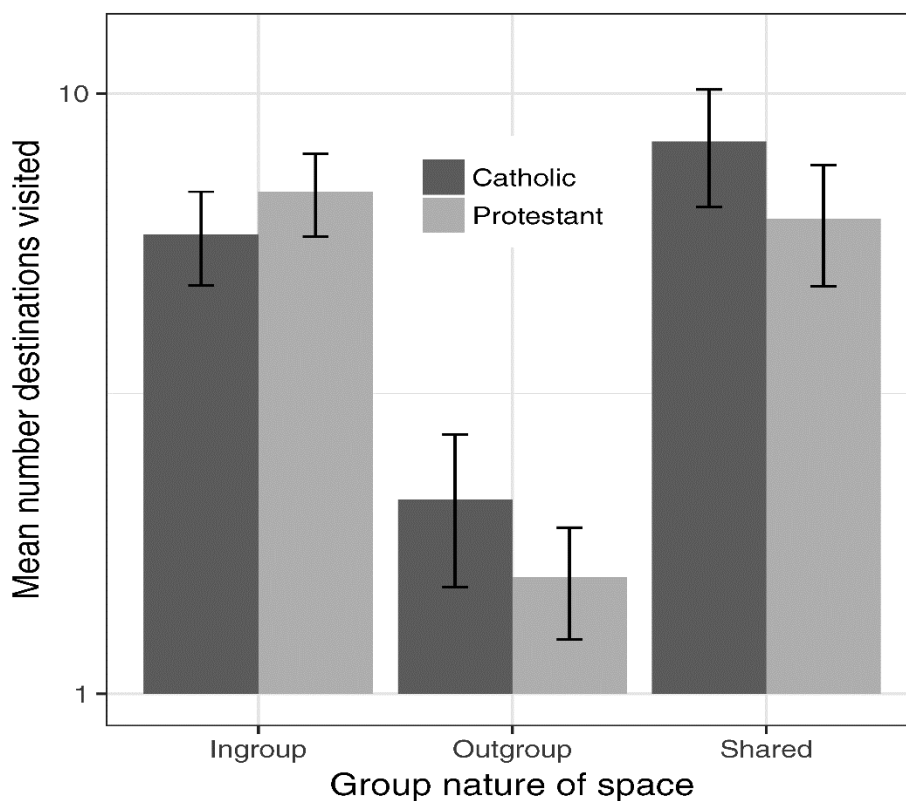

Figure 8. Mean number of destinations by type of space

Note: Mean destinations are based on the cumulation of all unique and non-unique destinations visited by participants
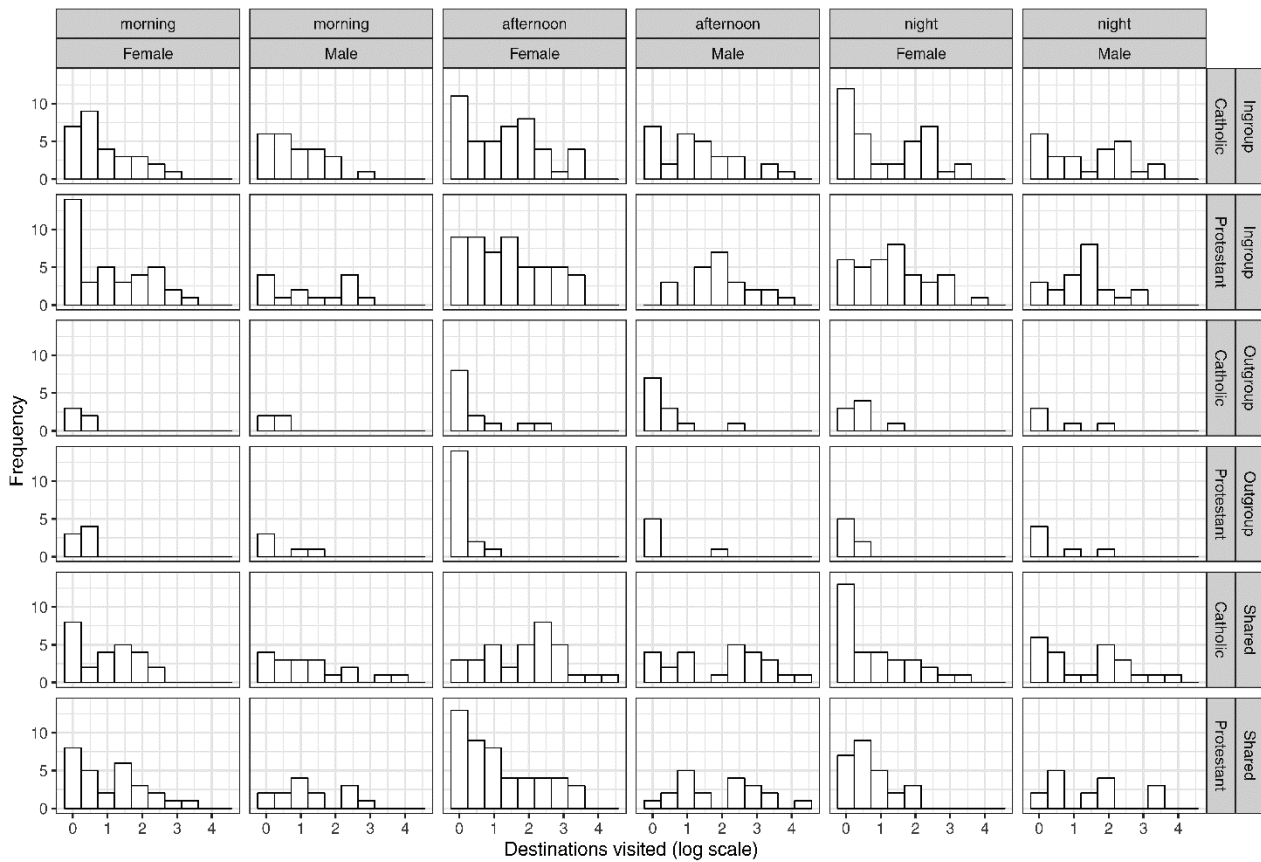
Figure 9. Distribution of destinations located in ingroup, outgroup and shared activity spaces by community membership, gender and time of day

We treated the number of destinations visited as a count variable and modelled it using Generalized Mixed Linear Modelling methods, assuming a Poisson distribution for the outcome variable. Even after removing zero frequencies, the distribution of number of destinations was highly skewed. Preliminary models had many high residual values and the residual patterns were strongly heteroscedastic, so we decided to recode frequencies into four categories. This regularized the distribution and in particular ameliorated the problems with model residuals.

Our modelling of destination counts used procedures similar to the modelling of time spent discussed in the previous section; that is, we employed a top-down process to discover the highest order of interaction needed and then pruned terms within the model of that order of interaction. Tests of k-way interactions suggested that no effects of higher order than main effects warranted retention (Table 4). Since only main effects were at issue, we proceeded straight to effect analysis (Table 5), obviating the need for further interaction analyses or additional post-hoc testing.

