Building better than we know: The residential built environment, trust, social behaviour, biology, and health

David McAleavey

A thesis submitted for the degree of Doctor of Philosophy (PhD)

Institute for Social and Economic Research

University of Essex

April 2023

Impact of COVID-19

Data collection for Study 2 of Chapter 3 of this thesis started prior to the first National lock-down (data collection period 1 - start: 05/02/2020). Data collection was suspended Monday, 16 March 2020 as part of the University's response to COVID-19 (under what became described as the Enhanced Protection operating model). In the Spring term of 2022, the University moved to the Targeted Protection operating model, thus, we returned to face-to-face data collection in the lab, with the required mitigations in place (data collection period 2 - start: 03/02/2022) However, due to very low levels of participation, on account of the then on-going campus-wide mitigations for the pandemic, the study was further suspended (31/03/2022). In the Autumn term of 2022, once the University was operating in a Steady State business model, the study returned once again to the lab (data collection period 3 - start: 21/11/2022). This period of data collection was recently suspended (03/03/2023) due to low and falling levels of participation. I remain 95 participants short of the necessary sample size (as estimated by a power calculation, see Method section of Chapter 3).

The Introduction and Method sections for this study (Chapter 3. ESSEXLab Follow-up Study: Study 2) are included in the present thesis as Appendix A. It is hoped that by the time of my defence, I will have restarted data collection, and be approaching, or have reached, the optimal sample size and hence be in a position to share preliminary findings.

Abstract

Over the last decade there has been a renewed interest in identifying exactly how aspects of the residential built environment “get under the skin” and affect the physical health of not only of those who dwell within, but reside and commute among, disorderly and deteriorating neighbourhoods.

This thesis is focused on better understanding how aspects of the social environment are crystallised in the residential built environment, and in particular the proximate environmental, behavioural, and perceptual mechanisms that account for how our interaction with the residential built environment modulates both our social behaviour and physical health.

Building on Wilson and O’Brien’s evolutionary construct of Community Perception, Chapter 1 reviews the relevant literature from across the evolutionary human sciences, social psychology, applied social epidemiology, and social neuroscience to propose a biologically plausible pathway from the residential built environment to physical health. The empirical chapters (Chapters 2 to 4), then test this framework through both experimental and observational studies.

Employing an eye tracking paradigm, in Chapter 2 we learn about the perceptual mechanisms that account for how residential maintenance has a significant impact on our assessment of the social environment. In Chapter 3 we find no significant difference in social behaviour, assayed through a behavioural economics paradigm, following affective priming via different levels of residential maintenance. A result which could be a consequence of methodological factors, or a finding due to the absence of task-specific relevance of the maintenance cue in a socially neutral

experimental framing. In Chapter 4, through an analysis of the UK Household Longitudinal Study biomarker data asset, we find that residential maintenance is significantly associated with poor physical health.

Chapter 5 then assesses the validity of the thesis's proposed framework, the thesis's contribution to the burgeoning field of inquiry, and considers future work towards generating impactful evidence-based public policy proposals.

Acknowledgements

The author would like to thank Rick O'Gorman for his support and enthusiasm throughout, and in particular for the valuable insights that helped to erect the scaffold that eventually allowed this theoretical construction project to come to fruition. Tom Foulsham, for his methodological guidance with the eye tracking study, and general encouragement during my time at Essex. Also, Amy Clair, for her guidance and encouragement with the UKHLS observational study.

This thesis has had a long incubation. I'd like to thank Vittorio Gallese for his early encouragement, and Kevin Laland for taking the time, over coffee and biscuits at conferences in Cambridge and Birmingham, to outline how self-evident some aspects of my proposed framework are. Blair Gross, Adam Linson, Berk Mirza, Gillian Pepper, Lucy Prior, and Ana Ribeiro were all generous with their time as I sounded them out regarding my inchoate ideas concerning the pathway from residential maintenance to chronic stress.

The seed for this thesis was sown by two lectures delivered, by David Sloan Wilson (https://youtu.be/Kr0RYLoySoM) and Nicholas Humphrey (https://youtu.be/CxI-yoVp4Rw) respectively, on one evening in New York City as part of the BMW Guggenheim Lab programme in 2011. Both of David and Nicholas have offered encouragement along the way; now it is completed, I look forward to fruitful exchanges with them both in the future, too.

A number of research assistants have contributed to the empirical studies reported in the following chapters. Lewis Mitchell and Ana-Maria Amzoiu were responsible for the majority of the data collection for the eye tracking study reported in Chapter 2.

Roxi Dumitrescu, Megan Cox, and Nick Walter all assisted in the data collection for the ESSEXLab study reported Chapter 3. Bethany Springall, briefly, in the spring of 2020, began the data collection for the still to be completed follow-up to the ESSEXLab study (Study 2 of Chapter 3; Appendix A); but it was Hasibah Hashim, masked, and armed with sanitizer, who ran the data collection sessions for this study during the most testing of testing periods, and on until the month before this thesis's submission (March 2023). Whilst I acknowledge all of their diligent contributions, it is to Hasibah I extend my most sincere gratitude.

Above all, I owe a great debt to Karolina, my wife, for the deep friendship and loving support she has given throughout the process of thinking about and writing this thesis. She has been my constant sounding board, most constructive critic, and inspiration.

Contents

Figures

Tables

Glossary

Whilst the majority of these definitions are the established ones of a particular discipline, as my work crosses a number of disciplinary boundaries, for clarity and consistency, I state in this glossary which definition is active in the present thesis and its disciplinary origin, where relevant.

Built Environment

Following Schulz and Northridge (2014) I understand the built environment to be “all of the buildings, spaces, and products that are created or significantly modified by people” (p. 456).

Collective Efficacy

A construct proposed by Sampson and colleagues, it refers to the ability of neighbours to control the behaviour of individuals and groups in their neighbourhood. Residents of a community with high collective efficacy can establish a secure and orderly environment through the regulation of individual behaviour due to their high level of social cohesion and "willingness to intervene on behalf of the common good" (Sampson et al., 1997, p. 918).

Cue

I follow Maynard-Smith and Harper (2003) who characterise cues as “feature[s] of the world, animate or inanimate, that can be used by an animal as a guide to future action” (p. 15). I follow Sims and Kiverstein (2022) who contend that cues can be contrasted with signals that are produced by a sender with the aim of modifying the behaviour of another organism - the receiver.

Further, I follow Sims and Kiverstein's again when they propose that:

> cues and signals can be thought of as information-bearing structures in the sense that the presence of a cue or signal raises the probability of a state of the world. This is because the cue (e.g., extracellular slime) and the state of the world (e.g., the depletion of food) stand in a relation of reliable causal covariation (Dretske, 1981).

Free Energy

In the context of cognitive science, the free energy principle is a theory that states that the brain works to minimize the difference between its predictions about the world and the sensory information it receives. In this framework, free energy is a mathematical construct that represents the discrepancy between the brain's predictions and the actual sensory input it receives from the environment. Minimizing free energy is seen as a way for the brain to improve its models of the world and make more accurate predictions, which, in turn, helps the organism adapt to its environment.

Neighbourhood

I follow Sampson in defining the concept of neighbourhood thus: "… a variably interacting population of people and institutions in a common place. … my strategy begins with neighbourhoods in physical space rather than elevating social interactions or identity to the definitional criteria" (Sampson, 2012, pp 228-229).

Neighbourhood Effects

Following van Ham and Manley, I consider neighbourhood effects to be the idea that residing in more disadvantaged neighbourhoods has a detrimental impact on residents' life chances above and beyond the influence of individual-level

characteristics (van Ham & Manley, 2012). Recently, the study of this construct has broadened the definition of the neighbourhood environment to include not only conventional exposures like air pollution (Galster, 2012) but also aspects of the built environment, such as walkability and the access to green spaces, as well as the social environment, such as social connectedness.

Priming

Sherman and Rivers (2021), following Molden (2014), recently characterised priming as the phenomenon whereby exposure to a stimuli effects subsequent behaviour without conscious direction or intent. Priming effects are commonly believed to come from the activation of mental representations that assist or inhibit subsequent behaviour.

Sematectonics

A term coined by E.O. Wilson (1975), extends the stigmergic construct (see below) to include any behaviour or physiological change in an organism evoked by evidence of work performed by other organisms in the environment, whether they are conspecifics or heterospecifics.

Social Trust

Following Nettle (2015) I understand social trust as a psychological variable that regulates expectations in social interactions between unacquainted individuals. Social trust is essential for the smooth functioning of society as it enables individuals to engage in various forms of social co-operation, including economic exchange and community participation.

Stigmergy

A phenomenon prevalent in complex systems, notably in social insects (where the term originated), where indirect communication and coordination among individuals occur through the modification of the environment. It involves the deposition of cues, such as pheromones, which serve as stimuli for subsequent actions. Stigmergy enables the collective achievement of tasks and problem-solving without the need for direct, explicit communication.

Trust

In the context of the trust game used in Chapter 3, I follow Cox who proposes that:

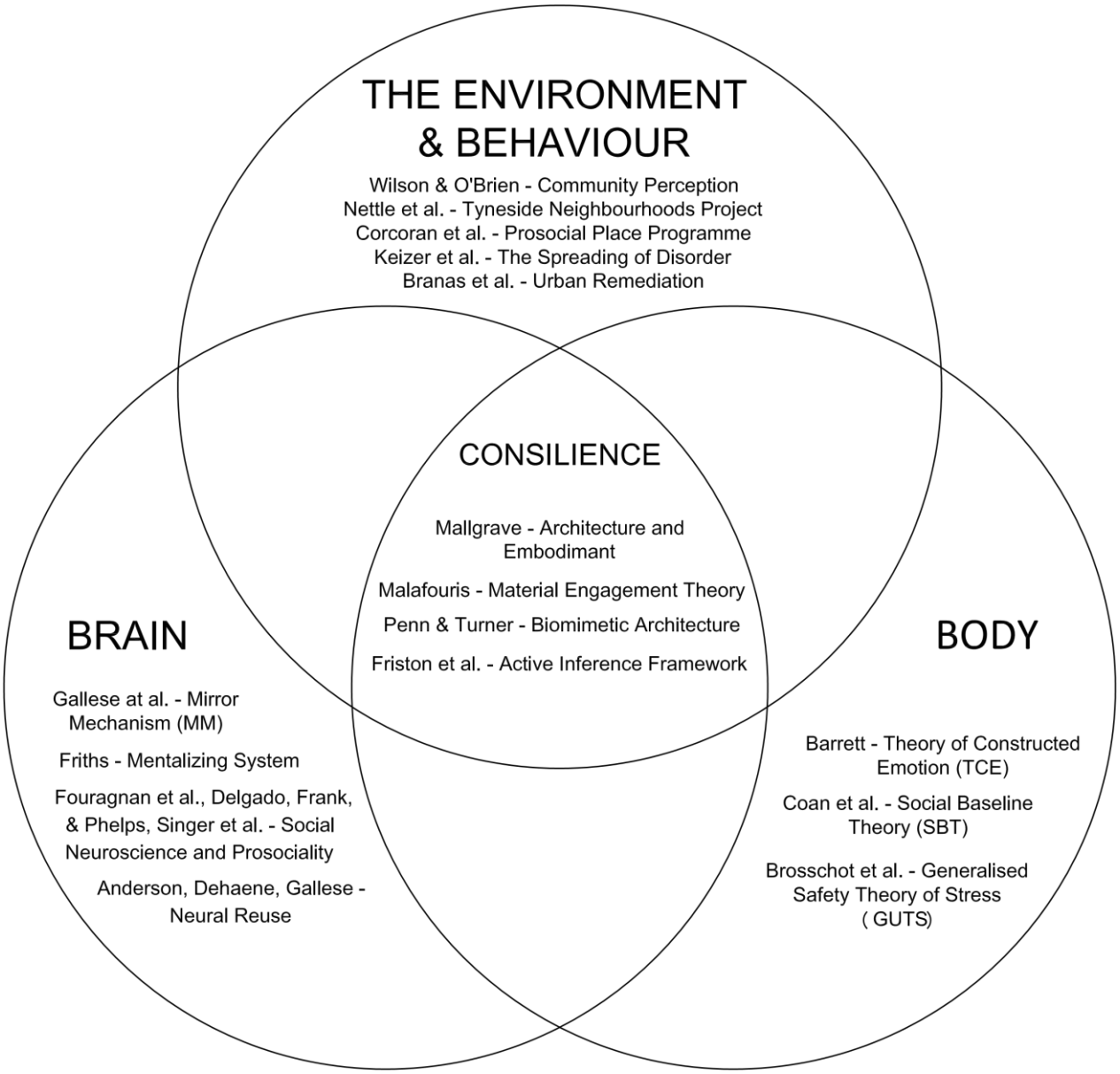
> "Trust" is inherently a matter of the beliefs that one agent has about the behaviour of another. An action that is trusting of another is one that creates the possibility of mutual benefit, if the other person is cooperative, and the risk of loss to oneself if the other person defects (Cox, 2004).

1. General Introduction

This General Introduction consists of six sections. Following a brief scene setting vignette in Section 1.1, Section 1.2 (The Environment & Behaviour) reviews attempts from across the evolutionary human sciences and beyond to understand, and in some cases manipulate, the impact the built environment has on human behaviour and health. Section 1.3 (The Brain) reviews relevant neuroscientific literature towards identifying the neural correlates and mechanisms that account for the environmental and context-specificity of the behaviours identified in Section 1.2. Next, Section 1.4 (The Body) explores the embodiment of these neural and environmental mechanisms, focusing on the phenotypes of emotional and physiological regulation, and their determinants. The fifth section, Consilience, presents several existing attempts, from across different academic disciplines, to synthesise the three preceding literatures, with the objective of situating this thesis's theoretical contribution. See Figure 1.1 for a mapping of Sections 1.2 to 1.5.

Finally, Section 1.6 outlines this thesis's theoretical framework, which, building on the foregoing literatures reviewed, treats the environment, behaviour, brain, and body as an extended instantiation of an enveloping cognitive social system (see Figure 1.2), and concludes by stating this thesis's research aims and questions.

Figure 1.1 *A Theoretical Mapping of Sections 1.2 to 1.5 of the General Introduction*



1.1. Introduction

All organisms need to negotiate their environment. Those that have evolved the ability to move, must also evolve adaptations to be able to identify, approach, and harvest nutrients, and avoid toxins. As we move across species, genus, and phylum, and up and down the physical scales, the same challenge, to locate and approach resources and avoid dangers, has been solved in many different ways throughout evolutionary history.

Consider, for example, the slime mould *Physarum Polycephalum*, which, when it senses nutrients in the environment, migrates in the direction of the resource (Reid et al., 2012), propelled through the environment by the change in the oscillatory frequency of the cells that sensed the nutrient, which also constitute the external membrane of the Physarum plasmodium. However, when toxins are encountered (e.g., salts), the oscillation of the cells that form the membrane that have sensed the threat decrease; correspondingly, the membrane tension increases in that region, functioning as a brake on the plasmodium's locomotion, and the Physarum avoids contact (Reid et al., 2012: Sims & Kiverstein, 2022). As simple as the slime mould appears to be as an organism, it has evolved clear mechanisms to respond to its environment in ways that advance its fitness.

As Sims and Kiverstein (2022) recently noted, another interesting fact about a Physarum's plasmodium is that when migrating through its environment, it leaves behind a clear residue of non-living extracellular slime. This slime trail consists entirely of the chemical residue of the process of locomotion itself and is used by the Physarum as an indexical cue of its previous foraging path. Reid and colleagues (2012) demonstrated that Physarum uses this chemical cue of its own migratory trail

through the environment to avoid returning to previously visited, and therefore nutritionally depleted, locations. As Sims and Kiverstein observe “avoiding unproductive expenditure of metabolic energy expenditure on revisiting nutrient-depleted locations, is undoubtedly relevant to a Physarum’s continued survival” (2022, p. 33).

Crucially, for the argument this thesis will later develop, an individual Physarum does not have to rely solely on its own migratory cues when navigating the environment, but can use cues from other conspecifics, and even heterospecifics, to guide its foraging behaviour, to the extent that the biochemical composition of the cue is similar (Reid, 2013).

For ultra-social species like humans (Richerson & Boyd, 1998; Tomasello & Wyman 2009; Tomasello 2014), the primary source of both bioenergetic resources and potential threats is the nature of the relationships between conspecifics, and their respective behaviour in the shared environment. This is also true of the eusocial species, such as leafcutter ants, the termite *Macrotermes*, and naked mole rats (Wilson, 2012).

In his treatment of the evolution of eusociality E.O. Wilson identified the prerequisites for all animals that have evolved into eusocial species: “first, in all of the animal species that have attained eusociality – all of them, without known exception – altruistic cooperation protects a persistent, defensible nest from enemies, whether predators, parasites, or competitors” (2012, p. 140).

Wilson (2012) explains how our path to becoming the ultra-social species we are today is on the trajectory towards a form of eusociality, and that since our adoption of first campsites, and then defendable stockades, in which we secured ourselves and

surplus resources in the form of grain and livestock from avaricious others, we, too, had met all of the prerequisites for the transition. It is a short step in evolutionary time from these first human settlements, which were typically constituted of a small number of family dwellings with total populations in double figures, to our present urban environments, with megacities with populations in the tens of millions.

In this thesis I will propose a framework for understanding human social behaviour in urban environments that is based on predictions about conspecifics and the bioenergetic consequences of these calculations, building on a construct of Community Perception introduced by O'Brien and Wilson (2011). I will argue that at the most fundamental level, our health and safety are inextricably linked to place, as place is both a repository of bioenergetic resources and a representation of the bioenergetic resources available.

I will argue that it is not just predictions about the direct benefits of bioenergetic exchanges between co-present conspecifics, but that, through both embodied and extended cognition and stigmergic and sematectonic processes, the mediated consequences of effort expended by conspecifics in place informs decision-making, with consequences for perception and behaviour in the short-term, and health, via the dysregulation of stress physiology, in the long-term. These mechanisms which we use to negotiate our contemporary urban environments comprise nothing less than a continuation of evolutionarily conserved adaptive strategies that resembles Physarum's ability to survive and thrive in its environment.

1.2. The Environment and Behaviour

1.2.1. The Built Environment Through the Evolutionary Lens: Community Perception

To date the most ambitious attempt to study urban living through an evolutionarily informed biosocial lens, taking a whole city as a field site, is David Sloan Wilson's Binghamton Neighbourhood Project (2011). The term community perception was coined by David Sloan Wilson and Daniel O'Brien to define the psychological construct that they proposed to account for a particular socially oriented cognitive process. They hypothesised that in an ultra-social group-living species, which must navigate not only their own but occasionally unfamiliar social environments, it would be adaptive to be able to quickly infer the kinds of social encounters that might occur there (O'Brien & Wilson, 2011).

In a series of studies conducted in the US city of Binghamton, they found that participants were able to generate accurate assessments of the social quality of unfamiliar neighbourhoods using only photographs of the physical context of the built environment (the visual diet: a term from vision science, to describe the everyday distribution of visual stimuli to which people are exposed [Nettle et al., 2012]).

Participants were less likely to cooperate in prisoner's dilemma games when paired with a person reported to be from a neighbourhood with low social quality (operationalised through scales measuring the perceived strength of ties between neighbours [social cohesion] and their ability to govern the neighbourhood [social control]), which O'Brien and Wilson (2011) interpreted as indicating an adaptive social response to a potentially threatening context.

In a follow-up study O'Brien and colleagues (2014) conducted an experiment, using self-report measures, to assess what it was in the visual diet of the built environment depicted in the photographs that might account for cultural differences in community perception; an aspect of the construct that they described as *local adaptations*. They hypothesised that individuals would be sensitive to different cues of disorder, and that these differences would be calibrated to the environment, both social and physical, in which they were raised.

The participants in the study came from three different urban settings, albeit all located in New York State. One setting was New York City (NYC) itself, the second was NYC suburbs and the third was the less densely populated areas in the upstate region of New York State (outside of, and north of, the NYC metropolitan area). Whilst participants from all three settings identified common categories of cues (which, through a principal component analysis, O'Brien et al. transformed into sanitation, vegetation, and pavement; 2014), the particulars of a participant's community perception, as predicted, was calibrated to the urban setting with which they had had most experience, which typically meant the one in which they had grown up. As an apparent consequence of these local adaptations, when a participant found themselves presented with a photograph from an unfamiliar built environment, the participants would err on the side of caution when it came to making decisions about the social quality of the neighbourhood depicted, a result that O'Brien and Wilson interpreted as consistent with error management theory (Haselton & Buss, 2000).

Recently, O'Brien and Montgomery (2015) have tested the prediction that if community perception can be understood as the ability to infer the social quality of a

community purely from visual cues in the built environment, then physical indicators of investment, building, and growth should have a positive effect on a participant's assessment of a neighbourhood (Montgomery & O'Brien, 2014). Using administrative records of building permits to measure growth, and neighbourhood surveys to assess residents' attitudes, they found that evidence of investment in the local built environment had a positive impact on residents' perceptions of the local social quality.

O'Brien and Wilson (2011) contend that urban living is far too recent a phenomenon for natural selection to have tailored an evolved adaptation to the specific selection pressures posed by the built environment, and therefore they propose that community perception is a functional reuse of two other adaptations, namely, personality perception (Ambady et al., 2000; Borkenau et al., 2004) and environment perception (Kaplan, 1992).

1.2.2. Tyneside Neighbourhoods Project

Inspired by Wilson and O'Brien's Binghamton Neighbourhood Project, Daniel Nettle and colleagues conducted their own studies on urban living in the UK through an evolutionary lens. The Tyneside Neighbourhoods Project began as a single study conducted by Nettle himself, but grew to involve a wide number of collaborators, from both within and beyond academia (Hill et al., 2014; Nettle, 2011; Nettle et al., 2011; Nettle et al., 2012; Nettle et al., 2014; Nettle, 2015; Schroeder et al., 2014).