Table 4. Model comparisons, top-down model building process, GLMM on destinations visited

Model	df	AIC	Log Likelihood	Deviance	Test	Chi square	df	p <
model1way	8	2491.3	-1237.7	2475.3				
model2way	10	2496.2	-1238.1	2476.2	1 way vs 2 way	0.00	2	1.00
model3way	33	2524.7	-1229.3	2458.7	2 way vs 3 way	7.10	23	0.78
model4way	37	2532.1	-1229.0	2458.1	4 way vs 3 way	3.76	4	0.97

Table 5. Effect analysis for GLMM model with main effects – destinations visited

	B	SE	Z	p <
(Intercept)	0.83	0.06	13.90	0.001
Day_section-afternoon	0.15	0.06	2.55	0.010
Day_section-night	0.04	0.06	0.64	0.520
Group_space-outgroup	0.57	0.09	-6.28	0.001
Group_space-shared	0.02	0.05	-0.40	0.690
Gender-male	0.14	0.05	2.22	0.027
Community-Protestant	0.01	0.05	0.23	0.820

Notes: *Variables*: Gender: male-female; Community: Catholic-Protestant; Group Space: ingroup, outgroup and shared; Day section: morning, afternoon and evening

Reference Condition. Group space: reference condition is ingroup space. Day section: reference condition is morning. Community: reference group is Catholic. Gender: reference group is Female. All tests are of the stated effect against the reference group.

Within the model containing all the main effects, gender, group space, and time of day were all statistically significant and the effect for group space (outgroup vs ingroup) was particularly strong (see Table 5). It is notable that there was no effect for community and that the effects for time of day and gender were small, albeit significant. Participants visited more destinations in the afternoon than in the mornings or evenings, and men visited more destinations than women. Figure 10 shows these main effects, with 95% confidence intervals around point estimates.
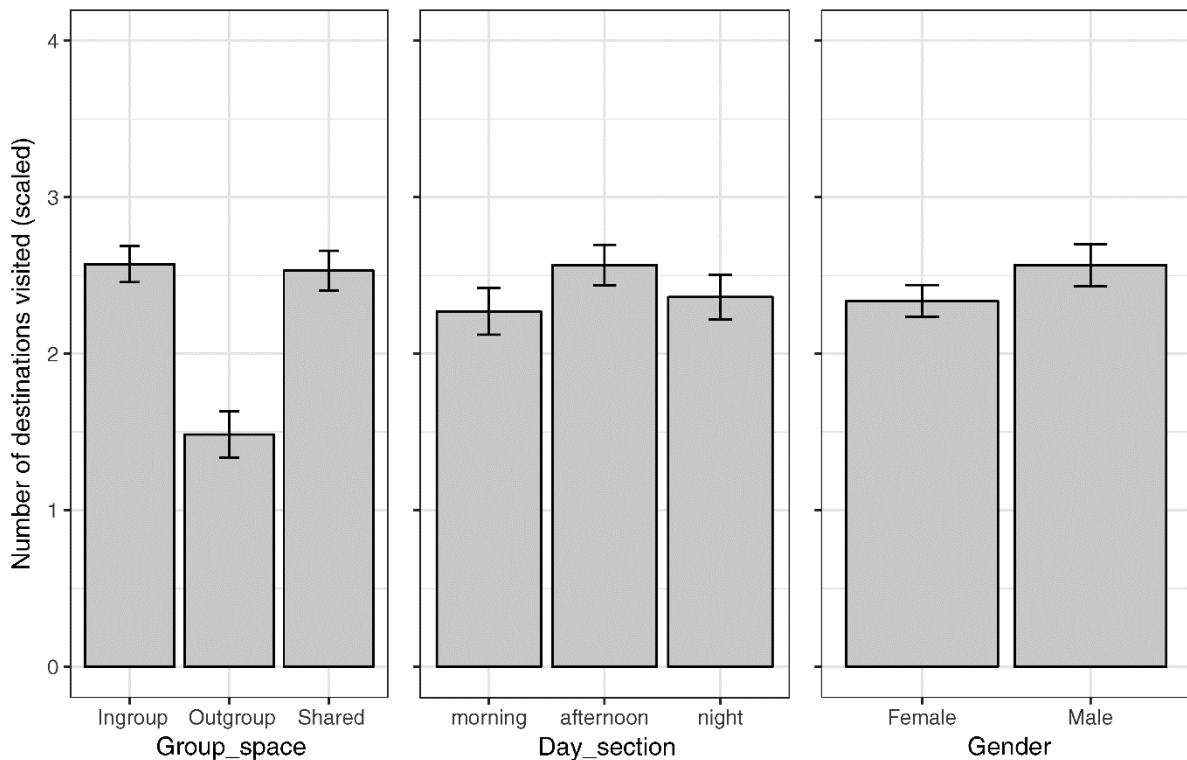
Figure 10. Main effects: Number of destinations visited

Discussion

Extending psychological and geographic research on the segregation of everyday life spaces (e.g., see McKeown & Dixon, 2017; Schnell & Yoav, 2001), Study 1 used a combination of GPS tracking and GIS analytics to explore activity space use in north Belfast and the city centre. We found that the mobility practices of members of both Catholic and Protestant communities sustained high levels of sectarian segregation, expressed via limited use of spaces, destinations and pathways located in outgroup areas. As Figure 4 powerfully captures, the street networks that link together different areas of the Protestant and Catholic neighbourhoods sampled in our study were used, almost exclusively, by members of the 'home' community. Similarly, facilities or services (e.g., newsagents and grocery stores) located in and around such neighbourhoods were seldom accessed by outgroup members.

At the same time, however, use of shared spaces was also common amongst members of both communities - particularly during the afternoon period between 12 and 6pm when activity space use was significantly more prevalent - and seemed to be focused mainly on shopping and leisure activities. As elaborated in our general discussion, these spaces lack the clear territorial demarcation

that defines other areas of Belfast. As such, they may be perceived as settings where sectarian identities are less salient and intergroup encounters relatively 'safe', though also, perhaps, fleeting and superficial. Belfast city centre is one such space. Analysis of patterns of usage suggests that this space is shared by Protestant and Catholic participants.

The demographic variables explored within our analysis, namely gender and community identity, had relatively limited impact on participants' patterns of movement and activity space use. Contrary to our expectations, gender seemed to be unrelated to observed patterns of segregation and mixing, at least on the dimensions that we analysed. Neither the time or the destinations data supported the hypothesis that women would be more able to cross sectarian boundaries than men (see also Dowler, 2007), making greater use of activity spaces located within the 'other' community's areas. There was a significant - though relatively small in terms of effect size - interaction between community identity and type of space in terms of time spent across different types of spaces, with Catholic respondents spending more time in shared and outgroup spaces than Protestant respondents. The behavioural data that we collected in Study 1 cannot explain why this was the case. One hypothesis is that Catholic respondents experience lower levels of intergroup threat and accordingly find use of such spaces more comfortable than Protestant respondents. Study 2 was designed to explore this and related hypotheses. Here, using a field survey, we sought to move beyond description of behavioural patterns of activity space segregation in north Belfast and towards analysis of the psychological factors that may sustain such patterns. Specifically, we sought to explore the conceptual relationships between contact, intergroup threat and mobility attitudes and practices captured within Figure 1 in our introduction (see p.12).