Through this series of studies, Nettle and his various collaborators employed a diverse range of experimental approaches to assess a variety of psychological mechanisms, but with a clear focus on attempting to identify the cognitive processes that calibrate the social behaviour of residents from two distinctly different

neighbourhoods in Newcastle upon Tyne, UK (Hill et al., 2014; Nettle, 2011; Nettle et al., 2011; Nettle et al., 2012; Nettle et al., 2014; Nettle, 2015; Schroeder et al., 2014). The two study sites, referred to as Neighbourhood A and Neighbourhood B, fell at either end of the socioeconomic spectrum. Apart from that, the areas were selected because they shared many of the same demographic and urban characteristics (e.g., a recognisable main street with a supermarket and other shops, residential housing stock from a similar period and of a similar architectural character. However, see Corcoran et al., 2018, for a challenge to this assertion).

Although the built environment was not central to the Tyneside Neighbourhoods Project framework, it was the variable of interest in the study that Nettle considers to have been the most significant of the project (Nettle, 2015). The study was composed of two parts, one of which involved using the novel paradigm of surreptitiously exposing naive participants, the visitors, to the built environments of the two study sites under the pretext of delivering materials to the resident participants (Nettle et al., 2014). The other part was a continuation of ongoing experimental work assessing trust, paranoia and levels of prosociality with the residents of the two neighbourhoods. Nettle et al. predicted that even an exposure to the visual diet of a neighbourhood's physical environment as brief as 45 minutes would have a significant directional impact on the visitors self-reported levels of social trust, personal trust, and paranoia. They also predicted that the visiting participants' scores on these measures would mirror the findings of the study's resident participants' results. Nettle et al.'s predictions were supported for all but one of the measures, that of personal trust. In hindsight, the group recognised that the design of the study had not been likely to impact this dimension of the visitors' social

cognition as the experiment had not manipulated their experience of people they knew personally.

1.2.3. Prosocial Place Programme

Rhiannon Corcoran and colleagues have also been studying the urban environment, and particularly the urbanicity effect construct, from an evolutionary perspective for over a decade (Corcoran & Marshall, 2016; Corcoran et al., 2017; Corcoran et al., 2018; Corcoran et al., 2019). Corcoran has worked with a wide range of collaborators, employing a diverse range of methods, towards better understanding how the urban environment "gets under the skin" and effects health and wellbeing (Curtis et al., 2020; McElroy et al., 2019; McElroy et al., 2021).

Like Nettle, Corcoran initially took her inspiration from David Sloan Wilson's Binghamton Neighbourhood Project, and with Graham Marshall, an urban design professional, and the evolutionary psychologist Tom Dickins, founded the Prosocial Place Programme in 2012 (Marshall, n.d.). Corcoran saw the potential for combining her academic research in psychology, neuroscience, and public health with research explicitly looking to identify the proximate mechanisms that account for the *Urbanicity Effect*. The urbanicity effect is a well-established finding that poor mental health conditions are more prevalent in inner cities than elsewhere. However, until Corcoran and her colleagues work on the construct there had been little psychological research into establishing a mechanistic account of its proximate determinants (Corcoran et a., 2018; Gong et al., 2016). The evolutionary model of human emotions proposed by Gilbert (1992), not O'Brien and Wilson's community perception (2011), serves as the theoretical framework for Corcoran and colleagues' research on this construct (Corcoran et al., 2019).

In experiments ranging from a walking study (Corcoran et al., 2018) to on-line contemplation (Corcoran et al., 2017) and laboratory-based eye tracking (Corcoran et al., 2019) studies, Corcoran and her colleagues have demonstrated that “places change minds” (Corcoran et al., 2017, p. 1). Consistent with Nettle et al. (2014) and Hill et al. (2015) Corcoran and colleagues found that even brief exposures in situ, or through mediation on-line and in the laboratory, to urban environments that differ in salient physical characteristic of their built environment, can evoke near immediate changes in both psychological states and biometric patterns of attention (Corcoran et al., 2017; Corcoran et al., 2018; Corcoran et al., 2019).

Recently, as the academic lead for the community wellbeing evidence programme at the What Works Centre for Wellbeing (Atkinson et al., 2017), Corcoran has turned her attention to first specifying, then measuring, community wellbeing, and this construct’s health consequences for the individuals that comprise a given community. Employing a number of different methods, ranging from systematic reviews to network analysis, and studying both the social and physical environment (Atkinson et al., 2020; Curtis et al., 2020; McElroy et al., 2019; McElroy et al., 2021), Corcoran and colleagues have examined the community-level determinants of poor mental health and disparities in wellbeing (Curtis et al., 2020). Corcoran and colleagues challenge the simple dualistic approach (see for example; Propper et al., 2005), one that maintains that individual-level characteristics are more strongly related to subjective wellbeing than place-level factors, and posit that subjective wellbeing is in fact a “network of mutually reinforcing relationships between individual, community and place characteristics” (McElroy et al., 2021, p. 1).

Corcoran's practical interest, made manifest through her work with the Prosocial Place Programme, is in creating environments that promote community and belonging (Corcoran, n.d.). Her work is motivated by her conviction that societal and environmental factors are the most significant determinants of wellbeing and mental illness, and hence that a better understanding of the proximate mechanisms of constructs like the urbanicity effect can lead to the design of better place-based intervention strategies to alleviate illness and promote both individual and community flourishing (Corcoran, n.d.; Corcoran et al., 2018).

1.2.4. Disorder and its Consequences

Keizer and colleagues work on disorder in urban environments is another approach to the study of human social behaviour that draws on an evolutionarily informed social psychological construct, which in this case is Lindenberg's goal-framing theory (Keizer et al., 2008, 2013; Lindenberg & Steg, 2007, 2013). In their 2008 study on the spreading of disorder, and their companion study of 2013 on the restoration of order, Keizer and colleagues have demonstrated that even subtle changes to the visual diet of the urban environment can have significant, immediate, directional effects on people's social behaviour. Working from the assumption that the visual diet of the urban environment reflects the behaviour of local residents, and whether the visual diet is in *order* or in *disorder* with regards to established local norms, Keizer et al. designed a series of field experiments to test how naive participants calibrated their own social behaviour in the presence of various visual and auditory cues (Keizer et al., 2008, 2013).

Keizer and colleagues (2008) showed that social disorder can spread. They found that on days when they experimentally introduced cues of disorder (in the form of

norms transgressions like graffiti and litter) into the streets of Groningen, people were less likely to uphold established local norms themselves. Not only did the contagion of disorderly behaviour spread (when the disorder cues were removed, behaviour returned to baseline), but also the norms violated by the participants crossed domains; e.g., both the introduction of graffiti into the environment, and the release of firecrackers during a prohibited period, increased levels of littering (an effect they called *cross-norm inhibition*).

In their 2013 study, Keizer et al. hypothesised that *respect* cues, that is, evidence that residents had been following established local norms of conduct, would work in a graduated manner in the opposite direction to the disorder cues. As predicted, the absence of disorder acted as a modest respect cue, seeding commensurate levels of prosociality in participants. Conspicuous acts of respect for established norms, which in the study was operationalised as a confederate “resident” demonstratively sweeping the public footpath, resulted in significant increases in the levels of prosocial behaviour of naive participants; operationalised by the extent to which a naïve participant would stop to help a confederate who had “accidently” dropped oranges onto the pavement.

As Nettle (2015) observed in his review of these two studies, perhaps the most important finding from Keizer and colleagues’ work is that the visual diet in the immediate environment has real-time effects on people’s behaviour, and that even seemingly modest experimental interventions can have predictable and graduated effects on levels of both antisocial and prosocial behaviour.

Recently, and to a certain degree in response to the methodological criticisms levelled against the original studies by Wicherts and Bakker (2014), Volker

completed an exact field replication of key experiments from both of the Keizer et al.'s studies (Volker, 2017). She reported that whilst she did find evidence for the directional effect of both disorder and order on social behaviour, these effects were considerably smaller than those reported in the original studies, and moderated by individual-level and neighbourhood-level factors (Volker, 2017).

Keizer et al.'s work informed Nettle and colleagues' (2014) study, and has also been cited as the catalyst for what is becoming widely regarded as one of the most significant public health intervention projects currently being undertaken by biologically informed social scientists (Klinenberg, 2018).

1.2.5. Remediation Through Cleaning and Greening

Since 2011 Charles Branas and colleagues have been examining how the maintenance condition of the residential built environment affects the health and safety of individuals, households, and neighbourhoods (Branas et al., 2011; Branas et al., 2018; Kondo et al., 2015; Kondo et al., 2016; MacDonald et al., 2019; MacDonald et al., 2022). Their growing collection of experimental and quasi-experimental studies demonstrate that cleaning and greening vacant lots (lot is the American English equivalent of the British English real estate term plot) and remediating abandoned buildings can both reduce serious and nuisance crimes and improve the wellbeing of residents and their communities (see MacDonald et al., 2019, for a review).

In an early study, the effects of a vacant lot greening remediation initiative in US city of Philadelphia, PA, on changes in crime at various statistical geographies - the lot, block group, and census tract level - were investigated (Branas et al., 2011). Branas and colleagues observed reductions in violent attacks, gun crime, and antisocial

behaviour related to the empty lot remediation. In a follow-up study, South and colleagues found that residents living in the immediate vicinity of the remediated lots, compared to those resident in the immediate vicinity of the randomly-matched control sites, reported a significant decrease in self-reported feelings of depression (South et al., 2018). In Youngstown, Ohio, empty lot remediation initiatives were evaluated by Kondo et al. (2016). They reported that these programmes dramatically reduced assault and property crimes in the area around the remedied lots, compared to lots that remained unoccupied and unmaintained.

Regarding the remediation of residential properties, Kondo and colleagues studied the effects of enforcing a City of Philadelphia ordinance that obliged property owners to ensure that functional windows and doors were fitted to abandoned homes (Kondo et al., 2015). In comparison to properties that did not comply with the ordinance, they discovered small but statistically significant decreases in crime around the properties that complied with enforcement notices (Kondo et al. 2015). Research by Jay et al. (2019) found that the demolition of abandoned structures in Detroit, Michigan, was linked to a sharp decline in assaults with weapons. The impact was greater in areas with a moderate number of demolitions than in areas with a higher number, a finding that Jay and colleagues interpreted as demonstrating that the demolitions had helped stabilise areas where residents were still present and had residual levels of communal solidarity (Jay et al., 2019).

Branas and colleagues theoretically situate their work at the intersection of two research traditions: broken windows theory and collective efficacy (MacDonald et al., 2019; Sampson et al., 1997; Wilson and Kelling, 1982). Broken windows theory emphasises that the physical manifestations of disorder spread fear that undermines

informal social controls within a residential community (Wilson and Kelling, 1982). In contrast, collective efficacy theory emphasises how the built environment of a neighbourhood shapes norms around civility in a particular residential community, and their likely enforcement by residents (Sampson et al.,1997; Sampson, 2012).

Branas and colleagues' contention, which they consider as integrating these theoretical traditions, is that improving a disorderly built environment encourages informal social controls by neighbours, improves a sense of belonging and ownership of places, and dissuades potential offenders (MacDonald et al., 2022). Whilst Branas and colleagues' foreground that their place-based experiments and quasi experiments provide clear implementation guidelines for motivated policy makers, they recognise that identifying candidate proximate mechanisms for explaining their findings would further help refine the design of future interventions (MacDonald et al., 2019).

1.2.6. The Foundations of Community Perception

What the majority of the reviewed studies thus far have in common is that whilst they propose candidate psychological mechanisms and their environmental determinants, their primary focus is on ultimate level explanations (Tinbergen, 1963). The exception is Corcoran and colleagues work, which spans both the proximate and ultimate levels of explanation (for example, see Corcoran et al., 2019, for a detailed theoretical account of the urbanicity effect). Taking O'Brien and Wilson's (2011) community perception as our starting point, the ambition of the present thesis project is to offer both a plausible theoretical account of how the proximate neural, perceptual, and embodied mechanisms that underlie the psychological construct of community perception are embedded within the environmental determinants,

grounded in both theoretical and empirical neuroscience, and then attempt to test, through experimental and observational studies, the hypothesised mechanism: a biologically plausible process theory of community perception.

It is with this goal in mind that I now turn firstly to a review of relevant neuroscientific work on person perception, focusing on the perception and cognition of the social aspects of the visual diet latent in the built environment (Section 1.3.1), as well as the perception and cognition of conspecifics in social situations (Section 1.3.2 and 1.3.3). Then, I will briefly survey the work on the reuse of neural mechanisms for such seemingly evolutionarily novel tasks as urban living (1.3.5). Next, I will review recent theoretical and empirical advances in the study of emotion, social neuroscience, and chronic stress (Section 1.4). Once this is completed, I will conclude with a brief review of recent attempts at consilience from across relevant academic disciplines (Section 1.5); all with the objective of locating the present thesis's theoretical framework, formulating the research questions, and designing the methodological approach (Section 1.6).

1.3. The Brain: The Built Environment and Neuroscience

1.3.1. The Mirror Mechanism

Recent interdisciplinary work by the neuroscientist Vittorio Gallese and his numerous collaborators has offered a promising explanation for how an important aspect of community perception may be accounted for neuroscientifically (Freedberg & Gallese, 2007; Gallese, 2015; Gallese & Gattara 2015). Gallese is best known for his

work with Giacomo Rizzolatti in the discovery of a class of neural cells now known as mirror neurons (Rizzolatti et al., 1996).

The mirror mechanism (MM), first identified in macaque monkeys, describes the process by which the mirror neurons in the motor regions of the brain are active both when one performs a goal-directed action and when one perceives (through any sense modality) the same action being performed by another (Rizzolatti et al., 1996). Building on the extensive theoretical and experimental work the MM has generated (Gallese et al., 2004; Gallese et al., 2007; Keyser, 2009; Rizzolatti & Craighero, 2004), Gallese has developed the theory of embodied simulation (ES) to account for how we might functionally reuse the MM to help us understand other people's mental states, through experiencing their actions, emotions (including attitudes) and sensations, in what is often colloquially referred to as *mindreading* (Gallese, 2014).

In addition to the mirror neurons, Gallese and his colleagues have also identified another class of neural cells, called canonical neurons (that are also motor neurons), which are activated when we manipulate, or simply perceive, an object with known affordances (Gallese et al., 1996).

In a series of experiments conducted over the last decade, ostensibly about ES and abstract art, Gallese and colleagues have demonstrated that the visible traces (also referred to as the "static consequences of a motor act"; Umilta et al., 2012, p. 7) of goal-directed actions (such as gestural brush strokes) are capable of activating the corresponding motor cortex in the observer's brain, with the concomitant activation of ES (Sbriscia-Fioretti et al., 2013; Umilta, et al., 2012).

Unlike many instances in contemporary life where the manufacture of an artefact is invisible to us, Gallese and colleagues hypothesise that the conspicuous

construction of most buildings, which are most definitely the result of goal-directed actions, and the affordances thus perceived, activate both MM and canonical neurons; i.e., the manipulation - handling - of the building materials themselves, the associated use of familiar tools, as well as the very act of construction itself (Gallese & Gattara, 2015; Pallasmaa et al., 2015). Thus, from this theoretical perspective, it seems reasonable to speculate that the *uncivil* actions that introduce disorder into the physical environment, as well as acts of *civil* maintenance, the cognate disrespect and respect cues of Keizer et al. (2008; 2013), would also result in ES in a similar way, and with the same psychological consequences, as the studies assessing abstract art and architecture described above (Freedberg & Gallese, 2007; Gallese & Gattara, 2014; Pallasmaa et al., 2015; Sbriscia-Fioretti et al., 2013; Umilta et al. 2012).

Through pre-reflectively (at a sub-personal level) embodying a simulation of the actions that we presume led to a particular material consequence in the physical environment (and assuming that it was the result of another agent's goal-directed action), Gallese thinks we not only experience the actions, but also the associated emotional and sensational states of its absent agent, through the intersubjectivity of ES (Gallese, 2014).

Thus, ES offers us a candidate neural mechanism to explain how we may be able to assess some of the emotional and mental states, and therefore, it is speculated, the likely social behaviour of a community's residents by reading the indexical evidence of their previous behaviour in the built environment (Gallese, 2014; Gallese, 2015; Gallese & Gattara, 2015; Pallasmaa et al., 2015; Sbriscia-Fioretti et al., 2013; Umilta et al. 2012).

1.3.2. The Mentalizing System

Neuroscientists like Uta and Chris Frith make a distinction between the simulation system (which is generally considered synonymous to the MM account outlined above) and the mentalizing system (2006). If the MM is primarily pre-reflective (sub-personal) aspect of person perception, then the mentalizing system can be considered as a reflective, although not necessarily a conscious, process of mindreading.

The neural correlates of the mentalizing system are predominately in the medial frontal cortex (Frith & Frith 2006). The particular pattern of neural activation is dependent on the nature of the social relationship one has with the agent whose mind you are in the process of attempting to read, the environment in which you find yourself, and your relevant prior experience of both. That these contextual factors modulate our ability to engage in mindreading is readily acknowledged by Gallese, but he believes that we employ a simple pre-reflective heuristic; what was the intention of the agent who did *X* (any goal-directed act)? If opaque, engage mentalizing system; if transparent, rely on ES to guide one's subsequent response (2014).

Interestingly, the same neural regions active in the convergence and integration of salient information from different modalities about an individual conspecific, are also active in the assessment of that individual's likely behaviour in particular places (Damasio et al., 2004). Researchers have also found that our assessment of objects is modulated, on a moment-by-moment basis, by the environment in which we encounter them; a finding that is thought to generalise to conspecifics (Miyamoto et al., 2006).

These findings about the neural correlates of both the ES and the mentalizing system, and the part they play in person perception, help ground the theoretical predictions and empirical findings of the studies by O'Brien and Wilson (2011), Nettle and colleagues (Hill et al., 2014; Nettle, 2011; Nettle et al., 2011; Nettle et al., 2012; Nettle et al., 2014; Nettle, 2015), Corcoran and colleagues (Corcoran et al., 2017; Corcoran et al., 2018; Corcoran et al., 2019), and others, that we reviewed in previous subsections (Section 1.2). They also begin to provide plausible candidates for the proximate neural correlates and mechanisms of the psychological processes involved in the assessment of a neighbourhood's social quality through the behaviour crystallised in the built environment.

1.3.3. Social Neuroscience and Prosociality.

In a number of recent studies, social neuroscientists have found that reputational priors can have a significant effect on experimental participants' prosocial behaviour (Fouragnan et al., 2013; Delgado et al., 2005). Building on the work of neuroscientists like the Friths and their collaborators, particularly Tania Singer (Singer et al., 2006), these studies, which usually employ an experimental economics game paradigm, have typically manipulated the participants' knowledge of the other player's reputation, essentially providing information on their trustworthiness, ahead of the social interaction.

In Singer et al.'s 2006 study, they found that participants' levels of ES, as well as the activation of their mentalizing system, was modulated by their own experience of social interactions with the other player, in this case a confederate of the investigator, in an experimental economics game. They also reported that there was a gendered difference in the nature of this modulation. They observed a decrease in

the activation of the pain network (marginal in women, but significant in men), which is the same network of neural regions that are engaged when we ourselves experience painful stimuli, when the participants witnessed the untrustworthy person receiving a shock (i.e., someone who had defected in the game), and a parallel increase in activity in the ventral striatum and orbitofrontal cortex (part of the reward processing and mentalizing system), although this increase was only found in the male participants. Singer et al. offered two interpretations for this gender effect. Firstly, that it might be an artefact of their experimental design, the physical nature of the punishment may have simply appealed more to males. Secondly, that it may actually reflect the predominance of males in the maintenance of norms in human societies.

Other studies in this field do not rely on an individual participant's personal experience of an interactant to form the reputational prior ahead of the testing episode, but manipulate reports of the other player's reputation, for instance in the form of a vivid short narrative about the prospective interactant's past, which is often provided by the investigator in situations where the participant never meets in person the individual they are purportedly playing the game with (Delgado et al., 2005).

Fouragnan and colleagues (2013) recently reported that, even in the face of their own experience of defections from particular players (i.e., the players that had been tagged as trustworthy by the investigator's narrative), participants' decisions were affected by the direction of the reputational prior administered by the investigator. Clearly, the modulating influence of prior information about the reputation of a contemporary from a reputable source (which in this instance was the investigator), has an immediate, significant, and long-standing effect on the participants' ability to

learn to read the intentions of their social partners, update their priors for trust and person perception (or whichever psychological mechanism one might propose to account for our ability to modulate our behaviour in such circumstances) accordingly, and therefore act adaptively in the immediate situation. Evidently, mediated accounts of reputation matter to us when decisions about trust, and corresponding levels of prosocial behaviour, are being made.

In light of the findings reviewed in this subsection, it seems reasonable to pose the question: can the crystallised consequences of salient social behaviour latent in the built environment itself serve as a mediated reputational prior?

1.3.4. Beyond (or Beneath?) the Mirror Mechanism and the Mentalizing System: The Active Inference Framework

In his recent assessment of the mirror system, an account that he characterises as deflationary, Andy Clark (2015), following Heyes (2001, 2010), Kilner et al. (2007) and Friston et al. (2011), has sought to synthesise and then subsume the two preceding approaches of how we might explain what Gallese (2007, p. 3) calls our "experiential understanding of others' actions" into the more fundamental framework of active inference proposed by Karl Friston (Friston et al., 2017).

Active inference offers a unified theory of perception, learning, and decision-making at computational and neural levels of description (Smith et al., 2022). The active inference framework describes a scheme for Bayes optimal behaviour. This means that arising perceptions and actions necessarily depend on the prior beliefs; or as Mirza and colleagues put it "the assumption that action and perception serve to minimize surprise or uncertainty under prior beliefs about how sensations are caused" (Mirza et al., 2016, p. 1).

Whilst it is beyond the scope of this General Introduction to give a full account of active inference (see Friston et al., 2022, for a beginner's introduction), it will be important to have an elementary understanding of active inference's tenets. Active inference assumes that through a cascade of top-down predictions about the expected sensory data that will be harvested from the world through perception, an organism creates endogenously (from memory, attention, and emotional state) a *generative model* about the state of the world.