Study 2

Method

Participants

Participants were recruited using door-to-door sampling conducted in the same five areas of north Belfast that featured in Study 1. They comprised 246 residents who self-identified as Protestant, 242 as Catholic, and 32 as 'other' (e.g., Jewish). Of the 488 Catholic and Protestant participants on which the present analysis focused, 291 were female and 197 were male ($M_{Age} = 44.9$ years). This sample included 169 participants whose movements were tracked in Study 1, opening up the possibility of exploring the relationship between self-report and behavioural measures. The

majority of the sample came from lower socioeconomic brackets in terms of annual household income, with 40% earning less than £10,000 per annum and another 28% earning between £10,000 and £20,000, a distribution that fits with the broader demographics of this economically deprived area of the city.

Measures and procedure

Participants completed a questionnaire (see supplementary materials for a full set of items and constructs) measuring their positive and negative contact experiences, perceptions of realistic and symbolic threat, anxiety about intergroup contact, and willingness to use activity spaces outside their own ethno-political community. Questionnaires were completed in participants' homes in the presence of two research assistants, a male researcher from Northern Ireland and a female researcher from the US. Participants were not financially compensated for their participation in the survey.

Positive contact: Experiences of positive contact were measured using five items (MacDonald's ω (hereafter just ω) = 0.93), each employing a 7-point scale ranging from 'Never' to 'Very often'. Items were adapted from previous studies (e.g., Dixon et al., 2010) and measured the extent to which respondents experienced intergroup contact as 'friendly', 'helpful', 'welcoming', 'positive' and 'cooperative'.

Negative contact: Experiences of negative contact were also measured using five items (ω = 0.90), each employing a 7-point scale ranging from 'Never' to 'Very often'. Items were similar to those used in other studies (e.g., Stephan et al., 2000; Barlow et al., 2012) and measured the extent to which respondents experienced intergroup contact as 'negative', 'disrespectful', 'unfriendly', 'verbally abusive' and involving 'ridicule'.

Contact Anxiety: Anxiety about having intergroup contact was measured using six items adapted from Stephan and Stephan's (1985) measure (ω = 0.86). These items used a seven-point scale anchored by 'Not at all' and 'Extremely' and measured the degree to which, for example, participants reported feeling 'Nervous', 'Anxious' and 'Comfortable' (reverse coded) when interacting with outgroup members.

Realistic Threat: Adapting and extending items used by Schmid et al. (2008) and Schmid and Muldoon (2013), our measure of realistic threat (ω = 0.78) focused on threats to personal safety. It employed a 5-point Likert scale that used five items tapping participants' responses to statements that included ''I worry about being physically attacked by members of the other community',

'Sometimes in Belfast I am afraid of being identified as a member of my community' and 'I rarely worry about threats to my personal safety from members of the other community' (reverse coded).

Symbolic Threat: Our symbolic threat measure again adapted and extended items used by Schmid and Muldoon (2013) in Northern Ireland. Using 5-point Likert scales, these five items included 'I feel threatened when members of the other community celebrate their cultural traditions', 'When I see flags flown that express the identity of the other community, I feel as though my own identity is under threat', and 'The cultural traditions and values of the other community are no longer a threat to the group identity of my own community' (reverse coded). This scale had good reliability ($\omega = 0.83$).

Use of space beyond own community: Participants' willingness to use spaces and facilities beyond their own communities was measured using six items that employed five-point Likert scales ($\omega = 0.92$). These items included 'I prefer to avoid using facilities that are located in or near the other community's areas of city', 'I prefer to keep clear of public spaces where I am likely to encounter members of the other community' and 'When walking or driving in the city, I sometimes change my route in order to avoid passing close to the other community's areas'.

Results

Descriptive statistics

Descriptive statistics for the scale variables used in the structural equation model are shown in Table 6. These are unit-weighted representations and thus approximations of the latent variables in the model described below (we used items retained after evaluation of the measurement model to constitute the scales). The descriptive statistics are broken down by gender and community, two key between-participant variables in our design. We note here that, even in this still divided context, positive contact experiences are reported far more frequently than negative contact experiences (see also Graf et al., 2014). We also report the correlations between the latent variables in Table 7, which were generated from the structural equation model rather than from unit-weighted variables.

Table 6. Descriptive statistics for self-reported contact, threat and activity space segregation

| | Female | | | | Male | | | | Female | | | | Male | | | |
| | | | | | Catholic | | | | | | | | Protestant | | | |
	n	mean	sd	range	n	mean	sd	range	n	mean	sd	range	n	mean	sd	range
Positive contact	139	5.23	1.71	6.00	103	5.08	1.82	6.00	148	5.52	1.71	6.00	93	5.29	1.76	6.00
Negative contact	137	2.48	1.51	5.60	99	2.79	1.57	6.00	146	2.35	1.51	6.00	90	2.43	1.60	5.60
Realistic threat	138	2.92	0.76	4.00	103	2.97	0.90	5.20	151	2.68	0.8	4.00	93	2.77	0.87	3.80
Symbolic threat	139	2.91	1.01	4.00	103	2.74	1.00	4.00	152	2.45	0.86	3.33	92	2.49	0.93	4.00
Contact anxiety	138	2.96	1.69	6.00	102	2.88	1.75	6.00	151	2.7	1.77	6.00	90	2.79	1.82	6.00
Willing to use space beyond own community	139	3.24	1.01	4.00	102	3.22	1.08	4.00	152	3.49	0.95	4.00	90	3.29	0.96	4.00

Table 7. Intercorrelations of latent variables

	Positive contact	Negative contact	Realistic threat	Symbolic threat	Contact anxiety
Negative contact	-0.23	1			
Realistic threat	-0.32	0.55	1		
Symbolic threat	-0.30	0.22	0.57	1	
Contact anxiety	-0.33	0.39	0.51	0.34	1
Willing to use space beyond own community	0.43	-0.38	-0.69	-0.56	-0.52

Structural Equation Model of interrelations between contact, threat and activity space use

We analysed the data with a structural equation model that proposed a particular set of directional relations between the predictor variables and the outcome variable: we took the outcome variable to be participants' willingness to use spaces beyond their own community's areas. Figure 1 above shows the model we predicted.