Active inference defines a generative model as an agent's best prediction from memory of the previous states of the world that account for the present sensory diet. Linson and colleagues' (2018) use the example of a first-time visit to a university campus to illustrate this mechanism:

> Since a university is a contingent cultural entity, no part of our biological inheritance should be expected to provide us with any campus familiarity. However, if we have any earlier exposure to other universities, from visiting, reading, or hearing about them, this experience may contribute to our expectations of familiar features: we could speculatively populate any given campus with some lecture halls, administrative buildings, cafes, and so on. This mental act of populating, in other words generating, amounts to using a *generative* model of a campus (i.e., generating consequences from causes). On a first-time campus visit, such a generative model allows us to "predict" (extrapolate from the model) that there is a cafe, or, more precisely, that there is a high probability of there being a cafe, even if in actuality, there is not one there. (Linson et al., 2018, p. 2)

If all is as predicted in the generative model, that is there is "no news", then a state akin to ES pertains. It is only when a top-down prediction is met by a bottom up *error* message (called a *prediction error* in active inference terminology), which occurs when the sensory data does not match the predicted state, that the system is forced

into plasticity, and a cycle of further top-down hypothesis creation and testing is dynamically engaged; where resources from across the brain, body and environment are recruited, much like the neural instantiation of the mentalizing system characterised above (Frith & Frith, 2006), until the sensory signal is accommodated (Linson et al., 2018).

Whilst retaining all of the properties claimed by Gallese and colleagues for both the mirror neurons and the canonical neurons, and the modulatory effects of the integration of knowledge from memory and context from the mentalizing system approach of the Friths, it is clear that Clark (2015) views what Gallese considers as ES as simply an instance of active inference with minimal *prediction error* (in as much as the generative model that the agent brought to bear on the situation produces few, if any, prediction errors).

Clark's position, as an advocate of both embodied and extended cognition, following Friston, is that the knowledge stored in memory (and *bio-external* resources like the built environment, which form part of the immediate situational context) functions to contextualise the "kinematic" (or the "static consequences" of actions) stimulus of other's actions, in the form of *priors*, which constitute the generative model that the agent has for that particular domain of behaviour (Clark, 2015; Friston et al., 2011; Kilner et al., 2007). So, far from being separate systems for social understanding, they are aspects of the same system with simply different functions dependent on the levels of prediction error to be resolved.

Furthermore, under active inference, the brain continually updates its prior beliefs based on emerging evidence, with all past life experiences contributing to these priors. These priors serve as the foundation for how the Bayesian brain makes

predictions, and thus decisions. Consequently, personality, early life adversity, attachment experiences, socioeconomic status, and other significant life events shape how the Bayesian brain selects strategies for ensuring future wellbeing through behavioural decision-making (Peters, et al., 2017).

As an illustration, individuals with secure attachment styles tend to actively seek social support and view the support they receive as positive. In contrast, those with insecure attachment styles, as noted by Collins and Feeney (2004), are less inclined to seek support and may not perceive it as positively. In line with attachment styles, my assertion is that early developmental experiences, and the broader social and physical environmental contexts in which individuals find themselves, play a role in moulding their generative models. Consequently, each person develops a distinct and individual generative model.

Thus, due to these varying generative models, the same social and physical environment can have differing effects on an individual's physiology, cognitive processes, and hence behaviour. Moreover, I anticipate that these individual differences in generative models endure, much like a biological set point, to the extent that the individual’s environment, social and physical, remains constant. However, should the individual’s circumstances change, then gradually, the generative model would update given the new evidence, and eventually predictions regarding the social and physical environment, and the (uncertainty reducing) information and bioenergetic resources it affords, will adapt to the new context.

1.3.5. Could Community Perception be a Combination of Personality Perception and Environment Perception?

Michael L. Anderson (2010, 2014, 2015), Stanislaw Dehaene (2005), and Vittorio Gallese (2014), have all proposed alternative accounts of how neural mechanisms that originally evolved for one purpose in a particular cognitive domain, might be later exapted (or co-opted) to facilitate adaptive behaviour in the same, or different, cognitive domain.

Anderson's (2010, 2014) view is the most radical, as he maintains that whilst neural tissue itself is differentiated into distinct *workings*, these workings are not domain (or modality) specific, and that through a process of transiently assembled local neural subsystems (TALoNS), over different timescales (evolutionary, developmental, and situational), these workings can be recruited to form new task-dependent networks. In Anderson's model of reuse, whilst the new assembly of workings that co-operate to address the novel environmental demands placed on an organism may or may not result in new psychological mechanisms, they will inevitably affect, and in turn be affected by, the other "uses" the newly assembled workings were previously recruited to perform in other networks; in fact, this is often the functional logic of an occurrence of reuse (2015).

For instance, a new network may recruit a particular working in order to functionally benefit from inheriting some aspect of its established role in some other use in an enduring cognitive process. In turn, depending on the demands the new use places on a particular working, it will have consequences for how the particular neural tissue develops, and therefore modulate its contributions to the other evolutionarily (or developmentally) more long-standing mechanisms it was hitherto implicated in.

Anderson (2014, 2015) claims that the well-established theoretical and empirical literature on embodied cognition, and in particular the work on Conceptual Metaphor Theory (Lakoff & Johnson, 1980), is a clear illustration of his formulation of reuse in action.

If Anderson's proposal for the fundamental mechanistic organisation of the brain is accurate, it is clear to see how O'Brien and Wilson's construct of community perception can be accounted for neuroscientifically (Anderson, 2010, 2014, 2015; O'Brien & Wilson, 2011). Additionally, if the community perception construct is grounded in the neural workings of personality perception, as O'Brien and Wilson hypothesise, it may also account for community perception's potential reuse of other associated aspects of personality perception, including reputational information, as it will inevitably engage these concomitant networks as a result of the activation of any common neural workings.

Furthermore, and in support of the unified mechanistic account I am looking to develop across this thesis, Clark, in his 2015 trade book treatment of active inference, integrated Friston's active inference framework with Anderson's neural reuse proposal, arguing that neural reuse was uniquely well resourced to account mechanistically for the neural instantiation of the dynamical nature of Friston's account of an organism's relationship with its developmental past (both phylogenetic and ontogenetic) and its present environment (Clark, 2015).

Dehaene's neuronal recycling model (2005), which he has developed to account for the neural instantiation of culturally novel activities such as reading, also supports community perception as conceived by O'Brien and Wilson in their 2011 study; that is as a simple combination of established adaptations for environment perception

and personality perception. In Dehaene's view, the neural tissue that is recruited to the novel task must have particular properties that it inherits from its evolutionary history, and as a result, he predicts that recycling will be restricted to the sense modality, and the established cognitive domain, that the original neural tissue evolved to function within.

Gallese was also an early proponent of this way of conceiving of the fundamental organisation of the brain (2014). The MM can itself be understood as an instance of reuse, in the sense that the action system is taken "off-line" to simulate the actions of another, or the imagined actions that resulted in some perceivable trace in the environment, in order to read, among other things, the agent's mental state, and in the process gain an understanding of their intentions. It was outlined above how the MM may account for aspects of community perception through ES.

It is beyond the scope of the present General Introduction to critically assess in detail the relative merits of the respective models of reuse proposed by Anderson, Dehaene, and Gallese. Suffice it to say that it is a very active area of research among leading neuroscientists, and the focus of much critical attention in the behavioural sciences more generally (Anderson, 2010, 2014, 2015). For the purposes of the present thesis, it is sufficient to observe that O'Brien and Wilson's (2011) claim that community perception may be an instance of the functional reuse of pre-existing neural correlates of established psychological mechanisms, is a reasonable one from a neuroscientific perspective, supported by both theoretical and empirical work (Anderson, 2010, 2014, 2015; Dehaene, 2005; Gallese, 2014).

Now we have completed our review of the relevant neuroscientific literature towards identifying the neural correlates and mechanisms that account for the environmental

and context-specificity of the behaviours identified in Section 1.2, we move to Section 1.4, The Body, to explore the embodiment of both these neural, environmental and behavioural mechanisms, focusing on the phenotypes of emotional and physiological regulation, and their determinants.

1.4. The Body: The Embodiment of the Social and Built Environment

1.4.1. Constructing Emotions (and Concepts)

According to Louise Feldman Barrett's *theory of constructed emotion* (TCE; Barrett, 2017a, 2017b), an organism's brain functions primarily to regulate all the physiological resources needed to meet immediate demands for action and learning in the short-term, and growth, survival, and reproduction, in the long-term. Emotions play a critical role in this process by guiding the organism's behaviour, as they motivate the actions necessary to both acquire the necessary resources to thrive now, and in the future, and to protect against threats and dangers.

The TCE emphasises the importance of conceptualization and affective sensations in the production of emotion, contending that, contrary to the classical view (e.g., Ekman, 1972), there are no basic emotions per se (e.g., fear, surprise, anger, etc.,), but that a given instance of any emotional state is created toward a situated purpose via the combination of these more fundamental cognitive processes (Barrett, 2017a, 2017b). Regarding the first of these two fundamental cognitive processes, Barrett's TCE builds on Barsalou's grounded theory of the human conceptual system (aka the theory of concepts; Wilson-Mendenhall et al., 2011).

For Barsalou, a concept aggregates information about category instances in memory into an integrated, and embodied, representation (Wilson-Mendenhall et al., 2011). Concepts are not static, however, as they are constructed dynamically and flexibly, as goals and context change. Over multiple studies, Barsalou has demonstrated that participant's concepts of both natural categories (e.g., bird), and abstract categories (e.g., "Things To Take From One's Home During A Fire") change as the goal and framing context changes (Barsalou & Sewell, 1984; as cited in Barratt, 2017a).

The way that Barsalou interprets these results is that when participants answered questions in different situations, they sampled different knowledge to construct the optimal instance of the concept for that particular situation. Most concepts can serve multiple purposes, and when constructing the "best" instance of a concept, the features sampled depend on the situational purpose (Wilson-Mendenhall et al., 2011). Barrett, Barsalou, and colleagues worked together to develop TCE, as currently specified, out of this earlier work (Barrett et al., 2015 and Wilson-Mendenhall et al., 2011).

Within the TCE framework, affective sensation is characterised as anything that is experienced as having the qualities of pleasantness or unpleasantness (valence) and high or low arousal (Barrett 2017a). Barrett thinks that the embodied process of affective sensation is a biologically basic mechanism, and that emotion science has hitherto mistakenly presumed that different combinations of valence and arousal, were in fact the neural, physiological, and behavioural signatures of discrete, basic, emotions; i.e., negative valence and low arousal being the "fingerprint" of sadness.

Thus, it is the integration of these two processes that "construct" a given, situated and embodied, instance of an emotion (Barrett 2017 a; Barrett 2017 b). In a recent

study Satpute and Lindquist (2019) proposed that it is the default mode network (DMN) which holds representational content for these discrete instances of emotional states.

Whilst it is sometimes contested whether trust is an emotional state or an attitudinal one (Jones, 1996), under Barrett's characterisation of the cognitive mechanism, these distinctions lose their significance; what matters is the consequences that the state has on the bioenergetic budgeting and subsequent behaviour of the agent and their decision-making regarding interactions with others. From an active inference perspective, trust, social or personal, reduces uncertainty about future states of the world – if an agent is considered trustworthy, it is a "relatively sure bet" that as an interactant they will behave co-operatively (Schoeller et al., 2021), a view that resonates with Nettle who characterises trust as a psychological variable that regulates expectations in social interactions (Nettle, 2015).

Being able to readily identify trustworthy individuals is an adaptive social skill (Tooby & Cosmides, 1996). Community perception was conceived as an extension of this adaptation, one that uses cues in the built environment as reputational information in decision-making situations, assessing, for instance, the effort expended in residential maintenance, to create a generative model of the social environment; consistent with the assumption that the visual diet of the urban environment reflects the behaviour of residents (Branas et al., 2018; Keizer et al., 2008; MacDonald et al., 2018). I think Barrett's TCE constitutes the cognitive level of description of the psychological process trust plays in the construct of community perception.

Given our foregoing review of active inference, it is clear that Barratt's TCE, and Barsalou's theory of concepts, are corollaries of Friston's more fundamental

framework (Demekas et al., 2020); Barrett (2017b) has recently made this relationship explicit.

1.4.2. Social Baseline Theory

Social Baseline Theory (SBT) is a construct proposed by James Coan and colleagues, and is also an evolutionarily informed approach based on the observation that humans are an ultra-social species (Beckes & Coan, 2011; Tomasello & Wyman, 2009; Wilson & Coan, 2021). Truisms like “a trouble shared is a trouble halved”, turn out to be an accurate account, at least to a first approximation, of how we recruit the bioenergetic resources of others to meet the challenges we ourselves face in our daily lives (Coan & Sbarra, 2014). Through the foundational fMRI studies that underpin this work, Coan and colleagues have demonstrated that being alone, the default assumption at the core of most scientific research in humans, is not the baseline condition for our species after all; being in social relation with others, is; and thus the nomenclature the construct (Beckes & Coan, 2011; Beckes et al., 2013; Coan & Sbarra, 2014; Zhang et al., 2013). Importantly, the quality of the relationship with this other matters, and Coan and colleagues have established that the more significant the other agent is to the focal individual, measured by the nature and quality of the relationship (operationalised neuroscientifically by a measure of self-other correlation in neural activations in response to threat stimuli; Beckes et al., 2013), the greater the expected bioenergetic resources afforded by their presence, the more able the focal individual is to regulate their emotional, physiological, and metabolic responses to experimental stressors (Beckes et al., 2013; Coan et al., 2013; Coan & Sbarra, 2014; Zhang et al., 2013).

Coan and colleagues, like Barrett (2017 a; 2017 b), maintain that emotions function to regulate our behaviour:

> So, emotion plays a vital role in alerting us to important features of the environment, mobilizing resources to deal with challenges, signalling the potential costs and benefits of any action or situation, and informing the budgeting of an individual's resources. The ability to choose behaviours and situations that have good cost/benefit ratios is critical in managing biological resources effectively. Emotion efficiently provides information about the number of problems we need to solve, what resources we need to deploy to solve them, and at what level of effort. Social context, in turn, exerts a powerful influence on our emotional responses. In this way, too, the social regulation of emotion economizes our interactions with the world. (Beckes & Coan, 2011, p. 984)

Recently, Saxbe, Coan, and colleagues have proposed a theoretical extension to SBT, social allostasis, in which dyads and groups function as regulatory systems in their own right (Saxbe et al., 2020). Further, they posit the construct of social allostatic load as a measure of the collective wear and tear of the pooled bioenergetic resources available among the respective members, with the concomitant reduction in stress system flexibility manifesting itself at both the individual-level and through relationship dysfunction.

From its inception, social baseline theory was conceived from within an economy of action (Proffitt, 2006) and Bayesian brain (Friston, 2010) framework. Coan and Beckes contend that "the brain uses the principles of Bayesian inference to generate moment-to-moment estimates of the potential cost savings associated with the distribution of risk and load sharing across social networks" (2011, p. 981). This is a Bayes optimal approach (Mirza et al., 2016). Thus, unsurprisingly, SBT is easily integrated into the active inference framework, too.

1.4.3. From the Built Environment to Stress via Mediated Social Relationships: The Place of Social Trust

Generalised Unsafety Theory of Stress (GUTS) is a recent development in the field of stress research, guided by evolutionarily informed theorising, that proposes a novel pathway from place to health, via chronic stress exposure (Brosschot et al., 2016, 2017, 2018). GUTS is predicated on the insight that the "stress response is a default response that is always ‘on’ but inhibited by the prefrontal cortex when safety is perceived" (Brosschot et al., 2018, p. 1).

According to Brosschot and colleagues (2018), hitherto, much of the stress literature has focused on acute exposure to stressors, usually characterised as potential threats to healthy functioning, and the resulting physiological consequences (Ursin, 1978; Selye, 1976), but has had little to say about the mechanisms of prolonged stress exposure, its determinants, and the body’s physiological response.

Brosschot and colleagues (2017, 2018) assert that acute threat stressors typically cause stress reactions that are too transient to pose a harm to physical health when they occur. They argue that for a stressor to cause disease, the stress response to it must be prolonged. A protracted physiological response will eventually result in a pathogenic condition of bodily "wear and tear," also known as allostatic load, which will eventually lead to disease (McEwen, 1998; Juster et al., 2010; Prior, Manley & Jones, 2018). They argue that the fundamental challenge for stress science is to explain how protracted physiological stress-related activity occurs. They propose GUTS as a framework that addresses this challenge.

O’Brien and Wilson’s community perception (2011), and much of the neighbourhood effects literature (e.g., Ross & Mirowsky, 2001; Sampson et al., 1997), when

considering the consequences of disorder in the built environment, assume, following the logic of the standard stress literature criticised by Brosschot and colleagues (2018), that it is as a threat that these cues are either unconsciously or consciously perceived by residents and visitors alike. Brosschot and colleagues's reframing of the stress mechanism, from a situation where the presence of a threat/stressor triggers an acute physiological response (which somehow leads to chronic physiological dysregulation), to one where the chronic absence of unambiguous cues of safety triggers an ongoing physiological response, also reframes these cues informational value: Does disorder signal the absence of unambiguous cues of safety?

Encouragingly, given this thesis's contention regarding the pathway the built environment might constitute in human health, in the paper in which they introduced the GUTS construct and mapped out their project's framework, Brosschot et al. (2018) identify the urban environment as "a territory of unknown others", and one of the domains in the category of a *compromised physical environment* (2018), which they propose functions as a cue of potential "unsafety" to a ultra-social species like ourselves.

Brosschot and colleagues (2018) speculate that, as the urban built environment is frequently the property of unknown others, meeting strangers and entering the territory of unknown others is both inevitable and likely to partially disinhibit the default stress response (a state of unsafety). Whilst not explicitly acknowledging that we are an ultra-social species, they do recognise that co-operation with, and consequently the necessity for social trust in, strangers is one of the foundations of our species' evolutionary success. Thus, in the absence of prior experience with a

stranger, Brosschot and colleagues observe that humans in urban environments must rely on positive cues, such as the maintenance state of the built environment, to generate social trust and thus perceive social safety. Importantly, when an environment offers negative, limited, or ambiguous information about unknown residents, as is the situation in disorderly urban environment, this social trust, and thus a sense of social safety, cannot be generated, which, they speculate, may result in a partially maintained default stress response (a generalised state of unsafety), and hence a chronic stress exposure.

Given the foregoing review of ES (Section 1.3.1), and this thesis's contention that mediated social encounters are latent in the built environment through the crystallised consequences of absent agents' goal-directed behaviour therein, I think this emerging approach to the activation of the chronic stress pathway, simply through the perception of the absence of cues of trustworthy others, and thus social safety, has much potential utility towards my aim of specifying a proximate pathway from the built environment to health. Furthermore, Brosschot and colleagues cite Coan and colleagues' SBT, to both ground their argument regarding the urban built environment functioning as "the territory of the unknown other" and their work on a domain they characterise as the *compromised social context* (Brosschot et al., 2018); an acknowledgement that I consider a recognition that these aspects, at least, of their reconceptualising of the determinants of chronic stress, are a corollary of SBT.

This review of Brosschot and colleagues' GUTS framework concludes our examination of the relevant literatures on the environment and behaviour (Section 1.2), the brain (Section 1.3), and the body (Section 1.4). The next section,

Consilience (Section 1.5), will present several existing efforts from various academic fields to integrate these three preceding literatures, with the aim of contextualizing the theoretical framework and empirical programme of this thesis (Section 1.6).

1.5. Consilience

1.5.1. Constructing and Excavating Consilience

The architectural historian and theorist Harry Francis Mallgrave (2013) has spent the last decade attempting to synthesise the respective literatures of evolutionary psychology and social neuroscience with his own field, and in particular his interest in German architectural aesthetics. For Mallgrave, there are clear resonances between contemporary research in these disciplines and the work of nineteenth and early twentieth century German aesthetician and architects, especially Heinrich Wöllflin, (1994). Recently, Mallgrave has begun to work directly with Gallese toward articulating the implication ES has for the practice of architecture in particular, and urban living in general (Pallasmaa et al., 2015). Mallgrave's specific focus is on the visual and material consequences of traditional construction processes, e.g., chiselled stone, carved wood, and the manipulation and movement of large masonry elements. He speculates that ES provides an account of how we experience and thus come to understand a place, and its creators and custodians, through our encounters with these elements of the built environment (Mallgrave, 2013, 2015a; 2015b).

And Mallgrave is not alone. An ever-growing number of scholars in the humanities, encouraged by the consilience programme initially proposed by E.O. Wilson (1998),

and sustained by Edward Slingerland and Mark Collard (2011), are critically assessing the implications evolutionary theorising and social neuroscience have for their respective fields. For instance, the archaeologist Lambros Malafouris (who has collaborated with, among others, Chris Frith; Renfrew et al., 2008) has advanced a radical approach to his field in light of such insights (Malafouris, 2015).

Malafouris (2015) proposal, Material Engagement Theory (MET), is his attempt to synthesise the work of neuroscientists like Anderson (2015), Dehaene (2005), and Gallese (2014), niche construction theory (Laland et al., 2016; Odling-Smee et al., 1996), and the gene-culture co-evolutionary perspective of Boyd and Richerson (1996). For Malafouris, echoing Anderson's TALoNS account of neural reuse, MET results in what he has termed *metaplasticity*; where the neural plasticity of the brain is embedded and enfolded in the inherently plastic culture of "things" to such an extent that our cognitive system is extended into the (constructed) environment over three different timescales; evolutionary, developmental, and situational.

> I propose that the phenomenon of material engagement brings within our reach and our conscious awareness the possible range of different time scales of activity available to us. Specifically, the engagement of mind with the material world provides temporal anchoring and binding that helps us to move and think across the scales of time. When humans engage the material world they establish a bridge with the larger-scale processes at work beyond their awareness or control which are embodied in the objects at hand. With things the past becomes present. Thus, the temporal structure they embody influences and partially constitutes the temporal experience of our shared present. Through their physical persistence and durable properties, things 'give to human awareness a sense of time extending beyond individual lives and perceptions' (Bailey, 2007, p. 198). The latter process must be very important for understanding how humans coordinate their actions and intentions in the shared present. (Malafouris, 2015, p. 365)

Whilst Mallgrave's and Malafouris's theoretical speculations presently lack empirical support, and thus do not provide any further foundations for my own thesis, they do demonstrate the broader zeitgeist for scholarship towards understanding the role the material environment plays, both presently and deep in our phylogenetic history, in human social development.

1.5.2. Biomimetic Architecture

And finally, for both this brief review of relevant consilience projects, and this General Introduction's literature review as a whole, we turn to a recent interdisciplinary attempt to examine the human urban environment as an explicitly biosocial phenomenon.

In their 2018 themed issue of the *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, titled *Interdisciplinary approaches for uncovering the impacts of architecture on collective behaviour,* the behavioural ecologist Noa Pinter-Wollman, architect Alan Penn, and colleagues declared that:

> an interdisciplinary exchange between behavioural ecologists, evolutionary biologists, cognitive scientists, social scientists, architects and engineers can facilitate a productive exchange of ideas, methods and theory that could lead us to uncover unifying principles and novel research approaches and questions in studies of animal and human collective behaviour. (Pinter-Wollman et al., 2018, p. 1)

In the paper Penn co-authored for the volume with J. Scott Turner, a social physiologist, they introduced the constructs of stigmergy and niche construction as candidate unifying principles (Penn & Turner, 2018).

Stigmergy, first proposed by Grassé (1959) for use in entomology, is defined as an indirect, mediated mechanism of action coordination where a trace of an action left in the environment prompts the performance of a subsequent action (Heylighen, 2016). It was first coined to describe the nest reconstruction and maintenance behaviour Grassé observed in termites of the genus *Bellicositermes* (Theraulaz & Bonabeau, 1999). Its cognate construct of sematectonics, also originating in entomology by E.O. Wilson (1975), extends the stigmergic construct to include any behaviour or physiological change in an organism evoked by evidence of work performed by other organisms in the environment, whether they are conspecifics or heterospecifics.

Penn and Turner's other candidate, niche construction, describes the process by which an organism alters its own, or another species', evolutionary niche (Laland et al., 2016; Odling-Smee et al., 1996). These alterations can take the form of a physical change to the organism's environment, like the building of nests, burrows, or a dam; an alteration to the chemical conditions of the environment, like when seabird guano transforms island shrub into productive grassland (Croll et al., 2005); or when an organism simply moves from one environment to another to experience a different habitat. When such modifications alter natural selection pressures on organisms, evolution by niche construction is a possible outcome (Laland et al., 2016).

Penn's collaboration with Turner resulted from the latter's earlier work on various animal systems and their constructed environments, work typified by his book *The Extended Organism* (2000). According to Turner, organisms have two different types of physiology: "the commonly defined 'internal physiology,' controlled by structures and devices inside the integumentary boundary of the organism, and an 'external

physiology,' which comes from adaptive change of the environment" (2000, p. 7). For Turner, the nests, burrows, and other structures made by organisms serve many purposes beyond simply providing a place to dwell; they function as extra physiological extensions that organisms develop to serve, for example, as auxiliary kidneys in the case of the earthworm, and lungs in the case of the termite (Turner, 2000). Further, Turner contends that the science of physiology is principally the study of how organisms employ energy to carry out order-creating work. Thus, Turner reasons that an organism's activity is as much physiological when they expend bioenergetic resources to work on establishing order in the external physiology of their constructed environments, maintaining their structural and therefore functional integrity, as when they work on the internal physiology of their own bodies (Laland, 2001; Turner, 2000).

Penn and Turner applied this reasoning to the human-built environment (2018). They did so by vertically integrating Turner's insights regarding physiology and animal-built structures with the frameworks of niche construction and stigmergy, and embodied and extended cognition, as advocated by researchers like Andy Clark (1997; 1998).

The proponents of embodied cognition contend that an organism's bodily and physiological processes effect cognition in such a way that motor, sensory, and perceptual systems determine the generation of concepts and categories (including emotions), and consequently decision-making (Clark, 1997; Barrett, 2017a; Barsalou, 2008). The construct of extended cognition has similar theoretical tenets as embodied cognition, and emphasises how organisms use their immediate environment to support and offload cognitive activity (Clark, 1997; Clark and Chalmers, 1998; Menary, 2007; 2008). For instance, when Physarum uses the

chemical cues of their own, or a conspecific's, migratory trails in the environment to decide where, and where not, to forage for nutrition, it is engaging in an instance of extended cognition (Sims & Kiverstein, 2022)

By describing how sensorimotor abilities and physiological states, when extended into the environment, affect cognition and behaviour, Penn and Turner contend that embodied cognition and extended cognition make significant theoretical contributions to our understanding of the interactions between the brain, body, and environment for humans and the other species that construct, to whatever extent, their own ecological niches (Penn & Turner, 2018).

Further, once integrated with stigmergy and niche construction (Penn and Turner contend that embodied and extended cognition offer proximate mechanistic accounts of how these constructs, stigmergy and niche construction, are instantiated across organisms and their environments), they think this synthetic approach may "serve as a starting point for unifying our thinking across disciplines, taxa and spatial scales" regarding organisms, their constructed environments, and the consequences these structures have for collective behaviour (Penn & Turner, 2018, p. 1).

In this context, it is important to emphasize that orderliness goes beyond being a mere synonym for tidiness or our common-sense notions of public realm maintenance. Instead, it represents a fundamental phenomenon involving the alignment, functioning, and conservation of energetic flows between living systems and their immediate environment across various spatial and temporal scales. The established construct of ecosystem services (Abson et al., 2014), and the recent research of Whitham and colleagues (2006) and Steen and colleagues (Steen et al., 2017), which conceptualise communities as assemblages of both biotic and abiotic

aspects within a given niche, frames them as natural entities with their own evolutionary trajectories. This perspective resonates with Turner's (2007) approach and aligns with the methodology adopted in the present thesis in exploring the dynamics of order and disorder.

1.6. Building Better Than We Know: A Theoretical Framework

If the psychological, and corresponding neural (Section 1.3), bodily (Section 1.4), and environmental mechanisms calibrating social behaviour (Section 1.2) are sensitive to both perceptual cues in the built environment signalling local levels of social quality and mediated reputational priors signalling levels of individual trustworthiness, can ambient levels of maintenance, through both conventionally cognitive (i.e., episodic memory when we use the mentalizing system) and embodied, extended, stigmergic, and sematectonic processes, function as a modulating aspect of our social behaviour via the construct of community perception?

As the foregoing review of the work of O'Brien and Wilson (2011), Nettle and colleagues (Hill et al., 2014; Nettle, 2011; Nettle et al., 2011; Nettle et al., 2012; Nettle et al., 2014; Nettle, 2015), Corcoran and colleagues (Corcoran & Marshall, 2016; Corcoran et al., 2017; Corcoran et al., 2018; Corcoran et al., 2019), Keizer and colleagues (Keizer et al., 2008, 2013), and Branas and colleagues (Branas et al., 2011; Branas et al., 2018; Kondo et al., 2015; Kondo et al., 2016; MacDonald et al., 2019; MacDonald et al., 2022) all demonstrated, places not only change minds, but can change behaviour, too. O'Brien and Wilson theorized that, as a ultra-social species, it would be adaptive for humans to be able to use cues latent in the built environment to guide our social behaviour when we encounter unfamiliar social

environments. They showed that the level of disorder in the visual diet can condition naïve participants' social behaviour, a finding they interpreted as an adaptive psychological response to a potentially threatening social context (2011; O'Brien, 2015). People use the evidence of the order-creating (Turner, 2000) effort expended by others in the maintenance of the environment to make judgements about those others (Kruger et al., 2004).

As both Nettle and colleagues (Hill et al., 2014), and Corcoran and colleagues (Corcoran et al., 2017; Corcoran et al., 2018; Corcoran et al., 2019) found, cues informative of the social quality of a given neighbourhood can have near instantaneous effects on both psychological states and perceptual processing. Keizer and colleagues (2008, 2013) demonstrated that manipulating these cues regarding the social quality of a neighbourhood also leads to predictable and graduated real-time changes in social behaviour; both antisocial and prosocial.

Leveraging Keizer and colleague's insights, Branas and colleagues (e.g., Branas et al., 2018) have designed interventions, involving the rudimentary maintenance of vacant lots and abandoned buildings, that have had significant effects across a range of important individual-level and community-level outcomes, including reductions in both serious and nuisance crime, and improvements in health and wellbeing. As such, not only do people use these cues as evidence to judge, but this translates into social behaviour such as levels of prosocialty at the individual-level, and collective efficacy at the neighbourhood-level (Sampson et al., 1997).

For a neuroscientific account of these findings, we first turned to Gallese and colleagues' (Freedberg & Gallese, 2007; Gallese, 2015; Gallese & Gattara 2015) construct of ES to provide a plausible mechanism regarding the neural, bodily, and

environmental instantiation of the process by which places change embodied minds and behaviour. We then looked to the Friths' (2006) work on mentalizing, our ability to infer the mental states of others, which foregrounded the importance of contextual factors in our ability of predict the likely behaviour of another.

Once we integrated these two approaches into Friston's (2017) active inference framework, following Clark (2015), as aspects of the same generative model learning process, with different levels of prediction error to resolve, we turned to Singer and colleagues (2006), Fouragnan and colleagues (2013), and Delgado and colleagues (2005), who have demonstrated how knowledge about the reputation of a particular agent influences subsequent interactions with them; even taking precedence in decision-making when one is faced with personal experience to the contrary.

Then, in this thesis's review of various theories of reuse, while I acknowledged that Anderson's (2010, 2014) neural reuse account of brain functioning accommodates community perception as conceived by O'Brien and Wilson (2011), that is, as simply the reuse of personality perception and environmental perception, I emphasized, again following Clark (2015), that neural reuse is also theoretically equipped to account for Friston's active inference framework, too. Thus, we can now see how the process of community perception is grounded neuroscientifically.

Next, in our project to find a way of vertically integrating the proximate mechanism still further, we found Lisa Feldman Barrett (2017a), Coan and colleagues (2011), Broschott and colleagues (2018), all provided theoretical frameworks and empirical evidence that were both consistent with active inference, and the picture of community perception this thesis is building, also.

Barrett (2017a, 2017b) furnished us with the theory of constructed emotion, where the integration of affective sensation and concept formation, updated “on the fly” as situational circumstances change, plays a crucial role in the process by determining our behaviour, as they motivate our actions, social and otherwise, dependent on the predicted bioenergetic consequences.

Coan and colleagues (2011) demonstrated that we are at baseline a social species, and thus, as an ultra-social agent, irrespective of the task we might be engaged in, an ongoing appraisal of the in-situ social environment will condition our decision-making and behaviour; with consequence for our ongoing bioenergetic budgeting. Being alone, the current baseline assumption of most scientific enquiry about human functioning, is already perceived by a human as being in potential deficit – with consequences at all levels of our perceptual, cognitive, and behavioural functioning (Gross & Medina-DeVilliers, 2020).

Brosschot and colleagues’ contention, that it is the absence of cues of safety, and not the presence of cues of threat, that typically account for chronic stress exposures in contemporary life, provides the necessary pathway from disorder in the built environment, via cues like ambient maintenance level, to physical health (Brosschot et al., 2018). We use our generative model, which includes the ES of the effort expended in the goal-directed, order-creating, maintenance of the built environment, or in its absence, the effort required to return the built environment to orderliness, to construct our own emotional state (via bioenergetic budgeting) and our emotional attitudes towards the predictability of the social behaviour of the people we might encounter (social trust). In the absence of signs indicating the presence of

dependable conspecifics, and as a functionally socially obligate agent, we sense a shortage of possible social resources and, hence, an unsafe social environment.

To finish the review, I briefly turned to those researchers engaged in projects of consilience, examining the transdisciplinary efforts that resonated with my own thesis project. Among these the archaeologists Malaforis (2015) reminded us of how ancient our species entanglement with material culture is. And, with his MET, pointed out how our environment adapting behaviour constitutes, at least by definition, the circumstance that might lead to selection by niche construction. A speculation that was repeated by Penn and Turner (2018), who also introduced the mechanism of stigmergy to account for the potential the constructed environment affords for coordinating collective behaviour, and built on Turner's (2000) previous work that reconceptualised an organism's physiology to account for order-creating energy expended on the adaptive structures they construct, individually and collectively, in their environment.

It is my contention, following Penn and Turner (2018) (but more specifically Turner, given his substantial contribution in this field; Turner, 2000; Odling-Smee & Turner, 2011; Turner, 2016) that both the initial construction and subsequent maintenance, by way of the energy expended in working towards preserving the functional orderliness in the adaptive structures once completed, of the human-built environment function as stigmergic and sematectonic processes for coordinating social behaviour. However, I think that this is by no means the only process in play.

The foregoing subsections of the literature review that introduced and explored a mechanistic neuroscientific account of the community perception construct, constitute the foundations of this thesis's theoretical framework as they specify both

the neural correlates and mechanisms of a process that I think, following Penn and Turner (2018), Clark (1997; 1998), Clark and Chalmers (1998), and others (see Anderson et al., 2012, for instance), extends across brains, bodies (our own and others), and into the environment through Anderson's (2014) proposed mechanism of TALoNS and Friston's active inference framework.

This extended instantiation of a cognitive process can recruit resources from across any one of these domains "on the fly" to realize its ends – which from an active inference perspective is the job achieving Bayes optimal behaviour through generating *desired states* (Friston et al., 2013). This is what is meant by the extended cognition assertion that cognitive processes can be supported or offloaded entirely, by some aspect of the environment (Clark, 1997, 1998; Sims & Kiverstein, 2022).

Further, Turner's extension of an organism's physiology to include the bioenergetic consequences of order-creating action in the constructed external environment, in my view, provides a model to extend SBT beyond the conspecifics within the focal individual's social environment, to the structures conspecifics inhabit and, crucially, expend energetic resources maintaining. I think it does this by theoretically enveloping into the focal agent's bioenergetic budgeting the consequences (via the "external physiological" mechanism), positive and negative, of not just their immediate social environment and the resources it affords (the established domain of SBT), but the mediated consequences of the agents in their social environment's order-creating actions in the built environment.

This proposed areal extension of SBT resonates with both Coan and colleagues' (Saxbe et al., 2020) recent social allostasis expansion of the construct, and Coan

and Wilson's recent proposal to identify groups – including communities – as viable units of functional organization from an evolutionary perspective (Wilson & Coan, 2021). I also consider it cognate to the work that Corcoran and colleagues have been doing toward specifying the construct of community wellbeing (Atkinson et al., 2017; Atkinson et al., 2020); a claim that I will return to in the final section of the General Discussion.

Thus, following O'Brien and Wilson's proposal of community perception, this thesis hypothesizes that in a ultra-social species with a material culture, where co-operation between kin and non-kin, and the requisite psychological adaptations for person perception, has already been established (Axelrod & Hamilton, 1981; Price, 2011; Tomasello & Wyman, 2009; Trivers, 1971), additional (or established) psychological adaptations might evolve to assess material artefacts as an index of socially germane behaviour of its maker(s) (and where appropriate custodian[s]).

As a consequence, organisms should be motivated to both display, and assess, the consequences of their own and others' mediated behaviour (through, for example, the static consequences manifest in the resulting material culture) to the extent that they signal salient information about their own and others' trustworthiness, and cooperative and coalitional qualities (leading to positive assortation and the fitness benefits thus accrued [Price, 2011]). Further, where aspects of this material culture are available for permanent group-wide public assessment, the inferential potential of the material to reveal information about such social qualities should be of particular importance. Following SBT, our *desired state*, from an active inference perspective, is to associate with reliable conspecifics; in whom we trust, and whom we consider as having our interests in mind, if not at heart.

Furthermore, groups with longstanding cumulative material culture (for instance, a given neighbourhood's built environment) afford present community members, and visitors, with additional opportunities to assess not only present levels of social quality in the extant spatial community (the conspecifics one might consider as the custodians), but the longstanding temporal continuity of the community (the original makers, and preceding custodians), and make social decisions with graduated levels of confidence about local, longstanding, norms of behaviour.

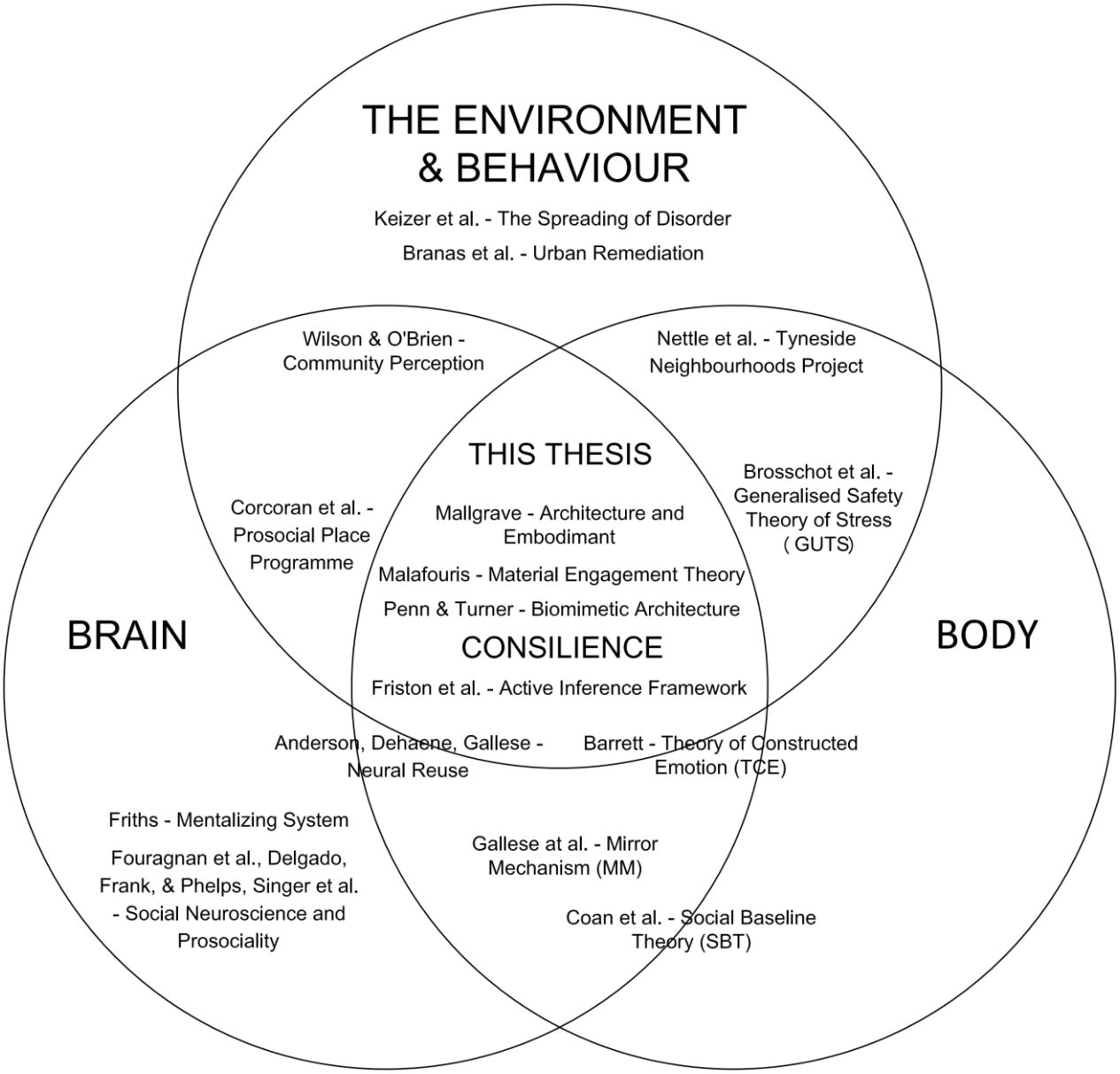
Hence, I think a neighbourhood with evidence that residential maintenance goes undone cues a cascade of different embodied and extended cognitive, as well as stigmergic and sematectonic, processes. For instance, in what is initially a stigmergic aspect of the process, humans are attentive to both the cues of energy expended in the construction and maintenance of the built environment as we encounter it (Keizer et al., 2013; Kruger et al., 2004; MacDonald et al., 2019; Montgomery & O'Brien, 2014; O'Brien & Montgomery, 2015; O'Brien & Wilson, 2011), and make an appraisal of the energetic expenditure required to perform any order-creating maintenance we perceive to be necessary (Turner, 2000). The resulting bioenergetic budgeting, realised through the process of ES (via embodied cognition), generates a "pending" expenditure which calibrates our emotional state and thus attitude towards a place and its people, through the process of constructed emotion (Barrett, 2017a), along a continuum of being disposed to interact, to not being disposed to interact. An integration of affective sensation and conceptualisation that will be experienced as the construct of social trust.

This pending burden, calculated through ES, of the bioenergetic expenditure required to complete the order-creating work in the disorderly neighbourhood also

conditions our perception of the ambient levels of safety (Brosschot et al., 2018); given that safety for an ultra-social species is to a great extent a function of the proximity of predictable, co-operative, conspecifics. It is this cue that I think is responsible, following Brosschot and colleagues, for chronic stress exposures that lead to negative long-term consequences for physical health.

All of this will be modulated by the extent to which the focal agent finds the built environment legible, via the generative model they have of it (Linson et al., 2018) including, for instance, the extent to which they have the requisite skills and knowledge to undertake the remediation work necessary to re-establish order (from picking up litter, to tending the unkempt garden, through to re-establishing a dilapidated wall). See Figure 1.2 for a mapping of this theoretical framework.

Figure 1.2 *A Theoretical Mapping of This Thesis's Integration of the Literatures Reviewed in the General Introduction*



1.6.1. Research Aims

Thus, this thesis project aims to formulate and empirically test, through experimental and observational studies, a plausible process theory to account for how the built environment, as an index of the social environment, “gets under the skin” and affects social behaviour, emotional and attitudinal states, and physical health.

The focus is on better understanding how aspects of the social environment are crystallised in the built environment, and in particular the proximate environmental, perceptual and biological mechanisms that account for how our interaction with the built environment modulates our social behaviour, emotional and attitudinal states, and physical health.

Levels of personal and social trust are the key factors that affect rates of prosocial behaviour (Nettle, 2015). In communities with low levels of trust, and correspondingly low levels of prosocial behaviour, multiple sources of chronic stress can result (Brosschot et al., 2018), which in turn lead to well established biological changes to the body’s immune system (McEwen, 1998; Prior, Manley & Jones, 2018). This typically results in negative health consequences across the life course (Pearlin et al., 2005).