We tested this theoretical model (see Figure 11) with Structural Equation Modeling, using the R Statistical Programming language and the package Lavaan (Rosseel, 2012). The measurement model proved a reasonably good fit to the data, using the Full Information Maximum Likelihood (FIML) method in Lavaan, computing robust Huber-White standard errors, and where fit was evaluated in terms of the standard measures of Root Mean Squared Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fit Index (CFI): RMSEA = .051 (90% CI [.047, .056]), SRMR = .051, and CFI = 0.95). However, we noticed a number of high standardized residual values, especially for two

symbolic threat items (both asked about the threats posed by wall and kerbstone murals), and for one contact anxiety item (an item asking whether the participant would feel comfortable interacting alone with people from another religious community). These residuals were for covariance terms across scales, and we decided to drop them from the scales in question rather than adding correlated error terms across factors. There were also high residual values within-scale for one item covariance on the realistic threat scale (between items asking about fear of identification as a member of one's community, and about being physically attacked by members of the other community), and one item covariance on the positive contact scale (between items asking about frequency of conversation with members of the other community, and frequency of co-operating well with members of the other community), and we allowed these to correlate with each other, within scale. Although we already had good measures of overall fit, the residual values suggested a local lack of fit within the model, and we therefore eliminated the items, and added correlated error terms, as described above. This improved the model, eliminating high residual values and improving absolute and relative fit indices (e.g., RMSEA = .041 (90% CI [.035, .046]), SRMR = .036, CFI = .97). The Chi Square test of model fit against the saturated model indicated room for improvement (χ^2 = 541.87, df = 307, p < .001), but with such a high df it is likely an over-sensitive test.

We then fitted the full model (measurement plus regression) against the data, using the Full Information Maximum Likelihood (FIML) method in Lavaan, and found a very good level of fit in the standard indices (RMSEA = .040 (90% CI [.034, .045]), SRMR = .034, CFI = .97). The Chi Square test of model fit against the saturated model once again indicated room for improvement (χ^2 = 541.41, df = 307, p < .001). Inspection of residuals showed two values marginally higher than would be expected from a model with so many parameters, and with correction for multiple inference, which seemed a minor departure all things considered. The fitted model is shown as Figure 11. The coefficients reported in the model are bootstrap coefficients (1000 replications). We do not report the detailed output for the full model for sake of economy of presentation but can provide this information on request.

Model Fit: RMSEA = .040 (90% CI = .034, .045) CFI = .974   SRMR = .034 Chi-square = 541.41 df = 307

Indirect (mediated) effects:

Positive contact on willingness to use space outside ingroup areas, through:

Realistic Threat	Z = 3.57	p < .001	β= .09 (.06)
Symbolic Threat	Z = 3.33	p < .001	β= .06 (.04)
Contact Anxiety	Z = 3.17	p < .002	β= .04 (.03)

Negative contact on willingness to use space outside ingroup areas, through:

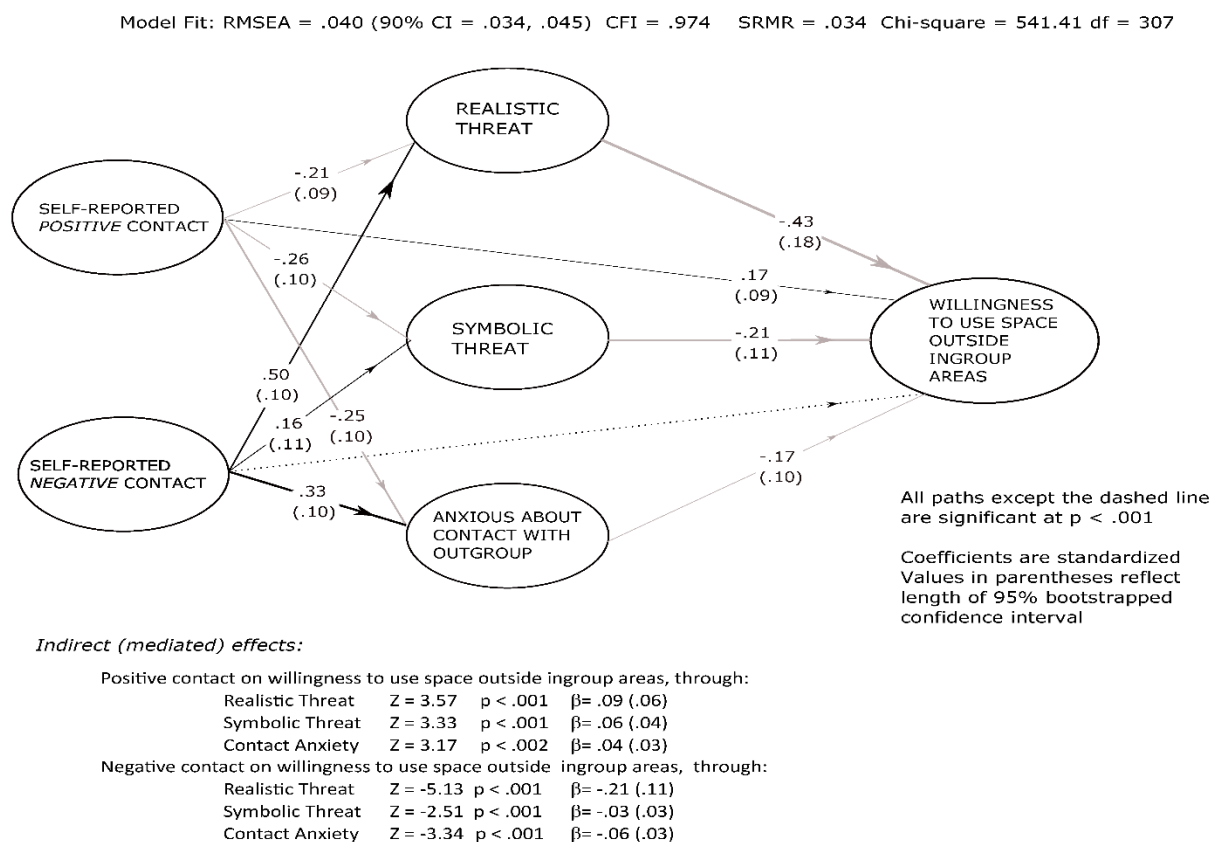|			
Realistic Threat	Z = -5.13	p < .001	β= -.21 (.11)
Symbolic Threat	Z = -2.51	p < .001	β= -.03 (.03)
Contact Anxiety	Z = -3.34	p < .001	β= -.06 (.03)

Figure 11. Empirical fit of structural equation model of the associations between contact, threat and self-reported activity space segregation

Note: to simplify presentation, the measurement model is not shown. Paths in grey are negative. Line weight is proportional to coefficient size.

As inspection of Figure 11 makes clear, there are several indirect effects potentially present in the model. We were interested in the indirect effects of positive and negative contact through each of realistic threat, symbolic threat, and contact anxiety on self-reported activity space use. Figure 11 reports the indirect effects and suggests that the effect of negative contact through realistic threat was particularly strong (β = -.21, 95% CI [-.32, -.10]). The other indirect effects are all statistically significant, but more modest in size. To corroborate the impression that indirect effects improved the model, we tested the model shown in Figure 11 against a model in which all the indirect effects were nullified (by setting the coefficients relating positive and negative contact to the three mediators all to zero). The model without indirect effects was considerably worse, as shown by a hierarchical test: χ^2_{diff} = 430.89, df = 9, p < .001[5].