Thus, a better understanding of the contribution the built environment has on social trust, that is an understanding of the proximate mechanisms that account for how the built environment “get under the skin”, will help illuminate one pathway through which the social environment and physical health are linked.

1.6.2. Situating the Project

Community perception is a psychological account of how people calibrate, and update, their social behaviour through assessing the physical consequences of conspecifics' behaviour in the environment. The biological foundations and consequences of this process, from the moment-to-moment changes in saccadic scan paths as we negotiate the urban built environment (Chapter 2), through in-situ and mediated changes in our attitudinal states towards the unknown others we encounter there (Chapter 3), to the long-term health consequences of chronic exposures to a stress-inducing disorderly built environments (Chapter 4), are the subject of this thesis.

1.6.3. Research Questions

In their recent review of the literature on fertility behaviour in industrialised populations, Stulp et al. (2016) foreground the value of conducting both primary (including experimental) and secondary (observational) work on a given topic in an effort to create research that benefits from a triangulation of methods. Advice I have taken in the design of this thesis project.

As both O'Brien and Nettle have observed, no biomarker data have been collected regarding which cues in the visual diet are attended to in an instance of community perception – despite this being "eminently amenable to experimental investigation using approaches such as eye-tracking" (Nettle, 2015, p. 110; D. O'Brien personal communication, 27 November 2017). Eye tracking has the additional advantage of being a paradigm often employed by researchers active in the field of active inference (although the majority of these studies use *in silico* protocols, e.g., Mirza et al., 2019), as active inference makes clear predictions concerning eye movements,

regarding salience, scan-path, and gaze duration, a process they label *epistemic foraging*, based on Bayes optimal behaviour (Mirza et al., 2016; Mirza et al., 2019).

Thus, Chapter 2 employs this paradigm to examine research question 1: How do we epistemically forage unmaintained (disorderly) vs. maintained (orderly) urban environments, and what effect, if any, does a poorly maintained environment have on our assessment of the trustworthiness of the unknown others who reside there?

Chapter 3 uses the stimuli generated from the study in Chapter 2 and a behavioural economics paradigm to answer research question 2: Are our attitudes towards an unknown other affected by mere exposure to the affective prime of unmaintained vs. maintained environments?

Whilst the ideas for these two experimental studies, and the particulars of their design, arose directly from the foregoing literature review, the idea for the observational study design (Chapter 4) emerged gradually from my growing familiarity with the UK Household Longitudinal Survey (UKHLS, University of Essex et al., 2018) dataset and parallel introduction to the literature on social epidemiology and health geography (e.g., Prior, Manley & Jones, 2018; Prior, Manley & Sabel, 2018; Ribeiro, 2018; and Ribeiro et al., 2022). The UKHLS tracks the lives of thousands of individuals in households over time. It is an internationally renowned study that provides evidence to social scientists and policymakers regarding the causes and effects of pervasive social issues (Benzeval et al., 2014; Fumagalli et al., 2017).

Thus, Chapter 4 will leverage the metadata, collected by the UKHLS interviewers, regarding the maintenance condition of the built environment in the vicinity of a focal household, and answer research question 3: Adjusting for the established individual-

level and household-level factors that affect physical health, is the ambient maintenance level of the immediate vicinity of a domestic dwelling predictive of its residents' physical health status?

1.6.4. Thesis Structure

The three empirical chapters that follow this General Introduction (Chapter 1) were designed as paper contributions and written with publication in mind. The work presented represents the prospective published article with minor alterations to enable consistency with the thesis. Chapter 5, the General Discussion, follows, where I assess the validity, following the empirical tests, of the thesis's proposed framework, the thesis's contribution to the burgeoning field of inquiry, and consider future work towards generating impactful evidence-based public policy proposals.

2. Building Better Than We Know: Maintenance, Eye Movements, and Social Trust

> We shape our buildings; thereafter they shape us.
>
> -Winston Churchill, *House of Commons Rebuilding, 1943*

2.1. Introduction

Throughout history philosophers and politicians have speculated on how the built environment of a city might influence its inhabitants' lives (Churchill, 1943; Lefebvre, 1991; Marx, 1867/1990; More, 1516/2002; Plato, trans. 1987). During the twentieth century, sociologists studied the impact a neighbourhood's physical condition could have on its residents' social behaviour, as well as their mental and physical health (Lefebvre, 1991; Park & Burgess, 1925; Sampson, 2012). It was not until the beginning of the present century that biologically informed social scientists started to systematically approach the subject of the urban environment and its impact on social behaviour and health from a Darwinian perspective (Corcoran et al., 2017; Corcoran et al., 2018; Corcoran et al., 2019; Krueger, et al., 2011; Nettle et al., 2014; Nettle, 2015; O'Brien, 2013; O'Brien & Wilson, 2011; O'Brien et al., 2012; Wilson, 2011). The present study contributes to this growing body of research by reporting the first eye tracking experiment to test O'Brien and Wilson's construct of Community Perception (O'Brien & Wilson, 2011).

As we reviewed in Chapter 1, the most ambitious attempt to study urban living through an evolutionarily informed biosocial lens to date is David Sloan Wilson's

Binghamton Neighbourhood Project (2011). To briefly recap, David Sloan Wilson and Daniel O'Brien coined the term community perception to describe the psychological construct that they proposed to account for a particular socially oriented cognitive process (2011). They speculated that in a group-living ultra-social species that must navigate not only its own but also occasionally unfamiliar social environments, it would be adaptive to be able to quickly infer the types of social encounters that might occur there. In an early test of this proposal O'Brien and Wilson (2011) found that participants were able to generate accurate assessments of the social quality of unfamiliar neighbourhoods using only photographs of the built environment as cues, and modulated their social behaviour in a prisoner's dilemma game accordingly. This result, in the opinion of O'Brien and Wilson, indicated an adaptive social response to a potentially threatening social context.

As we have also learnt in Chapter 1, in a later study, O'Brien et al. (2014) conducted an experiment to assess aspects of the visual diet of the built environment in relation to cultural differences in community perception. In this study they hypothesized that individuals would be sensitive to different cues of disorder, and the effort expended through maintenance to address it, and that these differences would be calibrated to the environment, both social and physical, in which participants were raised. Evidence for *local adaptations*, as O'Brien and colleagues termed these differences, in the assessment of sanitation, vegetation and the pavement were found, and when participants were presented with a photograph from an unfamiliar built environment, consistent with O'Brien and colleagues' predictions, participants would err on the side of caution when it came to making decisions about the social quality of the neighbourhood depicted.

Daniel Nettle's Tyneside Neighbourhoods Project, which we also learnt about in Chapter 1, was inspired by the Wilson's Binghamton Neighbourhood Project. The Tyneside Neighbourhoods Project sought to identify the cognitive processes that calibrate the social behaviour of residents from two distinct neighbourhoods in Newcastle upon Tyne, UK: neighbourhoods, simply designated A and B, at different ends of the socioeconomic spectrum (Nettle, 2015). To briefly recap once again, in the study that Nettle considers to be the most important of the Tyneside Neighbourhoods Project (2015), Nettle et al. (2014) found that even a brief exposure to a neighbourhood's built environment had a significant impact on the visitors' self-reported levels of social trust and paranoia. Significant enough that, and as Nettle and colleagues had predicted, the two traits, following exposure, mirrored the levels recorded among the residents of the respective neighbourhoods.

Community Perception: The Groundwork

O'Brien and Wilson describe their theoretical approach to the Binghamton Neighbourhood Project thus:

> We approach this topic with an evolutionary perspective, which is to say the focus is organised around two central ideas: (a) the environmental conditions that place selection pressures on the trait and its function (ultimate mechanisms) and (b) the specific manner in which the resultant trait operates (proximate mechanisms). (2011, pp. 606 - 607)

What O'Brien and Wilson (2011; Wilson, 2011) and Nettle and colleagues (Hill et al., 2014; Nettle et al., 2011; Nettle et al., 2012; Nettle et al., 2014; Nettle, 2015) have in common is that whilst they propose a candidate psychological mechanism and its environmental determinants, their primary focus is on ultimate level explanations

(Tinbergen, 1963). Neither group has proposed a detailed account of the proximate level cognitive and perceptual processes that account for their respective findings.

Further, and as we also learnt in Chapter 1, both O'Brien and Nettle have observed that no biomarker data have been collected regarding which cues in the visual diet are actually attended to in an instance of community perception – despite this being "eminently amenable to experimental investigation using approaches such as eye tracking" (Nettle, 2015, p. 110).

Thus, the ambition of the present study is to formulate a process theory of how the proximate level cognitive and perceptual processes that underlie the psychological construct of community perception are embedded within the environmental determinants. Once we have our candidate process theory specified, we will use it to formulate our hypotheses and then proceed to retest community perception, using an eye tracking paradigm, to assess what our novel formulation contributes to the construct.

Two Process Theories regarding Proximate Mechanisms

A process theory currently motivating many studies on individual differences in cognitive traits across the evolutionary social sciences, and thus addressing the local adaptation dimension of the community perception construct (O'Brien et al., 2014), is life history theory (Nettle & Frankenhuis, 2019; Nettle & Frankenhuis, 2020). Life history theory focuses on how bioenergetic resources are allocated across an organism's life course between the traits of growth, survival and reproduction. The field incorporates research on size at birth, growth rates, learning, age and size at maturity, reproductive investment (fecundity), and mortality rates and lifespans (Sear, 2020; Stearns, 1989, 2000). Identifying and estimating how features of both

the physical and social environment influence an organism's life history strategy, the local adaptation aspect of community perception, is an essential part of this approach (Partridge, & Harvey, 1988; Sear, 2020; Stearns, 2000).

One of the Tyneside Neighbourhoods Project studies conducted by Nettle and colleagues tested the life history hypothesis that the social diet of the two neighbourhoods, defined by analogy to visual diet as the daily distribution of the types of people one encounters in the street, differed by age profile, and thus provided different information about mortality rates and lifespans in the respective neighbourhoods (Nettle et al., 2012). Nettle et al. speculated that this difference might, in part, account for the variation in life history strategies adopted by young people growing up in the different neighbourhoods.

Other recent studies motivated by the life history approach (e.g., Ellis et al., 2017) have found that developmental exposures to stress, far from leading to blanket cognitive and perceptual deficits, which has been the prevailing presumption for decades (e.g., Bradley & Corwyn, 2002; Conger & Donnellan, 2007; Duncan, et al., 2012; McLoyd, 1998), can actually improve forms of attention, perception, and memory that are ecologically relevant in harsh or unpredictable environments – such as, I speculate, possibly being able to "read" a neighbourhood's social environment, through information crystallised in the built environment, more rapidly.

In the context of community perception, one would expect that a measure of life history strategy would predict both attitudinal states regarding social behaviour with unfamiliar others, with a fast strategy being associated with lower social trust – an adaptive response to an unpredictable social environment; and variation in perceptual processing, as a function of the harshness and unpredictability of the

developmental environment. Thus, we would predict that whilst all participants will be attentive to the effort expended in the upkeep of the built environment as indexed by residential maintenance, as O'Brien et al. (2014) found in their local adaptation study, fast life history strategists would be quicker to attend to these salient areas prior to making decisions regarding the trustworthiness of prospective interactants.

Active inference framework

As we also reviewed in Chapter 1 a theoretical approach gaining currency as a first principles foundation for both perceptual and cognitive research (Smith et al., 2022), which is also consilient with the life history approach outlined above (Pezzulo et al., 2022), is Karl Friston's active inference framework (Friston, 2009, Heins et al., 2020; Mirza et al., 2016; Mirza et al., 2019; Veissière et al., 2020). As we have established, the framework describes a scheme for Bayes optimal behaviour, which means that arising perceptions and actions necessarily depend on the prior beliefs (Mirza et al., 2016).

Further, and again as we learnt in Chapter 1, active inference assumes that through a cascade of top-down predictions about the expected sensory data from the world, an organism generates a generative model about the state of the world. This model is driven by endogenous states. When a bottom-up prediction error occurs, the system is forced into plasticity and a cycle of further top-down hypothesis creation and testing is dynamically engaged, with resources from across the brain, body, and environment recruited until the sensory data is accommodated into a new generative model (Clark, 2015; Friston, 2009, Linson et al., 2018; Mirza et al., 2016; Mirza et al., 2019).

Thus, for instance, in the context of community perception, the sequence of saccades to salient features of the environment (e.g., cues of disordered sanitation), and the duration of dwell time (a proposed proxy of processing depth and the resolution of prediction error) in a given scene are expected, from within the active inference framework, to be optimised in such a way as to reduce the agent's uncertainty through an ongoing process of the minimization of surprise as a consequence of higher level knowledge concerning the distribution, and differential value, of relevant sensory information (Clark, 2015; Heins et al., 2020; Mirza et al. 2019). Given prior experience of environments similar to where one presently finds oneself, and memories of both one's own behaviour and the behaviour of conspecifics therein, one should know where to look to find "the news", and thus to reduce uncertainty about the likely social behaviour of the residents of the neighbourhood. Hence, the active inference framework gives us a potential basis for integrating life history theory and community perception, and by doing so, a candidate process theory for the construct.

With these two theoretical perspectives informing and refining our hypothesis formulation and the methodological specification, we are now in a position to proceed with our study.

The Present Study

H_1 Consistent with previous experimental tests of the community perception construct, a participant will rate residents living on streets with properties in a poor state of repair as meriting lower levels of social trust.

H_2 Whilst a participant's gaze will follow a similar sequence in both conditions (maintained and unmaintained), consistent with the prediction of the active inference

framework, they will be quicker to attend to the cues of disorder in the unmaintained condition and spend significantly more time processing them.

H_3 A participant's response will vary as a function of their life history strategy: those with lower scores on the Mini-K scale, a psychometric measure of life history strategy (Figueredo et al., 2017), will have lower levels of social trust.

H_4 Those participants with lower Mini-K scale scores will be more efficient at visual foraging, that is that they will attend to targets with greater task relevant value more quickly when harvesting visual data.

2.2. Method

Participants

In total 97 participants (74 females and 23 males) residing in the UK completed the study in a laboratory setting. Participants were recruited through the University of Essex's Psychology Department participant pool. Participants received either a payment of 7 GBP or course credit for participation. All participants gave informed written consent, and the study received ethical approval from the University of Essex's ethics committee (DM1902). The age of the participants ranged between 18 and 68, with mean 23.72 years and standard deviation 9.77 years. All participants reported normal or corrected to normal visual acuity.

Materials

Experimental Stimuli and Fillers

To generate the experimental stimuli 10 residential neighbourhoods were identified from the first 10 areas (using the statistical geography of Lower Layer Super Output Areas) which fall within the first decile of the first percentile of the index of 32,844 English neighbourhoods in *The English Indices of Deprivation* (2015). Focal properties were then nominated from within these locations by a built environment professional during virtual site visits, via Google Street View (Google, n.d.), using a single criterion: *please identify all properties in serious need of maintenance.* Multiple studies have found that virtual audits using Google Street View are as accurate as in-person observational field audits in assessing multiple aspects of neighbourhood characteristics, including disorder in the built environment (Bader et al., 2017; Kelly et al., 2013; Mooney et al., 2017; Rundle et al., 2011). The source images used for the 20 experimental stimuli were then captured by the experimenter.

The unmaintained versions of the experimental stimuli were simply the cropped and colour corrected renderings of the aforementioned captured source images. The maintained versions of the stimuli had the salient aspects of physical disorder from the three categories of cues identified by O'Brien and colleagues' (2014) study on local adaptations of community perception - sanitation, vegetation, and the pavement - digitally remediated using Adobe Photoshop (see Figure 2.1 for an example, and the Open Science Framework https://osf.io/p5uh2/ for the complete stimuli set). Additionally, there were 15 filler stimuli which were chosen to match the experimental stimuli's urban characteristics (i.e., the same architectural style, period, and massing).

The number of 20 experimental stimuli was arrived at in light of the work of Orquin and Holmqvist (2018). When using naturalistic stimuli in eye tracking studies, Orquin and Holmqvist calculated that once the threshold of 16 different stimuli is passed, the potential bias the individual image level differences introduce into analysis is significantly attenuated (2018).

Figure 2.1 *Example of Experimental Stimuli in the Two Conditions*

Note. (A) Experimental stimulus as captured, simply cropped to an optimal display size and colour-corrected (the unmaintained condition); (B) Image with the digital remediation process completed (the maintained condition).

Measures

Covariate Measures

The covariates comprised demographic measures for age, sex, ethnicity, and region of birth. I created a measure of the micro-level developmental residential environment; “How would you describe the neighbourhood/area in which you grew up?” (*Urban*; *Suburban*; *Semi-rural*; *Rural*). The motive for the inclusion of the participant’s developmental residential environment was to see if the associations O’Brien et al. (2014) found in their local adaptations study affect to the paradigm I employ in the present study, too.

I also administered the Mini-K scale, a psychometric measure of life history schedule (Figueredo et al., 2014), and the general health questionnaire (GHQ) 12 scale; a screening tool designed to detect current state mental disturbances and disorders (Goldberg and Hillier, 1979). The inclusion of the GHQ 12 was done to allow for exploratory analysis of the data to see if clinically significant levels of minor mental disturbances were affecting eye movements and social trust. Previous eye tracking experiments have shown that depressed people selectively respond to "negative" stimuli for longer periods of time, while fixating on pleasant stimuli less frequently (Corcoran et al., 2019; Eizenman et al, 2003; Kellough et al., 2008).

And, finally, for those who identified as still being members on their parents’ households, I administered three measures of socioeconomic position: number of parents in household, parental education level, and parental household income. For those who identified as living independently of their parents, their own household income and educational level were also measured.

Outcome measures

The outcome measures comprised a biometric measure of attention (eye movements and fixations) and a single item 7-point social trust scale, “The residents of this street can be trusted” (1=*Not at all* to 7= *A great deal*). This social trust scale was adapted from an item from the Project on Human Development in Chicago Neighbourhoods study (Earls et al., 1994).

For biometric analysis, areas of interest (AOI) were designated for those aspects of the built environment that had been digitally manipulated to appear as maintained. Data Viewer 3.1 (SR Research, Canada) was used to create reports. The eye movement characteristics selected for analysis were: First Fixation Time (ms); First Fixation Index; and Total Dwell Time (gaze duration) (ms). Again, following the advice outlined in Orquin and Holmqvist (2018), I restricted the measures to the minimum required to operationalise the constructs of theoretical interest.

Procedure

On arrival in the laboratory participants read and completed consent forms and were asked to confirm that they had normal or corrected to normal vision. Then participants completed the survey containing the covariate measures on a desktop computer (administered online through Qualtrics; see Open Science Framework Chapter 2 Covariate Measures Qualtrics https://osf.io/p5uh2/).

Participants were then seated, with a chin-rest ensuring that their eyes were [approximately] 60 cm from the screen on which the stimuli were displayed. A 9-point calibration and validation was then completed to ensure that all recordings had a mean spatial error of better than 0.5°. Stimuli were presented on a 19-inch colour

monitor. At this distance, the image frame subtended approximately 38° × 30° of visual angle. The experiments took place in a dimly illuminated, sound-attenuated room. Stimulus generation, presentation and data collection were controlled by Experiment Builder software (SR Research, Canada) and run on a desktop computer (control PC). Monocular eye position was recorded using a desktop mounted Eyelink 1000 eye tracker (SR Research, Canada) sampling eye positions at 1000Hz. Saccades and fixations were defined according to Eyelink's acceleration and velocity thresholds.

At the start of the testing period, participants were given the instruction (via an on-screen text message): "You are to imagine yourself walking along a street where you would expect to encounter the houses depicted in the following images". Following every trial, they responded to the single item 7-point social trust scale. To record their social trust ratings of the stimuli, an IBM numeric keypad was connected via USB to the control PC. Each trial began with a fixation cross presented at the centre of a blank screen; the start of the 15 s trial being triggered by the participant's fixation on this point.

Two practise trials, constituting a practise block, with an option for the participant to ask the experimenter for clarifications regarding the procedure, preceded the two experimental blocks.

The experimental stimuli were presented in unmaintained and maintained conditions to each participant for 15 s each; counterbalanced over two experimental blocks and assigned in a random order to each participant. Each experimental block of 30 trials comprised 10 unmaintained stimuli, 10 maintained stimuli, and 10 filler stimuli.

Of the filler stimuli, 10 only appeared once over the course of the two experimental blocks, with the remaining five being repeated (unmodified) across both blocks (to echo the presentation of the experimental stimuli). Thus, each data collection session comprised of 60 trials, divided into two 30 trial experimental blocks, presenting a stimulus and the social trust scale.

The inclusion of the filler trials was to mitigate the potential of participants discerning the nature of the manipulation, and to serve as controls during the analysis stage (see Results). A scripted debrief conducted by the experimenter followed each session (see Appendix B), allowing for the identification of any participants who had discerned the manipulation, and if so, to what extent.

Further, to be able to analyse whether some factor regarding the sequence of the presentation of the stimuli was affecting participant's eye movements or social trust ratings, 49 of the participants were run with experimental stimuli 1 – 10 in the unmaintained condition in the first experimental block, and 48 were run with experimental stimuli 11 – 20 in the unmaintained condition in the first experimental block. Participants were randomly assigned to one of these two conditions. This design allowed me to first assess, and if necessary, mitigate, potential bias introduced by sequence effects during data collection at the analysis stage.

2.3. Results

Analysis Strategy

In terms of experimental design, it should be emphasized that for analytical purposes, following Holmqvist and Andersson (2017), I made the AOI the

experimental item, instead of the stimulus images; thus, maintenance as a category, constituted of distributed AOIs with homogeneous semantics, is the unit of analysis (Holmqvist and Andersson, 2017).

Biomarker Workflow

AOI and interest period (IP) data were first processed, and variable reports generated, using DataViewer 3.1 software (SR Research, Canada). The resulting files then went through further data management and cleaning using Microsoft Excel (2019). All descriptive and inferential statistics were conducted using Stata 14 (2015).