Moderation by community and gender

Community membership is a potentially important moderating variable for our structural equation model. We therefore conducted a group analysis of the model shown as Figure 11, using community membership as the grouping variable. We tested for measurement invariance as a preliminary step, using the R package semTools (semTools Contributors, 2016). The test sequence returned non-significant χ^2_{diff} statistics for configural, loadings (metric), and intercepts invariance, but did return significant statistics for residuals and means. However, the corresponding Δcfi was very low for each step in the sequence (max Δcfi = .008; see Cheung & Rensvold, 2002), and a reasonable conclusion is that the measurement model fit was good for each of the subgroups.

We then conducted a test of the equivalence of regression coefficients across the groups, for which we found a significant χ^2_{diff} (25.13, df = 11, p < .009). On inspection of the regression coefficients, we found few differences. The path between negative contact and symbolic threat was not significant, and weak, for the Protestant group (β = .02, p > .830), and strong and significant for the Catholic group (β = .25, 95% bootstrap CI[.12; - .37], p < .001). These differences do not seem of great import to us, given that the rest of quite a complex model matches well (over 70 parameters), and we conclude that community membership likely did not substantively moderate the model presented in Figure 11[6]. Of course, the difference in the path coefficient relating negative contact and symbolic threat is in itself interesting, but we think that some caution is in order when interpreting this difference, given the number of significance tests represented in the model.

Another potential moderating variable for the structural equation model is gender. We therefore conducted a group analysis of the model shown as Figure 11, using gender as the grouping variable, following the same procedure as for the group analysis of community membership. A test for measurement invariance returned non-significant χ^2_{diff} statistics for configural, intercepts, and mean invariance, but did return significant statistics for loadings and residuals. However, as the corresponding Δcfi was very low for each step in the sequence (max Δcfi = .007; see Cheung & Rensvold, 2002), a reasonable conclusion is that the measurement

model fit was good across gender. We then conducted a test of the equivalence of regression coefficients across the groups, for which we found a narrowly non-significant χ^2_{diff} (17.64, df = 11, p > .090). On inspection of the regression coefficients, we found minor differences. For men, the path between negative contact and symbolic threat was not significant and weak, (β = .01, p > .990) and stronger and significant for women (β = .28, 95% bootstrap CI [.17, .39], p < .001). These differences are again fairly minor, given that the rest of the model matches well (over 70 parameters). We would conclude, then, that gender did not act as a substantive moderating factor in the general model presented in Figure 11.

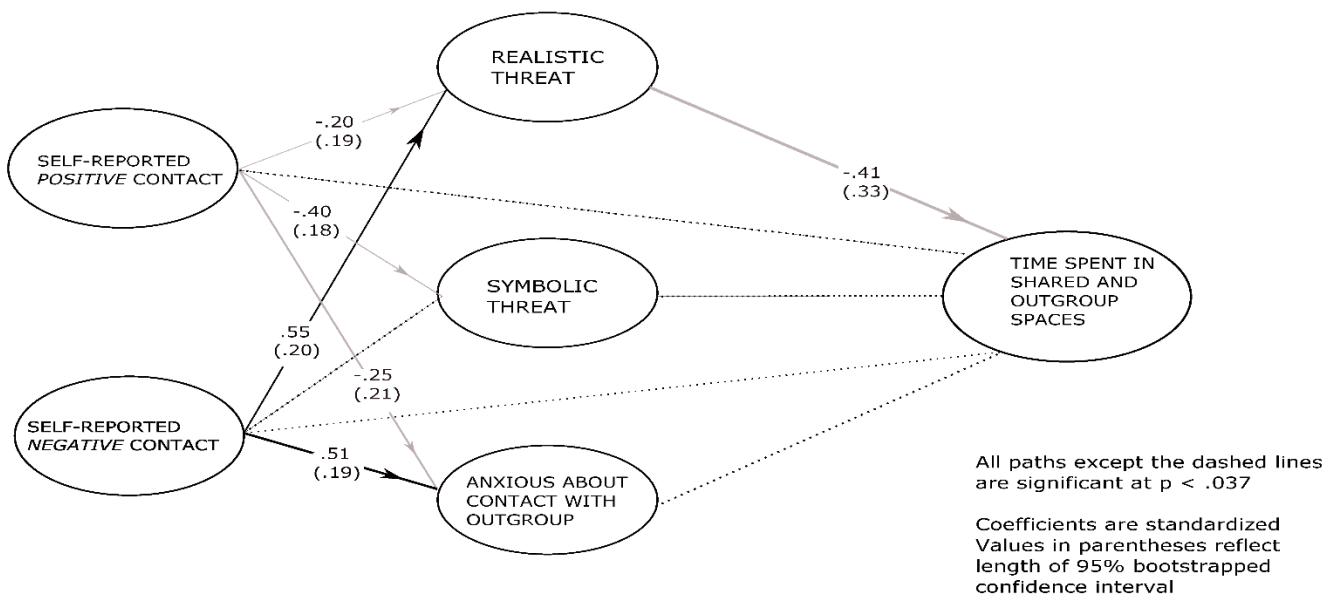**Relations between survey data and tracking data**

The tracking data collected in Study 1 captured time spent visited in three kinds of group spaces (ingroup, outgroup and shared space). By contrast, the survey data reflected self-reported willingness to use spaces beyond the ingroup community as well as measures of intergroup contact and threat. It is instructive to explore the relations between the self-reported data and movement data. This was possible because 169 participants who participated in Study 1 also completed the questionnaire instrument used in Study 2.

We modified the SEM shown in Figure 11, so that the logarithm of time spent in outgroup and shared spaces replaced the existing outcome variable 'willingness to use space outside own area'. It is evident from the tracking data reported in Study 1 (see especially Figure 6) that most participants spent little or no time in outgroup spaces, and so we combined time spent in outgroup space with time spent in shared space to have meaningful amounts of time spent to analyse. The total sample tracked in Study 1 was also a lot smaller (n = 181, but n = 169 for those who were tracked in Study 1 and for whom we also had survey data) than the sample used to test the SEM presented in Figure 11 (n = 488).

The distribution of time spent in shared and outgroup space was normalised to some extent by the logarithm transformation, but only once we excluded cases with time spent of more than approximately 2.7 mins (i.e., $\log_e 1$). Without trimming, the distribution was highly negatively skewed, with discontinuities in the distribution. The trimming left us with a sample of 122 observations.

We tested this model with Structural Equation Modeling, using the same analytic methods outlined earlier, assuming the same measurement model (except taking actual time spent in shared and outgroup spaces as the outcome variable). We found moderate fit values for RMSEA (.071, 90% CI [056, .085]) and CFI (0.94) and a moderate fit for SRMR (0.085). Of most interest to us, though, were the paths in the model, which are shown in Figure 12. The paths connecting positive and negative contact to the threat variables (realistic and symbolic threat, and contact anxiety) were almost all statistically significant and of a similar size to those found in the model we tested using self-reported segregation as an outcome. However, as Figure 12 indicates, only one path connecting the threat variables to the amount of time actually spent in shared and outgroup space was significant – there was a strong negative relationship between realistic threat and time spent, indicating that higher levels of reported realistic threat were associated with less time spent in shared and outgroup spaces ($\beta = 0.41$, 95%CI [.08, .74], $p < .007$).

Model Fit: RMSEA = .071 (90% CI = .056, .085) CFI = .94   SRMR = .085 Chi-square = 315.76 df = 196

All paths except the dashed lines are significant at p < .037

Coefficients are standardized
Values in parentheses reflect length of 95% bootstrapped confidence interval

Indirect (mediated) effects:
Positive contact on time spent in shared and outgroup spaces, through:
Realistic Threat   Z = 2.34 p < .02 β= .13 (.12)
Negative contact on time spent in shared and outgroup spaces, through:
Realistic Threat   Z = -2.43 p < .02 β= -.19 (.18)

Figure 12. Empirical fit of structural equation model of the associations between contact, threat and time spent in shared and outgroup spaces

Note: to simplify presentation, the measurement model is not shown. Paths in grey are negative. Line weight is proportional to coefficient size

Discussion

Contributing to work on intergroup contact and desegregation (Pettigrew & Tropp, 2001; Vezzali & Stathi, 2017), study 2 explored the association between negative and positive contact experiences, perceptions of intergroup threat and residents' willingness to use spaces beyond their own community areas in north Belfast. Four key findings are worth highlighting. First, personal safety concerns (realistic threat), challenges to ingroup values and identities (symbolic threat), and anxiety about interaction with outgroup members were all negatively related to self-reported willingness to use activity spaces and pathways beyond ingroup areas. Second, both negative and positive contact experiences were also significantly related to self-reported activity space segregation, with positive contact being associated with increased and negative contact with decreased motivation to use spaces beyond participants' ingroup community (e.g., see also Braddock & McPartland, 1989; Barlow et al., 2012). Third, in line with the theoretical model proposed in our introduction (see Figure 1), we found that the effects of negative and positive contact on activity space intentions were partially mediated by these three forms of threat, with the pathways through realistic threat being strongest for both Catholic and Protestant samples. Interestingly, the pathway from negative contact experiences through symbolic threat to activity space intentions was significant for Catholic but not for Protestant respondents. This may reflect the fact that such experiences often occur around areas heavily marked with unionist symbolism; for example, the extensive use of unionist flags in such areas has been a source of controversy in recent years and is sometimes identified as a source of identity threat to the Catholic community (Bryan & Stevenson, 2009).

Fourth and finally, follow up analysis of the relations between these self-report variables and behavioural measures of activity space segregation provided support for some of the relationships specified by this model, notably with regards to the role of positive and negative contact shaping activity space use via their relationship with realistic threat. However, being

based on cross-sectional analysis of a relatively small sample of residents, this evidence is suggestive rather than conclusive. Further research on the extent to which intergroup threat and contact experiences shape activity space use at a behavioural level is required. In our view, the wider factors that shape self-reported willingness to use shared activity spaces may differ from those that shape actual activity space behaviours. The latter, for example, may be constrained more strongly by environmental determinants such as physical limits on mobility, location of the nearest shops, and place of employment.

General Discussion

In his classic text *Strangers Next Door*, Williams (1964) emphasized the potential effectiveness of intergroup contact in reducing racial prejudice in urban environments. However, as his book's title implied, Williams also worried that such interactions would be blocked by ongoing practices of segregation. In a memorable passage, he observed how residents' pathways through the city maintained:

> "… a well-beaten, often trod, social trail from home to work, back to home, to lodge meetings, on Sunday to church and back, and then perhaps to visit relatives and friends. Once the pathways had developed, persons tended to stay on them; only once in a long while did they go into parts of the forest frequented by other tribes. For most persons, such paths were the normal walks of life that exposed them to only a few limited social environments." (p.141).

The present research has contributed methodologically, empirically and theoretically to understanding this kind of everyday segregation. In so doing, it has aimed to create an interdisciplinary space in which opportunities for integrating psychological and human geographic research on the dynamics of contact and segregation might be explored.

Methodologically, our research has employed a novel combination of GPS tracking, GIS analytics and survey methodology. This enabled us to investigate how sectarian segregation in the historically divided city of Belfast manifests behaviourally via analysis of the time that Protestant and Catholic residents spend in different kinds of social spaces, the pathways they use to travel the city, and the location of their destinations. The nature and scale of this investigation would have been impossible using the standard

observational methods that have featured in other psychological work on the segregation of everyday life spaces (Dixon et al., 2008; McKeown & Dixon, 2017): it required that we capitalise on methodological advances in research on human mobility practices (e.g., Palmer et al., 2012; Wang & Chai, 2012). Our use of GIS methods also enabled us to capture visually the day-to-day mobility patterns of ordinary people; that is, to depict the spatial morphology of their use of segregated and shared spaces, based on the accumulation of data on their movements over time. This proved valuable not only because it revealed the human geography of activity space segregation, but also because it identified the location of potentially shared spaces in Belfast.