Survey Workflow

Covariate data were recorded online using Qualtrics (n.d.); these were then exported for initial cleaning and management to Microsoft Excel (2019). Subsequently, these data were combined with the eye movement data and social trust scale ratings in Stata 14 (2015). Given the data structure, all analysis was planned to be conducted using an MLM approach.

The socioeconomic position (SEP) variable was derived from summing the scores of the three relevant measures: number of parents in childhood household, childhood household income, and parents' educational level, and assigning each participant to one of three levels (scores 2/3 = *low*, 4 = *medium*, 5/6 = *high*). In the cases where participants had established their own households, the highest levels in the respective measures across the two households was used to calculate the score. Ethnicity, region of birth, and developmental residential environment were rendered in broad categories due to small cell sizes for some groups. Following established

practice (Goldberg & Williams, 1988; James et al., 2013) I used a score of 4 as the cut-off point for the GHQ 12 Caseness variable. Descriptive statistics for the outcomes and covariates appear in Table 2.1.

Table 2.1 *Descriptive Summaries for Outcomes and Covariates*

Social Trust Rating	Mean(SD)	4.04 (1.25)
Dwell Duration	Mean(SD)	1520 ms (1255)*
First Fixation Index	Mean(SD)	7.80 (8.44)*
(N 3880)		
Age	Mean(SD)	23.72(9.72)
Sex	Female**	76.29%
	Male	23.71%
Mini-K Score	Mean(SD)	1.12 (.61)
GHQ12 Caseness	Three and below**	64.95%
	Case (four and above)	35.05%
Single-parent family	Two Parents**	68.04%
	One Parent	31.96%
Dev environment	Urban**	46.39%
	Suburban	35.05%
	Rural	18.56%
Ethnicity	White**	53.61%
	Non-White	46.39%
Region	UK**	69.07%
	EU	12.37%
	Non-EU	18.56%
SEP	High**	44.33%
	Medium	35.05%
	Low	20.62%
(N 97)		

Note. * = Untransformed data; ** = Reference category;
Dev Environment = Developmental Environment; SEP = Socioeconomic Position.

Analysis Checks

A *t*-test was conducted to assess whether there was any bias introduced to the social trust ratings of stimuli by sequence effects; first viewing ratings of the selected fillers (M = 4.39, SD = 1.46) and second viewing ratings (M = 4.22, SD = 1.43). The test was not significant, t (580) = -1.47, p = .143.

Potential Exclusion

Five of the 97 participants discerned the manipulation (as assessed by the experimenter's debrief). No significant differences were found in the distributions of either their social trust ratings or eye movements data, when compared to the rest of the sample. Thus, we retained their data for our main analysis (for comparison, see Appendix C for all of the inferential analyses that follow in this Results section computed after the participants who discerned the manipulation were excluded). All participants met satisfactory parameters for the calibration and validation of the eye tracker, so no participants were excluded on these grounds, either.

Social Trust Score

Table 2.2 presents multilevel regression results where the social trust score is the outcome: this is the assessment of H_1 and H_3.

In a null model predicting the social trust score, the interclass correlation indicated (ICC) 33.4 percent of the variation lay between participants (log likelihood -5734.9). Significant higher-level variation remains in both the fully adjusted model (34.3 percent) and the most successful model (36.8 percent).

The first hypothesis (H_1) is supported; as model 1 in Table 2.2 shows, images of residential properties with higher levels of remedial maintenance completed (the maintained condition) are associated with higher social trust scores (log likelihood -5460.9; likelihood ratio test χ^2 (1) = 548.13, $p < .001$).

The introduction of the maintenance variable as a random slope in model 2 also significantly improves model fit. The negative direction of the correlation (-.20) signals that, for participants with lower levels of overall social trust, the level

maintenance has a greater impact on their decision-making regarding trustworthiness (χ^2 (2) = 11.71, p = .003).

Table 2.2 *Multilevel Regression Analysis for Models Estimating Social Trust Score as a Function of Maintenance, Mini-K Score, and Covariates*

Variable	Null	Model 1	Model 2	Model 3	Model 4
Intercept	4.04*** (0.08)	3.67*** (0.08)	3.67*** (0.08)	3.35*** (0.15)	3.11*** (0.31)
Maintenance		0.74*** (0.03)	0.74*** (0.04)	0.74*** (0.04)	0.74*** (0.04)
Mini-K score				0.28* (0.12)	0.38** (0.12)
Single-parent family					0.16 (0.18)
Age (ref: 18 and 19)					
20 to 29					-0.06 (0.17)
30 and over					0.19 (0.26)
Sex (ref: Female)					
Male					-0.02 (0.19)
Dev environment (ref: Urban)					
Suburban					0.01 (0.17)
Rural					-0.16 (0.22)
Ethnicity (ref: White)					
Non-White					0.30 (0.20)
Region (ref: UK)					
EU					0.29 (0.25)
Non-EU					-0.47* (0.22)
SEP (ref: High)					
Medium					-0.05 (0.17)
Low					0.20 (0.21)
Variance components					
Level 1 Variance	0.52*** (0.04)	0.53*** (0.04)	0.55*** (0.04)	0.52*** (0.04)	0.46*** (0.04)
Level 2 Variance	1.04 (0.01)	0.90*** (0.01)	0.89*** (0.01)	0.89*** (0.01)	0.89*** (0.01)
Random slope Maintenance			0.05*** (0.01)	0.05*** (0.01)	0.05*** (0.01)
Correlation of random slope Maintenance and intercept			-0.20 (0.17)	-0.22 (0.17)	-0.24 (0.19)
N	3880	3880	3880	3880	3880
AIC	11475.9	10929.8	10922.1	10918.5	10929.3
ICC	0.334	0.369	0.381	0.368	0.343
Log likelihood	-5734.9	-5460.9	-5455	-5452.2	-5446.6

Note. Standard errors in parentheses
Dev environemnt = Developmental environment; SEP = Socioeconomic Position.
*P<0.05; **P<0.01; ***P<0.001

The addition of the life history measure (Mini-K score) in model 3, which is also significant, improves model fit still further (log likelihood -5452.2). It signals that a participant at the *fastest* (-3) end of this scale would have a trust score 1.70 units lower, on average, than a participant with the *slowest* (3+) schedule for the typical property, χ^2 (1) = 5.59, p = .018.

Thus, H_3 is supported. A participant's reaction to the stimuli is significantly related to their Mini-K score in the predicted direction.

These relationships remain significant after controlling for socio-demographic characteristics (model 4). In the instance of the life history measure, its effect is greater and more significant after the inclusion of the participant-level controls (0.28, $p < 0.05$ vs. 0.38, $p < 0.01$). These results show that property maintenance informs decision making regarding the trustworthiness of unknown residents, and that a participant's life history schedule is a further determinant in the process.

In the fully adjusted model, only nationality, with non-EU residents being significantly less trusting, reaches significance. A signal of a macro-level developmental effect. The micro-level developmental environment (whether the participant grew up in an urban; suburban; semi-rural/rural, context) had no significant impact on participants' attitudinal state.

Models that included interactions between theoretically relevant factors (most saliently, between life history schedule and maintenance) were performed but found not to be significant. As they were not predicted, they are not presented here.

It is worth noting that although the log likelihood of the fully adjusted model is an improvement on the previous model (log likelihood -5446.6 vs. log likelihood -

5452.2), it does not constitute an overall improvement in model fit – the log ratio test between model 3 and the fully adjusted was χ^2 (11) = 11.20, p = .427. The Akaike information criterion (AIC) also indicates a decrement of fit (AIC 10918.5 vs. AIC 10929.3).

Dwell Duration

Dwell duration on the areas of the images where maintenance was identified as being required was positively skewed and so a square root transformation was performed for multilevel regression analysis.

Table 2.3 presents the results where the transformed dwell duration is the outcome: this is the assessment of prediction H_2.

In a null model predicting dwell duration, the interclass correlation indicated 4.8 percent of the variation lay between participants (log likelihood -16429.9). Significant higher-level variation remains in both the fully adjusted model (7.8 percent) and the most successful model (9.0 percent).

Table 2.3 *Multilevel Regression Analysis for Models Estimating Dwell Duration as a Function of Maintenance, Mini-K Score, Mental Health, and Covariates*

Variable	Null	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	35.15*** (0.46)	39.85*** (0.53)	39.85*** (0.63)	39.24*** (1.00)	40.74*** (0.68)	41.99*** (1.42)
Maintenance		-9.39*** (0.51)	-9.39*** (0.59)	-9.39*** (0.59)	-9.39*** (0.59)	-9.39*** (0.59)
Mini-K score				0.55 (0.69)		
GHQ 12 Caseness					-2.54** (0.86)	-2.52** (0.86)
Age (ref: 18 and 19)						
20 to 29						1.16 (0.94)
30 and over						0.46 (1.41)
Sex (ref:Female)						
Male						-1.72 (1.03)
Dev environ (ref: Urban)						
Suburban						-0.49 (0.95)
Rural						0.20 (1.21)
Ethnicity (ref: White)						
Non-White						-0.19 (1.13)
Region (ref: UK)						
EU						-2.25 (1.39)
Non-EU						-2.74* (1.22)
SEP (ref: High)						
Medium						-1.31 (0.95)
Low						-0.23 (1.13)
Variance Components						
Level 1 Variance	13.80*** (1.48)	14.36*** (1.48)	25.99*** (2.75)	25.38*** (2.73)	24.29*** (2.63)	20.91*** (2.43)
Level 2 Variance	271.34*** (3.12)	248.71*** (2.86)	246.49*** (2.87)	246.49*** (2.87)	246.49*** (2.87)	246.49*** (2.87)
Random Slope Maintenance			8.68*** (2.41)	8.69*** (2.41)	8.69*** (2.41)	8.69*** (2.41)
Correlation of random slope Maintenance and intercept			-1.56* (0.74)	-1.49* (0.67)	-1.71 (0.96)	-1.77 (1.07)
N	3880	3880	3880	3880	3880	3880
AIC	32865.8	32538.3	32524.2	32525.6	32517.9	32525.1
ICC	0.0484	0.0546	0.0954	0.0934	0.0897	0.0782
Log likelihood	-16429.9	-16265.2	-16256.1	-16255.8	-16251.9	-16245.6

Note . Standard errors in parentheses
Dev environ = Developmental environment; SEP = Socioeconomic Position.
*P<0.05; **P<0.01; ***P<0.001

The H_2 is supported; images of residential properties with lower levels of remedial maintenance completed (the unmaintained condition) are associated with longer dwell durations on the areas of disordered materials (log likelihood 16265.2; likelihood ratio test χ^2 (1) = 329.46, p < .001).

The introduction of the maintenance variable as a random slope in model 2 also significantly improves model fit (log likelihood -16256.1). The negative direction of the correlation (-1.56) signals that for participants with shorter durations of overall dwell time in the areas of interest, the level of maintenance has a greater impact on their decision to dwell longer in the unmaintained condition (χ^2 (2) = 18.12, p = 0.001). Participants who typically have shorter dwell durations at the areas of interest in the maintained condition gaze significantly longer at the disordered materials in the unmaintained condition.

The addition of the life history measure (Mini-K score) did not improve the model fit (model 3) Table 2.3 (log likelihood -16255.8; χ^2 (2) = 0.61, p = .437). Thus, the H_4 is not supported.

However, an exploratory analysis introducing the GHQ 12 caseness variable (model 4) did significantly improve the model fit, log likelihood -16251.9; χ^2 (1) = 8.30, p = .004.

These relationships remain significant after controlling for socio-demographic covariates. The results signal that maintenance acts to inform the phenotypic trait of dwell duration – a behavior associated with participants paying greater attention to information salient to a task, and that a participant's mental wellbeing is also significantly associated with dwell duration, with those meeting the clinical cut-off for concern regarding mental ill health attending to the areas of interest for less time than their healthy counterparts.

In common with the social trust score results, in the fully adjusted model, only nationality, with non-EU residents being significantly less likely to dwell on the areas of interest, reaches significance. A macro-level developmental effect. And, in another

similarity with the social trust score results, the micro-level developmental environment had no significant impact on participants' behaviour.

Models that included interactions between theoretically relevant factors (most saliently, between GHQ 12 caseness and maintenance) were performed but found not to be significant. They are not presented here.

Again, it is worth noting that although the log likelihood of the fully adjusted model is an improvement on the previous model (log likelihood -16251.9 vs. -16245.6 log likelihood), it does not constitute an overall improvement in model fit – the log ratio test between model 4 and the fully adjusted model was χ^2 (10) = 12.76, p = .238. The AIC also indicates a slight decrement of fit.

First Fixation Index

First fixation index is a measure of the temporal sequence of fixations in a viewing session; with the number 1 indicating the first point of fixation. As part of H_2 I predicted that participants would be quicker to attend to the cues of disorder in the unmaintained condition than the corresponding areas in the maintained condition.

As with dwell duration, the first fixation index results were positively skewed and so a square root transformation was performed for multilevel regression analysis.

In a null model predicting index of first fixation, the interclass correlation indicated 2.5% of the variation lay between participants (log likelihood -6819.9). This does not meet the conventional threshold to warrant conducting MLM analysis (see Mehmetoglu & Jakobsen, 2016). Thus, a single-level approach to analysis was adopted.

In this revised analytical strategy, an exploratory *t*-test was first conducted to assess whether the areas of interest in the unmaintained condition (*M* = 2.283, *SD* = 1.236) were visited earlier in the viewing session than the corresponding areas of interest in the maintained condition (*M* = 2.542, *SD* = 1.552); an image-level assessment of difference. The test was significant, although the effect size was small, *t* (3878) = -5.734, $p < .001$, *d* = -.18. This finding supports prediction H_2, participants will be quicker to identify and attend to salient information regarding their task.

Following this, and in order to test H_4, a single-level regression was performed with a robust estimation of standard error, to account for the clustering in the data structure (Table 2.4). Whilst the level of maintenance remained significant, the effect size was, again, small. Neither the Mini-K or GHQ 12 Caseness measure were significant in subsequent model specifications. Thus, H_4 is not supported. When a model with the socio-demographic covariates was run, sex, with male participants being quicker to the areas of interest, and socioeconomic position, with participants in the low SEP category being slower to the area of interest, both returned significant results. But with such low effect sizes, the drawing of any inferences would be unwarranted.

Table 2.4 *Robust Linear Regression Analysis for Models Estimating First Fixation Index (Transformed) as a Function of Maintenance, Mini-K Score, Mental Health, and Covariates; Accounting for Clustering*

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	2.283*** (0.036)	2.291*** (0.080)	2.306*** (0.043)	2.159*** (0.096)
Maintenance	0.258*** (0.047)	0.258*** (0.047)	0.258*** (0.047)	0.258*** (0.047)
Mini-K Score		-0.007 (0.057)		
GHQ 12 Caseness			-0.064 (0.069)	
Age (ref: 18 and 19)				
20 to 29				0.080 (0.059)
30 and over				0.123 (0.091)
Sex (ref: Female)				
Male				-0.190** (0.067)
Dev Environment (ref: Urban)				
SubUrban				0.021 (0.066)
Rural				0.165* (0.079)
Ethnicity (ref: White)				
Non-White				0.06 (0.079)
Region (ref: UK)				
EU				0.033 (0.100)
Non-EU				-0.137 (0.094)
SEP (ref: High)				
Medium				0.012 (0.073)
Low				0.304*** (0.077)
N	3880	3880	3880	3880
R^2	0.008	0.008	0.009	0.020
R^2 Adjusted	0.008	0.008	0.008	0.017

Note. Standard errors in parentheses
Dev environmentt = Developmental environment; SEP = Socioeconomic Position
*P<0.05; **P<0.01; ***P<0.001

Exploratory Analysis: Social Trust Score and Dwell Duration

Table 2.5 presents multilevel regression results where the social trust score is once again the outcome: only this is time we test an exploratory hypothesis; does dwell duration itself associate negatively with social trust?

Table 2.5 *Multilevel Regression Analysis for Models Estimating Social Trust Score as a Function of Dwell Duration, Maintenance and Mini-K Score*

Variables	Null	Model 1	Model 2	Model 3	Model 4
Intercept	4.039*** (0.075)	4.396*** (0.084)	3.826*** (0.086)	3.825*** (0.088)	3.503*** (0.158)
Dwell Duration		-0.010*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)
Maintenance			0.704*** (0.032)	0.704*** (0.039)	0.704*** (0.039)
Mini-K score					0.287* (0.118)
Variance Components					
Level 1 Variance	0.523*** (0.039)	0.533*** (0.040)	0.530*** (0.040)	0.554*** -0.043	0.524*** -0.041
Level 2 Variance	1.043 (0.012)	1.014 (0.012)	0.898*** (0.010)	0.885*** -0.01	0.885*** -0.01
Random slope Maintenance				0.051*** -0.01	0.051*** -0.01
Correlation of random slope Maintenance and intercept				-0.220 (0.172)	-0.234 (0.173)
N	3880	3880	3880	3880	3880
AIC	11475.9	11374.6	10915.5	10908.1	10904.4
ICC	0.334	0.345	0.371	0.385	0.372
Log likelihood	-5734.9	-5683.3	-5452.7	-5447.0	-5444.2

Note. Standard errors in parentheses
*P<0.05; **P<0.01; ***P<0.001

As with our previous analysis of the social trust score, the null model returns an interclass correlation indicating that 33.4 percent of the variation lay between participants (log likelihood -5734.9). Significant higher-level variation remains in the fully adjusted model (37.2 percent).

Our exploratory hypothesis is supported; as model 1 signals, for every one unit increase in dwell duration there is a statistically significant decrease in the social trust score (log likelihood -5683.3; likelihood ratio test χ^2 (1) = 103.27, p < .001).

Unsurprisingly, given our previous results, the size of this effect is attenuated when we introduce the maintenance condition variable, first as a random intercept (model 2), and then as a random coefficient (model 3); once again, the negative direction of the correlation, which is now marginally increased (-.22), signals that, for participants with lower levels of overall social trust, the level of maintenance has a greater positive impact on their decision-making regarding social trustworthiness.

This pattern is followed when we introduce the life history measure (Mini-K) into the model; substantively the same results as our first planned analysis, but with a marginal improvement of model fit when compared to model 4 from Table 2.2 (log likelihood -5452.2 vs. log likelihood -5444.2; χ^2 (1) = 16.08, p < .001). Not only do we gaze for longer at the areas we either find, or expect, to be rich in information about maintenance, the longer we gaze at these areas in a given residential location, the less trustworthy we report people resident there to be.

2.4. Discussion

Community perception was proposed more than a decade ago by two evolutionary social scientists, building on the cognate constructs of collective efficacy and neighbourhood effects from sociology, criminology, social epidemiology, and public health (Galster, 2012; O'Brien & Wilson, 2011; Sampson et al., 1997). The current study confirms, using a different methodology, the findings of O'Brien and Wilson (2011), and the work they inspired by Nettle and colleagues (2014); social trust is significantly affected by residential maintenance.

The present study also reports the first eye tracking evidence in support of the findings of O'Brien and Wilson's (2014) self-report study that found that cues that afford an assessment of ambient levels of maintenance, a class of cue that Friston and colleagues have recently categorized as "epistemic resources" (Veissière et al., 2020), are selectively attended to when engaged on the task of assessing the social value of imagined residents.

The study also finds evidence consistent with the active inference framework approach to perception, with participants "foraging" for longer at disordered areas of the built environment and attending more rapidly to the epistemic resources therein (Mirza et al., 2019; Veissière et al., 2020; Clark 2015). In addition, I find a negative association between the duration a participant spends visually foraging, and social trust; the longer we gaze at disordered areas, the less we trust.

The present study also builds upon the community perception literature further to demonstrate that, as predicted, an individual's life history strategy affects cognitive processes relating to social trust. However, it does not find evidence of the predicted association between perceptual processing and this construct. And, although we find an association between which global region a participant grew up in and our measures of social trust and dwell duration, it is noteworthy that we find no associations between the particular residential environments experienced during development and our outcomes.

Finally, the findings of our first exploratory analysis, which examined whether mental health status, as measured by the GHQ 12 scale, affected eye movements, were significant but inconsistent with previous eye tracking studies that found increased negative attentional bias in depressed people (Eizenman et al, 2003; Kellough et al.,

2008). This result could be explained by the fact that poor residential maintenance, in and of itself, is not always considered a negative stimulus.

“Avenues of Intervention”

Unusually for a social researcher ostensibly working in the field of ethnography, but in common with O’Brien and Wilson, Nettle has speculated about possible “avenues of intervention” that might make a significant difference to the lives of the residents in communities like Neighbourhood B in the Tyneside Neighbourhoods Project; an area which falls within the most deprived category of the English Indices of Multiple Deprivation (2015, p. 113). Nettle observed that simply addressing the ambient maintenance of a neighbourhood might lead to significant gains in the perception of the quality of the social environment (2015).

With the present study, the motivation behind the selection of residential properties from areas identified as the most deprived by the English Indices of Deprivation (2015), was led by such an intervention-focused agenda. I speculated that the margins between the malign social environment prevalent in such neighbourhoods and a benign social environment might be bridged through a systematic, easily replicable, maintenance-led intervention. The present study demonstrates that people naturally attend to these disorderly features in the environment, and that, whilst holding all other visual aspects of the scene constant, participant’s attitudes to the trustworthiness of imagined residents were positively impacted by the digital remediation of their residential neighbourhood; hence making these features viable targets for future initiatives seeking to increase social trust.

As we reviewed in the General Introduction (Chapter 1), in both surprising and encouraging work recently conducted by Charles Branas and colleagues in the US,

actual remedial interventions to poorly maintained residential properties and vacant lots in deprived neighbourhoods have been proven to reduce gun crime by 29% (the primary motivation for the group's federally funded interventions), nuisance crime by 30%, increase the rate at which people report sharing the same values as their neighbours by 39%, and decrease instances of self-reported depression by 46% (Branas et al., 2018). Branas has labelled such interventions as "win win win science" on account of the multiple benefits that accrue from the relatively inexpensive remediation of the residential built environment (Branas, 2018). Whilst Branas and colleagues theoretically ground their work within the collective efficacy and broken windows theory frameworks (Kondo et al., 2015; MacDonald et al., 2019; MacDonald et al., 2022; Wilson and Kelling, 1982; Sampson et al., 1997), they are yet to identify a clear causal pathway to account for the multiple social benefits that result from their interventions. We think the community perception construct is well placed to do this work. Thus, whilst improving levels of social trust might primarily motivate the design and delivery of an initial intervention informed by the insights of community perception as expounded in the present study, downstream health and wellbeing benefits associated with increased social capital, in line with those reported by Branas and colleagues, would be predicted to follow (MacDonald et al., 2019).

Limitations

There are at least six potential limitations concerning the results of this study. Clearly being invited into a well-resourced and carefully maintained laboratory to undertake an experiment where you gaze at static photographs on a monitor is significantly different from the experience of being a pedestrian visitor to a residential street in a

deprived, and unfamiliar, part of town. Foulsham and Kingstone (2017) found that there are differences between where people look when they are actually a pedestrian in the environment compared to looking at a picture of the same scene. That said, Wilkins and colleagues have found that photographs function as good surrogates for the natural scenes themselves whilst studying visual discomfort triggered by urban scenes employing a near infrared spectroscopy paradigm (Le et al., 2016).

In future work on community perception, mobile eye tracking equipment could be used to record eye movements in real-time and in situ. Nevertheless, the present study does demonstrate that, at the very least, disordered features of a mediated residential built environment are a priority for people when considering the question of social trust.

The urban topography of the UK is markedly different to the US context in which O'Brien and Wilson conducted their study (2011). Additionally, the commitment to using neighbourhoods identified as being within the first decile of the first percentile of the index of 32,844 English neighbourhoods in The English Indices of Deprivation (2015) limited my potential sample to areas which are predominately made up of late nineteenth and early twentieth century terraced housing stock. Consequently, these factors precluded the opportunity of exploring two of the three aspects of O'Brien et al.'s (2014) refined construct of community perception, namely, vegetation and pavement, as distinct categories.

Additionally, although the present study, in line with O'Brien and Wilson original design (2011), uses stimuli with an isolated view of the focal property, their induction protocol also provided the participants with views along the residential street, in both

directions, together with the view directly opposite the focal property, thus giving the participant a sense of the urban context. Given the pragmatic constraints of the eye tracking methodology, I restricted the stimuli sample, and the experimental manipulation, to solely the straight-on view of the focal (experimentally manipulated) residence. This pragmatic decision reduces the ecological validity of the present study in comparison to O'Brien and Wilson's protocol and could have inadvertently primed the participant to focus solely on the presumed resident of the focal residence, rather than the broader social environment, when making their response to the trust question.

Both of these limitations could be addressed with the use of mobile eye tracking protocol outlined above.

Also, due to a concern regarding the experimental burden placed on participants, whilst I did collect measures of individual differences, such as sex, socioeconomic status, life history, and the immediate built environment experienced during development, I did not collect measures of either personality or attachment style. Both of these constructs are dimensions, as foregrounded in the General Introduction, which form the generative model of the participant, and thus would have been experimentally relevant to control for during analysis. This may account for some of the null results across some of the outcome variables. In future studies, the inclusion of short-form scales for these two dimensions (for instance the Attachment Style Questionnaire - Short-Form, Iwanaga et al., 2018) should be considered.

Another challenge to the external validity of the present study was the composition of the sample; predominately staff and students at the University of Essex. Further

research is required using representative samples from both resident communities and actual visitors to a specific location to see if similar associations remain present. With sufficient funding, and the use of a portable eye tracking set-up, data collection in community settings in urban and suburban locations could help address this concern and open up the possibility of testing both residents and visitors to a given neighbourhood. Nonetheless, and as cited in the Introduction, Nettle et al. (2014) found that actual visitors' psychological reactions, including measures for social trust and paranoia, tracked those of actual residents of the two study sites of the Tyneside Neighbourhoods Project. Further, both O'Brien and Wilson's and Nettle and colleagues' wider series of studies have consistently found that lab-based photographically mediated visits to study sites evoke psychological responses broadly in line with data collected from participants in situ (Hill et al., 2014; O'Brien & Wilson, 2011).

I hypothesise that this level of near real-time updating of psychological and cognitive mechanisms could account for the lack of any association in the present study between a participant's developmental residential context and the outcome variables; humans adjust quickly. A hypothesis that contradicts O'Brien et al.'s (2014) local adaptation proposal, but one consistent with Nettle and colleagues' (2014) findings and the active inference framework (Linson et al., 2018; Mirza et al., 2016; Mirza et al., 2019; Veissière et al., 2020; Clark 2015).

In a recent special issue of Evolution and Human Behaviour, several contributors challenged attempts in the evolutionary human sciences to account for inter-individual differences in cognitive, perceptual, physiological, and morphological traits from a life history perspective – arguing that it is essentially a between group or

species-level account of variation (see, for instance, Stearns & Rodrigues, 2020). Further, among those prepared to countenance its use within human populations and between individuals, it was contested whether the tools of the psychometric approach, such as the Mini-K, function as valid assays of an individual's life history strategy (Sear, 2020). In short, it is an open empirical question whether this perspective will prove a valuable addition to theorising community perception as proposed in the present chapter. This thesis employed the Mini-K scale unaware of its author's commitment to a largely genetically determined conception of a single life history continuum; with all humans, male and female alike, falling somewhere along a single fast-slow dimension (Black et al., 2017; Figueredo et al., 2014; Sear, 2020). Clearly, given my interest in the harshness and predictability of developmental environments (i.e., Ellis et al., 2017), O'Brien et al.'s (2014) local adaptations extension of community perception, and Nettle et al.'s (2014) rapid updating of cognitive and psychological processes as a function of exposures to different residential built environments, Figueredo's conception of life history (Black et al., 2017) does not resonate with this thesis's approach. In future work, I recommend adopting Sear's (2020) advice for a more nuanced approach to both construct measurement and theorising; retaining the fast-slow continuum as a motivating heuristic, not as an exhaustive formal description.

In a final issue regarding validity, it should be noted that a number of top-down models of visual search (e.g., Guided Search 6.0, Wolfe, 2021; Yarbus, 1967) would also be consistent with the findings reported here as support for Friston's active inference framework (Linson et al., 2018; Mirza et al., 2016; Mirza et al., 2019; Veissière et al., 2020). I prefer the active inference approach because I contend it provides a more fundamental proximate account of perception, cognition, and

behaviour, and is thus better resourced for both our present purposes and future research attempting to develop a process theory of community perception (Clark, 2015; Smith et al., 2022).

Conclusion

Residential maintenance matters when people make judgements about the social behaviour of others. Different fields across the social sciences are looking to influence public policy by leveraging such findings to design interventions that promote human flourishing in deprived neighbourhoods. Adopting a biosocial approach, informed by evolutionary theory, we demonstrated a first principles account of aspects of the cognitive processes at play in an instance of community perception. Future work will look to further elucidate the proximate mechanisms that underlie this cognitive process, in the hope that it will lead to still more impactful evidence-based policy proposals.

3. Residential Maintenance as an Affective Prime: The ESSEXLab Study

3.1. Introduction

Both the Binghamton Neighbourhood Project and the Tyneside Neighbourhoods Project have used experimental economics games to test their respective predictions regarding community perception and social behaviour (O'Brien et al., 2007; O'Brien & Wilson, 2011; Nettle et al., 2011; Nettle, 2015; Schroeder et al., 2014). The two projects have yielded evidence that aspects of both the immediate and mediated social environment, once made experimentally salient to the participants, affects social behaviour in predictable ways (O'Brien & Wilson, 2011; Nettle et al., 2011; Nettle, 2015; Schroeder et al., 2014). This motivated me to design an experimental economics study to test my hypothesis regarding residential maintenance and its effect on social trust.

Nettle and colleagues have used dictator games to study co-operation (Nettle et al., 2011), and third-party punishment games to examine antisocial behaviour and the punishment of antisocial behaviour (Schroeder et al., 2014) in adult samples drawn from their two study sites in Newcastle upon Tyne, UK. O'Brien and Wilson have used sequential prisoner dilemma games to test levels of prosociality at both an individual-level and neighbourhood-level in school-aged children and an undergraduate population in Binghamton, NY, US (O'Brien et al., 2007; O'Brien & Wilson, 2011).

After reviewing a range of experimental economics games (Davis & Holt, 2021), I opted to use a different paradigm, the trust game, to test my hypothesis. Berg, Dickhaut, and McCabe introduced their investment game, as it was initially called, in

1995, since which time it has come to dominate the study of trust in both experimental economics, and trust research more widely (Berg et al., 1995; Delgado et al., 2005; Fouragnan et al., 2013; Johnson & Mislin, 2011). I made this choice because my focus in the present study is on the mechanism of social trust, and this paradigm benefits from being a well-validated measure of two different aspects of this construct; the extent to which the participant trusts their prospective interactant, and, if the participant plays both roles in the game, the trustworthiness of the participant themselves (Alós-Ferrer & Farolfi, 2019; Johnson & Mislin, 2011)

In another echo of the Binghamton Neighbourhood Project and the Tyneside Neighbourhoods Project, I decided to utilise the stimuli I had created to conduct the eye tracking study in Chapter 2 as the stimuli for the present study (O'Brien & Wilson, 2011; Nettle, 2015). I also drew further inspiration for the design of the present study following a review of the methodological approaches of the other work completed under the auspices of the two projects. For instance, Hill et al. (2014) used slideshows comprised of photographs of the two Tyneside Neighbourhoods Project study sites with and without the presence of police vehicles to measure whether judgements about a neighbourhood's quality were sensitive to physical disorder, police presence, both, or neither. Hence, I decided to divide the experimental stimuli from Chapter 2 into maintained and unmaintained sets and create slideshows from the respective pools to similarly manipulate perceptions of the neighbourhood, in this case, the impact of time and resource investment in the urban environment.

In Chapter 2 we established that participants' attitudes towards the trustworthiness of residents were significantly affected by the level of residential maintenance. In the

present study I wanted to test whether maintenance level alone would function as an affective prime that could impact economic behaviour, without the social framing of the subsequent measure being explicitly about a prospective interaction with a resident from the area depicted (Klauer, 1997; Klauer & Musch, 2003; Mariia & Tatiana, 2021).

Whilst a review of the priming literature failed to yield any research explicitly examining social behaviour that has used depictions of the built environment as an affective prime, in a recent priming study conducted by a group associated with the Tyneside Neighbourhood Project, Harrison and colleagues (2018) found that participants who identified as social drinkers were more likely to seek alcohol following a brief exposure to images depicting residential properties in poor environments when compared to properties in affluent environments. Harrison et al. interpreted this result in the context of a wider body of research investigating how poverty influences mood and behaviour, and consider their work to be a contribution to a growing literature that demonstrates that brief exposures to environmental cues associated with deprivation can influence attitudinal states and behavioural choices (Corcoran et al., 2018; Harrison et al., 2018, p. 7; Liu et al., 2012; Zhong & DeVoe, 2010; for review, see Haushofer & Fehr, 2014).

This thesis demonstrated in Chapter 2 that maintenance is a cue that affects our social attitudes towards others, with the imagined residents of streets where maintenance remains undone being assessed as significantly less trustworthy. With the present study I wanted to test if it would act as an affective prime, independent of it functioning as explicit situational information regarding the potential social behaviour of the prospective interactant.

The Present Study

As we have reviewed in the General Introduction (Chapter 1) to this thesis, the introductory section of Chapter 2, and briefly in introduction to the present study, research suggests that the social environment affects how we co-operate and socially interact (Nettle et al, 2011; Nettle, 2015; O'Brien & Wilson, 2011; Schroeder et al., 2014). One cue to the social environment lies in the buildings we inhabit and their levels of maintenance (Branas et al., 2011; Branas et al., 2018; Keizer et al., 2008, 2013; Kondo et al., 2015; Kondo et al., 2016; MacDonald et al., 2019; MacDonald et al., 2022; Nettle et al., 2014). Most existing work has focussed on behaviours in those environments by those located there (Corcoran et al., 2018; Keizer et al., 2008, 2013; Nettle et al., 2014), or participants in laboratory studies attitudes or behaviour towards a particular neighbourhood's residents during mediated interactions (Hill et al., 2014; O'Brien & Wilson, 2011), but few have examined responses to those environments resulting from mere exposure, without an explicit social framing, and how they may vary (Harrison et al., 2018). We identify social trust as one key social variable that is likely impacted by variations in environments, and which has a wide-ranging impact on quality of life (Nettle, 2015). I thus propose examining the reactions of participants to different maintenance levels in the residential built environment by measuring how they behave in a trust game.

Using a between-subject design, participants will be assigned to one of two affective priming conditions; maintained and unmaintained (see Chapter 3 Materials and Stimuli; Study 1 Stimuli, for the two stimuli sets in Open Science Framework: https://osf.io/p5uh2/). Following this affective priming exposure, participants will play two rounds of an anonymised trust game, with a neutral framing, to examine whether

the maintenance prime alone is sufficient to impact levels of social trust. I predict that participants in the maintained condition will be more trusting and trustworthy than participants in the unmaintained condition, as they will have been exposed to a positive affective prime due to our association of residential maintenance with trustworthiness (Chapter 2).

3.2. Method

Participants

In total 226 participants (93 males, 133 females) residing in the UK completed the study in a laboratory setting. Participants were recruited through the University of Essex's ESSEXLab participant pool. All participants received a minimum payment of at least 4 GBP for their contribution. The age of the participants ranged between 18 and 75, with mean 27.50 years and standard deviation 12.67 years. All participants gave informed written consent, and the study received ethical approval from the University of Essex's ethics committee (DM1901).

Sample Size

A thorough review of the emerging literature on community perception (and cognate constructs) yielded sufficient relevant empirical findings to be able to perform a power analysis using G*Power software (Faul et al., 2013) based on prior research and effect size conventions with an alpha of 0.05, a power of 0.80 (f^2 0.06). As my planned analysis strategy was constituted of multiple linear regressions, I thus calculated a sample size of more than 204 would provide the study with the necessary power to detect a small-medium effect size.

Materials and Measures

Experimental Stimulus

The complete set of experimental stimuli from Chapter 2 were animated into two different slideshows by manipulation condition using Microsoft PowerPoint (2019): maintained and unmaintained (for more details about the selection and manipulation of these stimuli, see the Method section of Chapter 2). Both slideshows presented the properties in the same sequence, and for the same duration - 7 minutes 15 seconds (see Open Science Framework https://osf.io/p5uh2/ Chapter 3 Materials and Stimuli; Study 1 Stimuli); thus, the only difference between the two conditions was the level of residential maintenance depicted.

Covariate Measures

Participants completed the same covariate measures as were administered in Chapter 2 (see Method section), with the addition of an adapted version of the financial subscale of the DOSPERT Risk-taking Scale (Blais & Weber, 2006). The items from the original scale were retained with minor amendments to reflect a contemporary UK context: Item 1: “Betting a day’s income at the horse races”; Item 2: “Investing 10% of your annual income in an ISA (Individual Savings Account)”; Item 3: “Betting a day’s income at a high-stake poker game”; Item 4: “Investing 5% of your annual income in a very speculative stock”; Item 5: “Betting a day’s income on the outcome of a sporting event”, and Item 6: “Investing 10% of your annual income in a new business venture”. The items were scored on a 7-point scale (1 = *Extremely Unlikely* to 7 = *Extremely Likely*). The items were reverse coded where necessary and summed to create a 37-point (6—42) *Risk-taking Score.*

I created two new items, following the register of the established items from DOSPERT Risk-taking Scale, to measure participant's altruistic disposition: Item 7: "Donating a day's income to a homeless charity"; and Item 8: "Volunteering for a day at a food bank". As with the risk-taking score above, the items were scored on a 7-point scale (1 = *Extremely Unlikely* to 7 = *Extremely Likely*). These two items were summed to create a 13-point (2—14) *Charity Score* (see Open Science Framework Chapter 3 Covariate Measures Qualtrics https://osf.io/p5uh2/).

These measures were introduced to allow for the statistical adjustment during analysis of pre-existing individual differences in attitudes towards both risk-taking and forms of other-regarding behaviour like altruism (Andreoni & Miller, 2002). Recent studies have found that these two dispositional characteristics can systematically affect behaviour in experimental economics games (Alós-Ferrer & Farolfi, 2019; Andreoni & Miller, 2002; Cox, 2004).

Outcome Measure

Following the conventional trust game protocol (Johnson & Mislin, 2011) this measure involved participants being allocated an endowment (3 GBP), any proportion of which they could share (as first-mover) with an anonymous and randomly assigned partner (second-mover), keeping the remainder for themselves. The amount shared was tripled, and the second-mover could then return any amount back to the first-mover of that tripled amount, keeping the remainder for themselves.

To maximise the amount of data collected, participants played both roles, serving once as first-mover (which is considered a measure of how "trusting" a participant is; Burks et al., 2003) and once as the second-mover (which is considered a measure of how "trustworthy" a participant is; Burks et al., 2003). Previous research has found

that participants' behaviour is not affected by playing both roles in this paradigm, as long as they are not informed in advance that they will be doing so (Burks et al,. 2003; Johnson & Mislin, 2011).

As is standard within behavioural economic protocols, participants remained anonymous within the session and were randomly paired for the trust game. Participants received a fee (4 GBP) for attending that was not affected by game play; any earnings from the trust game itself constituted an additional payment.

Procedure

The study was conducted in the ESSEXLab at the University of Essex, a purpose-built experimental economics laboratory with 32 testing stations. It was done in groups of no more than 30 participants a session (*M* 25.1). The priming slideshow and trust game were programmed and administered through z-Tree, a widely used software package for developing and carrying out economic experiments (Fischbacher, 2007). The covariate measures were administered online via Qualtrics (n.d.).

On arrival, participants were randomly assigned to testing stations by drawing a numbered ball from a bowl (this process also constituted the assignment of condition, as z-Tree randomly allocated an exposure condition to participants based on their testing station ID). Once seated, participants were invited to read the information sheet and complete the consent form. This was followed by a verbal presentation of the study instructions by the experimenter (participants also received a printed copy of the instructions to follow along with). The instructions for the treatment are reproduced in Appendix D.

Once the consent forms had been completed by the participants and collected by a research assistant, and any questions from the participants regarding the instructions had been answered by the experimenter, participants completed the survey comprising the covariate measures.

Next, participants were given the instruction via an on-screen text message: “You are to imagine yourself walking along a street where you would expect to encounter the houses depicted in the following images” and were subsequently presented with one of the two slideshows, dependent on their condition assignment. Following this exposure, all participants engaged in consecutive rounds of the trust game to measure if levels of social trust had been affected by the level of residential maintenance.

Finally, at the end of the experiment, all participants received their 4 GBP fee, plus any additional game play earnings, in an envelope handed to them at their testing stations by a research assistant. These earning were calculated by z-Tree and administered by the experimenter (Fischbacher, 2007).

3.3. Results

Both the percentage of the endowment given by participants in the first-mover role, and the percentage returned when in the second-mover role, were characterised by non-normal distributions; thus, an examination of alternative analysis strategies was undertaken using the ladder of powers diagnostic tool in Stata 14 (2015). Fortunately, a square root transformation was found to modify the distributions of both sets of data sufficiently to be able to proceed with the planned parametric

multiple linear regression analysis strategy (Byrne, 2010; Hair et al. 2010). See Table 3.1 for descriptive statistics (untransformed and transformed).

Table 3.1 *Descriptive Statistics by Manipulation Condition (Untransformed and Square-root Transformed)*

Variable	*N*	*M* (%)	*SD*	Min	Max	*M* (sqrt)	*SD*	Min	Max
		Untransformed				Transformed			
First-Mover Percentage Sent (trust)									
Both Conditions	226	66.35	0.301	0	100	1.284	0.112	1	1.414
Unmaintained (A)	108	66.56	0.284	0	100	1.286	0.112	1	1.414
Maintained (B)	118	66.16	0.318	0	100	1.283	0.127	1	1.414
Second-Mover Percentage Returned (trustworthiness)									
Both Conditions	217	43.92	0.240	0	100	1.195	0.100	1	1.414
Unmaintained (A)	104	42.61	0.253	0	100	1.190	0.107	1	1.414
Maintained (B)	113	45.11	0.229	0	100	1.200	0.094	1	1.414

Contrary to my prediction, adjusting for sex, age, life history strategy, ethnicity, nationality (by region, due to small cell sizes at the continental level), socioeconomic position, charity score and risk-taking score, we found no effect of the maintenance manipulation for either the first-mover "trust" endowments (B = -0.011, p = .527), $F(16, 209) = 0.96$, $p < .001$, $R^2 = .068$, $R^2_{Adjusted} = -.003$; or the second-mover measure of "trustworthiness" (B = .004, p = .757), $F(17, 199) = 2.12$, $p < .001$, $R^2 = .153$, $R^2_{Adjusted} = .081$ (Table 3.2).

Table 3.2 *Multiple Linear Regression Analysis Estimating First-Mover and Second-Mover Transfers in Percentages (Transformed) as a Function of Maintenance Manipulation and Covariates*

Variable	First-Mover	Second-Mover
Intercept	1.279*** (0.050)	1.035*** (0.044)
Maintenance Manipulation	-0.011 (0.017)	0.004 (0.014)
Mini K Score	-0.011 (0.014)	0.008 (0.012)
Age	-0.000 (0.001)	0.001* (0.001)
Sex (ref:Female)		
Male	-0.024 (0.018)	-0.010 (0.015)
Ethnicity (ref: White)		
Asian	-0.077** (0.028)	-0.014 (0.023)
Black	-0.021 (0.028)	0.006 (0.023)
Other	-0.005 (0.034)	0.021 (0.028)
Region (ref: UK)		
EU	-0.026 (0.026)	0.039 (0.021)
Non-EU	-0.010 (0.024)	0.019 (0.020)
Dev Environment (ref: Urban)		
Suburban	-0.007 (0.019)	0.038* (0.016)
Semi-rural	0.005 (0.025)	0.030 (0.021)
Rural	-0.016 (0.033)	-0.024 (0.027)
SEP (ref: High)		
Medium	0.026 (0.020)	0.020 (0.017)
Low	0.012 (0.020)	-0.01 (0.017)
Charity Score	0.007* (0.003)	0.006* (0.003)
Risk-Taking Score	0.001 (0.001)	0.000 (0.001)
Sent [a]		0.006* (0.003)
N	226	217
R^2	0.068	0.153
R^2 Adjusted	-0.003	0.081

Note. Standard errors in parentheses

Dev environemnt = Developmental environment; SEP = Socioeconomic Position.