The capacity for such GIS methods to generate novel psychological hypotheses about local patterns of activity space use is worth underlining. Consider, for instance, Figure 13 below, which depicts residents' journeys to the Cityside Retail Park, located on the outskirts of Belfast city centre (see Figure 2 above). Our destination data suggested that this facility was treated in practice as a shared space, being visited almost by equal numbers of times by Protestant (n=74) and Catholic (n=72) participants in our research. However, as Figure 13 indicates, community members generally accessed the Park using different routes. Catholics favoured the western entrance (Point A), with Protestants making greater use of the eastern and southern entrances (Points B and C). This spatial pattern raises some intriguing social psychological questions that, we believe, have wider resonance. Does it reflect the local ecology of residential segregation and thus the effects of factors such as physical proximity and perceived convenience? Does it reflect social norms? Does it reflect decision-making - whether implicit or explicit - driven by related psychological processes such as perceived intergroup threat, social identification or prejudice? We would again argue that the marriage of methods drawn from psychology and geography opens up new ways of addressing such questions and thus new opportunities for understanding how segregation is maintained in everyday life.
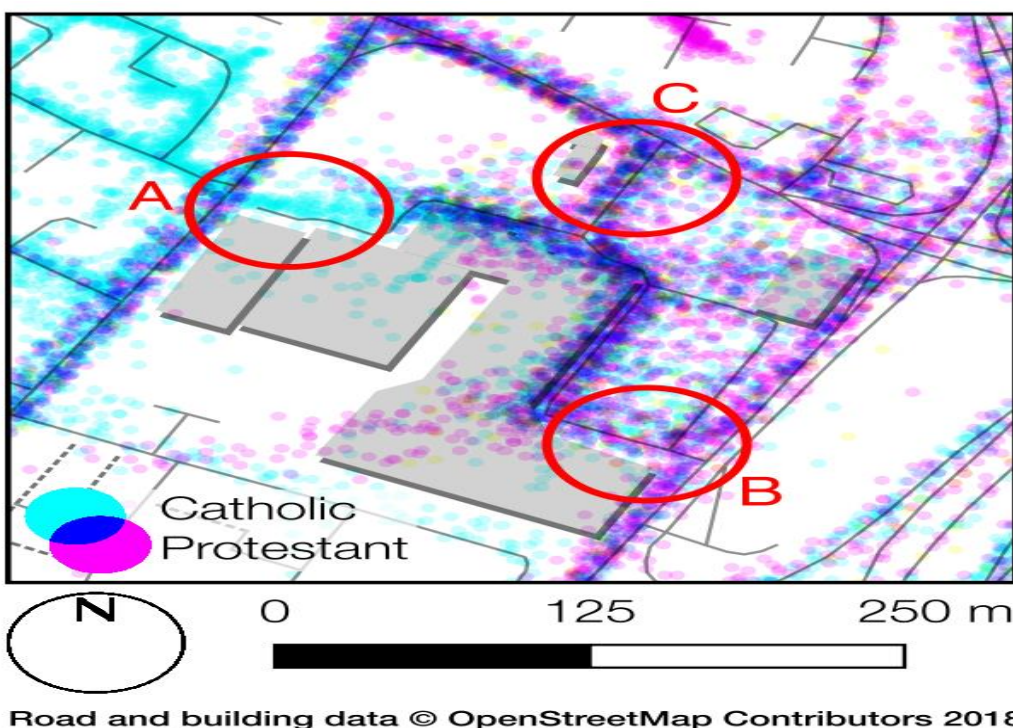
Figure 13. Mapping Catholic and Protestant pathways into the Cityside Retail Park

Note: The upper circle A designates the western entrance to the Park, the lower circles B and C the eastern and southern entrances

Empirically, our research has presented novel evidence on the nature of activity space use in north Belfast, contributing to emerging work on mobility practices in the city (e.g., Bairner & Shirlow, 2003; Dowler, 2017). Although local Catholic and Protestant residents tend to live in close proximity, they often lead the kinds of parallel lives that concerned Williams (1964). The majority, for example, seldom enter the residential areas of the other community or use the associated street networks (see also Grannis, 1998). Similarly, they generally eschew related facilities such as shops, newsagents and post offices, even if this means going further afield. Such patterns reveal the close relationship between activity space use and residential segregation in north Belfast, supporting Pettigrew's (1979) contention that residential segregation is often the 'structural lynchpin' of other forms of segregation.

At the same time, use of shared spaces also proved common amongst both communities who participated in our research, mainly being focused on activities rooted in commercial locations such as supermarkets, retail outlets and the city centre. It is perhaps revealing that such

locations exemplify what Auge (2008) provocatively labelled 'non places' – places devoid of strong historical, relational or identity-relevant meanings. In stark contrast to the residential enclaves of north Belfast, they provide an unthreatening environment where sectarian identities can quietly recede and contacts between individuals and communities can perhaps occur. Equally, however, we would intuit that such contacts are a far cry from the kind of intimate, meaningful exchanges that research on the contact hypothesis has prioritized. To the contrary, they may evidence Taylor and Moghaddam's (1994) claim that intergroup interactions in historically divided societies are often fleeting and shallow, being engineered to pre-empt social tensions rather than to generate meaningful communication.

Interestingly, the sectarian patterning of activity space behaviours and attitudes was comparatively unaffected by gender and community identity, with one exception: Catholics spent more time in shared and outgroup spaces than Protestants (Study 1), although this tendency was not reflected in either our destinations (Study 1) or self-report data (Study 2). Further research is needed to explain this finding. One possibility is that it reflects broader shifts in the human geography of Belfast. The city's growing Catholic population has created a housing shortage, impelling some Catholic residents to move to historically Protestant areas in search of accommodation (e.g., see Shuttleworth & Lloyd, 2013), a process colloquially known as 'the greening of Belfast'. For a similar reason, Catholic residents may increasingly need to access activity spaces and facilities beyond their own communities, including retail and leisure facilities. Another, potentially related, possibility is that Catholic residents have come to experience shared settings as less threatening and are thus more willing to use them than Protestant residents.

Theoretically, our research has sought to clarify some of the social psychological factors that may explain activity space sharing and segregation. On the one hand, we have highlighted the association between varying forms of intergroup threat – realistic threat, symbolic threat and contact anxiety – and everyday practices of segregation. The general tendency of intergroup threat to promote avoidance of others (Stephan et al., 2009), it seems, finds more specific expression within the choreography of residents' day-to-day mobility choices. On the other hand, we have highlighted how varying experiences of intergroup contact may affect activity space use by virtue of their impact on these three forms of threat. By diminishing threat, positive contact

experiences may reduce residents' motivation to avoid public spaces and pathways beyond their own communities and in turn, via a virtuous circle, create opportunities for further intergroup contact[7] (Braddock, 1980; Braddock & McPartland, 1989). By intensifying threat, negative contact experiences may work in the opposite direction. That is, they may exacerbate residents' tendency to stick within the narrow confines of ingroup pathways and spaces, reducing the possibility of interacting members of other communities (Barlow et al., 2012; Hayward, 2016).

Theoretically, our research has also contributed to emerging work on the 'time geography' of segregation (e.g., Aksyono, 2011; Kwan, 2013). Such work has highlighted how socio-spatial divisions may emerge not only via the uneven distribution of social groups across residential areas of cities, but also via the time-space pathways of individuals moving through everyday life spaces. As discussed in the introduction to this paper, it has also highlighted how (often unacknowledged) spatial *constraints* on individuals' daily movements may sustain the segregation of everyday life, focusing particularly on the role of capacity, coupling and authority constraints (see Miller, 2004).

Extending this kind of approach, the present research has emphasized the potential relevance of social psychological dynamics in shaping the pathways and destinations that individuals prefer in their day-to-day lives. In particular, we have explored how varying forms of intergroup threat may influence such preferences and how residents' experiences of negative and positive contact may, in turn, shape such constructions of threat. Although our work is just a step towards a more complex framework for understanding the relations between contact, intergroup threat and mobility practices, we would again emphasize the conceptual value of integrating work on the psychology of contact and segregation with related work in companion disciplines such as human geography. Indeed, in this sense, our paper has sought to answer Lenntorp's (1999) call for research that moves beyond a 'mechanistic' conception of time-geographic processes in order to acknowledge their 'human dimension' (p.155).

Limitations and future directions

This paper has attempted to develop a novel approach to investigating a form of segregation that has featured comparatively rarely in the extensive literature on segregation, namely the segregation of everyday activity spaces over time. In conclusion, we want both to

acknowledge the limitations of our research and to highlight potential directions for future research.

To begin on an obvious point of external validity: we acknowledge that Belfast is a 'post-conflict' city whose residents have experienced a long history of violence. Accordingly, intergroup threat and avoidance may be more salient here than in other parts of the world. The city's residents suffered, for example, around 1664 of the estimated 3665 sectarian-related deaths that occurred during Northern Ireland's 'troubles' (McKittrick et al., 2001), of which 560 occurred in our study area of north Belfast. They also suffered the majority of the estimated 47541 physical injures that resulted from the conflict (see Conflict Archive on the Internet, 2018). In the so-called 'post conflict' era, residents of north Belfast have continued to experience ongoing intergroup violence focused, for example, on loyalist parades and the use of sectarian flags (e.g., see Jarman, 2003, 2006). In short, how intergroup threat shapes activity space use elsewhere is a matter for further research, and the present project may represent a case study *in extremis*. Certainly, the relationship we found between contact experiences, realistic threat and time spent in shared and outgroup spaces warrants investigation across a wider range of contexts.

Second and related, the cross-sectional nature of the survey data presented in Study 2 does not sustain general conclusions about causality. As Abrams and Eller (2016) recently argued, the relationship between contact, threat and specific psychological or behavioural outcomes are typically complex, bi-directional and historically shifting. Their elucidation requires longitudinal research conducted across a wider variety of contexts than have featured in our project. Such research might also seek to clarify how different forms of threat may interact to shape activity space segregation over time and how this may be associated with conceptually related factors such as identity salience, prejudice and intergroup trust (e.g., see Stephan et al., 2009).

Third, given its links to the human geography of everyday life, the topic of activity space use also highlights a form of intergroup threat that has yet to feature prominently in the psychological literature (though see Durrheim & Dixon, 2005). As residents move through the city, they encounter places where they feel belonging, attachment and familiarity, but also places where they feel estrangement, dis-identification and uncertainty. The latter experiences of *place identity threat* are arguably particularly powerful in a city such as Belfast, where flags, wall

murals, kerb paintings, graffiti and other forms of 'territorial personalization' (Greenbaum & Greenbaum, 1981) are prominent features of the everyday environment (e.g., see Jarman, 2012; Bryan & Stephenson, 2009), constantly reminding residents about 'who belongs where'. In short, the role of place identity dynamics in creating, reproducing and transforming segregated activity spaces merits further exploration.

Fourth, our primary analysis of activity space segregation in Study 1 was based on top-down assumptions about how to classify 'ingroup', 'outgroup' and 'shared' spaces, albeit drawing on census data on Belfast's residential demography. An alternative approach might develop a 'bottom-up' methodology that seeks to recover lay perceptions of the nature of shared and divided spaces in a given setting and then to examine how, when and why activity space use is shaped by such perceptions. We would again highlight here the value of combining psychological and geographic methods. We would highlight more specifically the potential contribution of *participatory GIS methods*, which aim to capture how, and with what consequences, ordinary people themselves represent everyday social spaces (e.g., see Huck et al. 2017).

Finally, an obvious but key applied implication of our research is worth underlining: interventions to create more inclusive urban spaces should target the interrelations between contact, threat, and everyday mobility practices. Such interventions are important not only because avoidance of others may sustain wider forms of intergroup prejudice and conflict, but also as a matter of social justice. As our Northern Irish case study starkly illustrates, segregation shapes citizens' capacity to move without restriction through the city, access freely its public spaces and benefit fully from its resources and facilities. In order to build fairer and more inclusive cities, urban planners should consider the potential impact of experiences of intergroup contact and threat on residents' day-to-day mobility concerns and behaviours.

Footnotes

1. Interface barriers, also known in Northern Ireland as 'peace walls', are physical barriers (e.g., walls, fences) designed to separate Protestant and Catholic communities.
2. Because we considered only amounts of time greater than 30s, an important threat to the validity of our analysis might be that a different pattern emerges below this thresholding across group space, time of day, and community membership. Hence, we conducted a

subsidiary analysis in which we created a binary dependent variable, reflecting periods of time shorter or longer than 30s respectively. We then conducted a Generalized Linear Mixed Model on this dependent variable, using the same predictors as analysis of scores > 30s, with the LME4 package in R (Bates, Maechler, Bolker, & Walker, 2015). Since we found a very similar set of results when analysing scores ≤ 30 seconds, we report only the analysis for scores > 30 seconds in this article. However, the details of the former are available on request.

3. Note that there are two widely recognised ways of building mixed linear models, namely the bottom-up and top-down approaches (e.g., Zuur et al., 2009). We opted for the top-down approach, in which the model with k-way interactions (and lower order terms) is compared with the model with (k-1)-way interactions and so on - until one finds the minimum value of k for which one of the models is significantly better, and where the starting value of k is the number of variables or terms in the saturated model. Interactions within the accepted model are then pruned. Lower order terms that are implied in the significant higher order interactions must be retained, but lower-order terms not implied can be tested for inclusion. Both top-down and bottom-up approaches have associated costs, but some authors recommend the bottom-up approach when the principal aim is to explore, rather than to test hypotheses, where the top-down approach is preferred (e.g., Molenberghs & Verbeke, 2000).

4. As in the analysis of time spent in areas < 30s, we checked our analysis by creating a binary dependent variable, reflecting zero and non-zero frequencies of destinations visited respectively. We conducted a Generalized Linear Mixed Model on this dependent variable, using the same predictors as in the analysis of non-zero destination frequencies, with the LME4 package in R. As we found no meaningful difference between these analyses, we do not report the analysis that included zero frequencies here, but it is available on request.

5. The complex nature of the model we tested means that there are likely many alternate equivalent or near-equivalent models. Some alternate models could result from re-specification of the directionality of effects, for instance, or inclusion of other potential exogenous and endogenous variables. We have no way of deciding whether these

alternate models would be better than the model we have tested, but this is quite typical of complicated SE models. One possible alteration within our reach would be to add directional effects between the mediating variables (e.g., adding paths from realistic threat to symbolic threat, and to contact anxiety), but this is not our theoretical focus in the present article and would not invalidate the model presented.

6. On the suggestion of a reviewer, we tested a moderated mediation model for realistic threat, in which the regression of activity space preference on positive and negative contact, respectively, was mediated by realistic threat, and the mediation relationship itself moderated by community membership. We did not find significant moderated mediation for either positive or negative contact ($\beta = -.003$, $z = -0.11$, $p > 0.91$; and ($\beta = -.04$, $z = 1.33$, $p > 0.18$).

7. It is important to recognize here, of course, that sharing particular activity spaces may create opportunities for intergroup contact, but not lead to actual face-to-face interaction.

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