[a] Sent, scaled 0-9, reflecting the value in GBP of the first-mover endowment once it had been tripled.

*P<0.05; **P<0.01; ***P<0.001

Of the covariates collected for use as controls during analysis, when examined through a multiple linear regression without the manipulation condition in the model specification, only ethnicity was predictive of the amount trusted in the first-mover role, with Asian students giving significantly less than their contemporaries (Table 3.3). Regarding the amount returned in the second-mover role, the measure of trustworthiness (also Table 3.3): Age, with older participants returning significantly more, and micro developmental environment, with participants raised in suburban circumstances also returning significantly more than their contemporaries raised in other circumstances, were both predictive. The charity score was also, unsurprisingly, predictive; with those scoring higher on our 13-point scale returning significantly more of the money trusted to them. The effect of the size of initial first-mover transfer (the variable Sent, scaled 0–9, reflecting the value in GBP of the first-mover endowment once it had been tripled) was also predictive of the amount returned, with higher first-mover endowments yielding higher levels of second-mover return transfers. Asian students were no less trustworthy than their contemporaries.

Table 3.3 *Multiple Linear Regression Analysis Estimating First-Mover and Second-Mover Transfers in Percentages (Transformed) as a Function of Covariates*

Variable	First-Mover	Second-Mover
Intercept	1.270*** (0.049)	1.039*** (0.043)
Mini K Score	-0.011 (0.014)	0.008 (0.012)
Age	-0.000 (0.001)	0.001* (0.001)
Sex (ref:Female)		
Male	-0.024 (0.018)	-0.010 (0.015)
Ethnicity (ref: White)		
Asian	-0.073** (0.028)	-0.016 (0.023)
Black	-0.022 (0.028)	0.007 (0.023)
Other	0.000 (0.034)	0.019 (0.027)
Region (ref: UK)		
EU	-0.028 (0.026)	0.040 (0.021)
Non-EU	-0.012 (0.024)	0.021 (0.019)
Dev Environment (ref: Urban)		
Suburban	-0.007 (0.019)	0.038* (0.016)
Semi-rural	0.006 (0.025)	0.030 (0.021)
Rural	-0.015 (0.033)	-0.023 (0.027)
SEP (ref: High)		
Medium	0.027 (0.020)	0.020 (0.017)
Low	0.014 (0.020)	-0.012 (0.017)
Charity Score	0.006 (0.003)	0.006* (0.003)
Risk-Taking Score	0.001 (0.001)	0.000 (0.001)
Sent [a]		0.006* (0.003)
N	226	217
R^2	0.064	0.151
R^2 Adjusted	0.002	0.087

Note. Standard errors in parentheses

Dev environemnt = Developmental environment; SEP = Socioeconomic Position.

[a] Sent, scaled 0-9, reflecting the value in GBP of the first-mover endowment once it had been tripled.

*P<0.05; **P<0.01; ***P<0.001

All but one of these covariate results, that of people raised in suburbia being more trustworthy than those raised elsewhere, are consistent with the findings reported in Johnson and Milsin's meta-analysis and elsewhere in the trust game literature (Alós-Ferrer & Farolfi, 2019; Burks, 2003; Cox, 2004; Johnson & Mislin, 2011) and thus function as robustness checks for the present study's design. The novel finding regarding suburbia is a product of our current design, as the variable's inclusion is a consequence of the hypothesis motivating Chapter 2, that developmental environment would affect community perception (O'Brien et al., 2014).

3.4. Discussion

Contrary to my prediction, maintenance-primed people were no more trusting, or trustworthy, than those primed with the unmaintained condition. As foregrounded in the introduction to this study, in the absence of participants actually or hypothetically interacting with residents from the neighbourhoods depicted in the stimuli, this experiment was an examination of the affective priming effects of depictions of maintenance in the residential built environment on a behavioural measure of social trust. So, it is to behavioural priming literature we will turn first in our effort to account for the null result.

Behavioural Priming

As has been well documented, there is an ongoing replication crisis in social psychology (Bakker et al., 2012; Świątkowski & Dompnier, 2017). A significant factor in this crisis have been growing concerns regarding the validity of celebrated findings from the social and behavioural priming literature, following several high-profile

failures to replicate (Camerer et al., 2018; Chivers, 2019; Kahneman 2012, 2017; Sherman & Rivers, 2021). In their recent review of this “train wreck”, a term introduced by Kahneman to describe the situation he saw looming for the field (2012), Sherman and Rivers (2021) have proposed that the primary issue might be one of research design and not the priming paradigm in and of itself.

Sherman and Rivers (2021) found that priming studies that employ a within-subject design, which also often comprise multiple prime-target combinations, usually have sufficient statistical power to detect relatively small effect sizes, and have replicated well. Conversely, those that employ a between-subject design, which usually have a single prime-target combination, have rarely had sufficient statistical power to detect equivalent effect sizes, due to sample size constraints. Sherman and Rivers highlight that studies with this between-subject design, double-digit sample sizes, and correspondingly low statistical power, such as Bargh et al. (1996), are almost exclusively those that have failed to replicate.

Thus, it could simply be the case that my confidence in this methodological approach to testing my hypothesis about residential maintenance was misplaced, and that the null result is the consequence of a genuine absence of an effect when using a priming paradigm with a between-subject design due to insufficient statistical power. However, I think this interpretation is unlikely, as my sample exceeded the value computed by the power calculation given our expectation of a small to medium effect size.

Mind the Gap

Notwithstanding this methodological issue, every theory of priming, behavioural or otherwise, predicts that the effect is attenuated as the gap between the prime and

the target increases – a gap usually measured in seconds and not minutes (Becker et al.,1997; Sherman & Rivers, 2021). I had designed the present study with the sequence of stages and not particular timescales in mind. The trust game, my assay of social trust, was completed immediately following the experimental priming exposure, consistent with the process of experimental exposure followed by target measures reported in the procedural sections of all the motivating studies (Harrison et al., 2018; Hill et al., 2014; O'Brien & Wilson, 2011). Hence, an incidental lag in the present study - it takes someone with English as a first language approximately 35 seconds to read the instructions for the trust game - could have led to a decay in the strength of the maintenance prime manipulation by the time participants came to making their target decisions regarding the endowment. This simple methodological flaw could account for the null result, with the maintenance prime manipulation being insufficiently psychologically salient during the subsequent target decision-making stage because of temporal decay.

Social Framing

As both Burks et al. (2003) and Johnson and Mislin (2011) point out, participant's behaviour in experimental economics games is sensitive to the framing of social interactions in the laboratory; minor differences in procedures may cue participants to follow very different norms, with large consequences for observed behaviour (Burks et al., 2003, p. 195-196). In O'Brien and Wilson's study (2011), participants were run individually and experienced nine consecutive 50 s experimental windows: participants spent 20 s attending solely to the stimuli, followed by 30 seconds during which they played a round of a sequential prisoner's dilemma game. In addition, critically, O'Brien and Wilson introduced the social frame to their study that the

participants would be playing the game with a resident of the neighbourhood depicted in the preceding stimuli, albeit through a mediated encounter, as the resident's gameplay behaviour had been recorded during a previous study in the Binghamton Neighbourhood Project (O'Brien et al., 2007). In Hill et al.'s (2014) study, participants were also run individually in a laboratory setting. The experimental exposure took the form of a slideshow of 40 images depicting a particular residential neighbourhood presented for 10 seconds each (a total running time of 6min 40s). After viewing the slideshow, participants completed the target measures (comprising a five-item social capital scale, and a single item on fear of crime) having been instructed explicitly to have the neighbourhood depicted in the preceding slideshow in mind (Hill et al., 2014). Thus, for instance, whilst the experimental exposure in the present study was administered in the same way as in the Hill et al. study; the social framing of the experiment, both during data collection, and the administration of the target measures, were not.

Furthermore, in addition to the limitations regarding the stimuli set identified above (Chapter 2, pp.89-90), given the experimental manipulation focused primarily on the focal property, and not the entire sweep of the residential context, the null result in the present study might simply be a result of the prime induction not being sufficiently salient visually.

The confidence I had in the maintenance manipulation following Chapter 2, together with the results of the experiments that were reviewed in the preparation of the power calculation (Keizer et al., 2008, 2013; Nettle et al., 2014; O'Brien & Wilson, 2011; Volker, 2018), led me to conceiving and executing the present study without the inclusion of an explicit social framing involving the residents of the

neighbourhoods depicted. My prediction was that the carry-over effect of the affective prime would be strong enough to influence the participant's subsequent target interaction with an agent not directly associated with the priming stimuli.

Furthermore, in contrast with these motivating studies, but consistent with many experimental economics game paradigms, data collection was conducted in a large group (*n* >23) in a purpose-built experimental economics lab. This may have undermined the paradigm. Participants, following their arrival at the ESSEXLab, waited together in a designated orientation space prior to their session. They then went through the procedure of the random assignment to testing stations, and listened to the orientation address by the experimenter, as a member of this group. It was also with members of this assembled group that they were instructed to play the target trust game, following the affective priming exposure. Thus, their being in a group, the majority of whom were contemporaries at the University of Essex, whilst not being made experimentally explicit, would have been salient throughout the data collection session. All of which could account for aspects of the uniformity of the participants' responses, as an ingroup psychology might have inadvertently been activated (for a discussion of the potential bias introduced to the results of trust game protocols by the organization of data collection, see Hargreaves Heap & Zizzo, 2009).

Foreseeable Finding?

A retrospective analysis of the study's pilot session data, to explore if the null result could have been anticipated, revealed that there was evidence of a significant difference in the means between the two conditions (first-mover: unmaintained condition 56% vs. maintained 64%: Second-mover: unmaintained 36% vs.

maintained 41%). Interestingly, whilst by present standards the pilot had insufficient power to reliably detect an effect of the size we predicted following our assessment of the relevant studies (see Method), it is noteworthy that the participant numbers for it (n = 30) actually matches the total experimental samples of those of some of the most celebrated priming studies in this now contested literature (e.g., Bargh et al., 1996; see Schimmack et al., 2017).

Situational and Dispositional Behaviour

One striking finding in the present study is the scale and near uniformity of the first-mover endowments. Regarding the scale, across both manipulation groups, participants trusted the entire endowment of 3 GBP 35.40% of the time (32.41% in the maintained condition vs. 38.14% in the unmaintained condition). If we compare the mean percentage amount given by those in the present study and those from the UK sample from Johnson and Mislin's meta-analysis (with an N = 274 across five studies), the current study is 12.34% greater (66.34% vs. 54.00%); a difference that is statistically significant using a one-sample two-tailed t-test ($t(226) = 6.16$, $p<0.001$) (Johnson & Mislin, 2011).

Regarding the near uniformity of first-mover endowments across the two conditions of the present study, my initial interpretation was that this was an artefact of the design, considering that 66.6% (the median amount given in the present study) corresponds to a 2.00 GBP endowment. Although the mean was also similar, at 66.34%, the mode endowment was in fact 100%, with 80 participants (35.40%) trusting the entire endowment compared to 42 participants (18.58%) giving exactly the sum of 2.00 GBP.

There was also a significant difference in the mean percentage amount returned across the manipulation groups combined, behaviour interpreted as an act of trustworthiness on the part of the second-mover (Burks, 2003), by those in the present study compared to those from the UK meta-analysis; 43.97% vs. 28.00% - a difference of 15.97%, which is also statistically significant using one-sample two-tailed *t*-test ($t(217) = 9.80$, $p<0.001$). The patterns in the covariate results, with age and the charity score, for instance, being predictive of social trust behaviour, is in line with the established trust game literature, as I outlined in the Results section (Alós-Ferrer & Farolfi, 2019; Burks, 2004; Cox, 2003; Johnson & Mislin, 2011).

One interpretation of these findings is that whilst the situational factors of being in a well-maintained and purpose-built laboratory with a socially salient group positively affects social trust behaviour, dispositional factors are still predictive of the participant's own level of trustworthiness, even when the baseline level is possibly elevated by the situational factors.

This is evidence in support of the post hoc interpretation above that I had inadvertently triggered an ingroup behavioural response from the participants because of them being run as members of a salient social group.

Concluding Remarks

In summary, the decision to use a behavioural priming paradigm with a between-subject design, the potentially attenuating temporal lag introduced between the prime and the target, the neutral social framing of the trust game, and the fact that data collection took place in the company of a salient social ingroup, who were also the experimental interactants during the game play stage of the study, are all factors that could account for this null finding.

Next Steps

I will address these post-hoc explanations for the null result in a follow-up study. Whilst I consider that the lag between the prime and the target might have been consequential, I think the two critical factors that account for the null result are the absence of the explicit social framing between the stimuli and the prospective interactant and the fact that data collection took place in a large group in a purpose-built laboratory.

Thus, I will make the new study an explicitly behavioural assessment of the participant's judgement of the social reliability of a prospective interactant, and the neighbourhood they reside in, based on the level of ambient residential maintenance of their particular neighbourhood. Further, participants will be run individually in a psychology laboratory booth designed for single occupancy (see Appendix A: Chapter 3. ESSEXLab Follow-up Study: Study 2 Method section for details on how these and other alterations will be implemented).

4. Why Maintenance Matters: Disorder in the Built Environment and Physical Health

> It is not too much to say that an adequate solution of the housing question is the foundation of all social progress. Health, and housing, are indissolubly connected. If this country is to be the country which we desire, a great offensive must be taken against disease and crime, and the first point at which the attack must be delivered is the ugly, unhealthy, overcrowded house, in the mean street, which we all of us know too well.
>
> — King George V, Speech to representatives of British Local Authorities, 1919.

4.1. Introduction

It is now over a century since King George V (monarch of the United Kingdom; 1910-1936) made this observation regarding the centrality of housing in tackling the structural inequalities experienced by disadvantaged urban populations. His remarks, addressed to representatives of local authorities in the Britain of the day, resonated with emerging research, and practice, on both sides of the Atlantic (Park & Burgess, 1925; and the “Addison Act” – Housing and Town Planning [United Kingdom] Act, 1919). Housing continues to be recognised as one of the key determinants of an individual’s life outcomes in the neighbourhood effects literature, a field that typically takes the residential neighbourhood as the principal ecological unit of analysis (Galster, 2012; Krieger & Higgins, 2002; Ribeiro, 2018; Sampson, 2011, 2012).

Established findings about the respiratory health consequences of living in damp conditions are perhaps the most obvious way in which poor housing functions as a

vector of disease at the household-level (Shaw, 2004). However, recent work by Clair and Hughes (2019) has demonstrated how tenure type and housing typology also impact individual-level physical health outcomes for residents.

Over the last decade there has been a renewed interest in identifying exactly how physical aspects of residential housing in particular, and built environment more broadly, “get under the skin” and affect the health not only of those who dwell within, but reside and commute among, disorderly and deteriorating buildings (Corcoran et al., 2018; Galster, 2012; Keizer et al., 2008, 2013; Kruger et al., 2011; Sampson, 2012; Volker, 2017).

In parallel, across the different disciplines that constitute the neighbourhood effects literature (e.g., social epidemiology, public health, health geography, and medical sociology), there is a growing acknowledgement that unpacking the “black box” of neighbourhood effects will require a principled theoretical approach that proposes plausible causal pathways between the area-level neighbourhood context and individual-level health; that is a concerted effort to answer not only the “why?” (ultimate) question, but the “how?” (proximate) question, too (Glaster, 2012; Prior et al., 2018; Ribeiro, 2018; van Ham & Manley, 2012). As Prior and colleagues (2018) have asserted, this is best achieved by adopting a biosocial approach to the subject; one which recognises that chronic stress is most likely to play a key mediating role between the neighbourhood context and individual-level health outcomes.

Recent work in social science from an evolutionary perspective has identified a candidate cognitive mechanism that might account for the contribution the physical built environment plays in this process (Hill et al., 2014; Keizer et al., 2008, 2013; Nettle, 2015; O’Brien & Wilson, 2011). Community perception, as we have reviewed

in the General Introduction and Chapter 2, was hypothesised by Daniel O'Brien and David Sloan Wilson as a cognitive mechanism that humans, as an ultra-social group-living species, might have evolved (2011). They speculated that, as humans must inevitably negotiate not only their own familiar physical and social environments but also unfamiliar ones, it would be adaptive to be able to rapidly infer the kinds of social agents that might reside there, and their likely behaviour in any subsequent interaction. In their foundational studies conducted in US city of Binghamton, which have gone on to inspire similar work in groups in the UK (the Prosocial Place Programme in Liverpool, Corcoran et al., 2018; and the Tyneside Neighbourhoods Project in Newcastle; Nettle, 2015), they found that participants were able to make accurate assessments of the social environment of unfamiliar neighbourhoods using only images of the built environment as stimulus (O'Brien & Wilson, 2011).

More recently, O'Brien and colleagues completed a meta-analysis of public health studies that have examined the association between physically disordered neighbourhoods and life-limiting health conditions (O'Brien et al., 2019). They identified three possible pathways from area-level urban disorder to negative individual-level health consequences, which are prevalent in this literature. O'Brien and colleagues characterize Pathway 1 as a direct effect route, where *cross-norm disinhibition*, which proponents claim results from individuals simply witnessing evidence of transgressive behaviour in the disorderly environment, leads not only to similar misdemeanors being perpetrated by residents and visitors alike, but other forms of risky, health endangering behaviours, too (Keizer et al., 2008; Rachele et al., 2016). Pathway 2 is characterized as an indirect effect route, where the disorderly environment leads residents to withdraw from the public realm, resulting in reduced physical exercise and the concomitant deterioration in both physical and

mental health. Pathway 3, also characterized as an indirect effect route, is labelled the psycho-social pathway by O'Brien and colleagues, and it describes the process whereby the presence of disorder serves as an ever-present reminder of the threatening, and therefore stress-inducing, neighbourhood in which the resident lives. O'Brien and colleagues only found evidence supporting pathway 3, and even that came with methodological caveats and the qualification that there was no consistent evidence for disorder's impact on physical health (2019).

This psycho-social framing and finding is consistent with Jos Brosschot's generalized unsafety theory of stress (GUTS; Brosschot et al., 2018). A hypothesis also derived from an evolutionary perspective, GUTS predicts that a disorderly neighbourhood (which Brosschot and his colleagues would characterize as a "compromised domain", 2018, p. 12) would trigger a stress response, even in the absence of conventionally understood stressors, on account of the absence of cues of safety. This is a crucial nuance on the typical characterization, as propounded by researchers like O'Brien and colleagues (2019), which presumes that disorder is salient as a cue of the mediated presence of a threat.

The GUTS framework predicts that the absence of signals of reliable co-operative conspecifics, or the agents more colloquially known as trustworthy neighbours, which in this context would be cues of a disordered and poorly maintained neighbourhood realm, will increase the perceived burden of daily living, and thus lead to chronic exposures to social stress (Brosschot et al., 2018).

These frameworks together suggest a relationship between community perception and physical health. However, to date, the relationship between community perception and physical health has not been directly tested; we think the construct is

well placed, regarding the particular vector that the materiality of the residential built environment constitutes, to contribute to the project of finding a plausible process theory for the pathway between neighbourhood-level and household-level factors, and individual-level health.

Thus, the present study integrates the constructs of community perception (O'Brien & Wilson, 2011) and GUTS (Brosschot et al., 2018) to conduct an analysis of the effect levels of physical disorder in the residential neighbourhood, including litter and the maintenance of domestic gardens, has on physical health, using C-reactive protein (CRP) as a biomarker for physical health. A reliable indicator of chronic inflammation (Clair & Hughes, 2019; Pearson et al., 2003), CRP is a biomarker associated with chronic stress, and thus we consider it a good measure for examining the hypothesised causal pathway from place to health (Prior et al., 2018).

4.2. Methods

The present study uses data from Waves 2 and 3 of the UK Household Longitudinal Study (UKHLS); a nationally representative study of approximately 40,000 households (University of Essex, 2010, 2018). Information on CRP is taken from the nurse health assessment subsample (n = 13,517) of UKHLS, a selection which determines the upper limit of our sample size. The nurse visits occurred within five months of the main survey interviews (all data collected between 2010 and 2012: Wave 2 sample 10,175; Wave 3 sample 3,342). Further details regarding the nurse health assessment methodology and the collection and processing of the biomarkers are available in McFall et al. (2014) and Benzeval et al. (2014).

CRP levels above 3 mg/L are associated with chronic stress and cardiovascular disease, whilst levels above 10 mg/L are associated with the body's acute response to an infection (Benzeval et al., 2014; Pearson et al., 2003). As this thesis is investigating the health consequences of chronic exposures to disorder in the built environment and not acute disease, I excluded participants with CRP results above this acute category cut-off point. I then linked CRP, along with the individual-level and household-level control variables (see Measures), to the study's metadata on household-level and area-level factors regarding the built environment in which the participants reside (data collected on the Address Record Forms [ARF] by the NatCen [National Centre of Social Research] interviewers who were employed to conduct the survey). The present study combines these two waves of the UKHLS, treating them as a single cross-sectional sample for the purpose of this analysis. In cases where a variable required for our planned analysis was only collected at the wave prior to, or succeeding, the nurse visit, this thesis extrapolates across the two waves.

The necessary licence to conduct the research was granted by the UK Data Service (Project 118841).

Measures

The five items selected for use in computing our Maintenance Index (MI) from the ARF were as follows:

- Item 1) "Does the address have an unkempt garden?" (0=*No* or 1=*Yes*);
- Item 2) "Are any of the following present or within sight or hearing of the address? Trash, litter or junk in the street/road?" (0=*No* or 1=*Yes*);

- Item 3) “Are any of the following present or within sight or hearing of the address? Boarded houses, abandoned buildings, or demolished houses?” (0=*No* or 1=*Yes*);
- Item 4) “Which of these best describes the condition of residential properties in the area?” (*Mainly good* = 1, *Mainly fair* = 2, *Mainly bad* = 3 *Mainly very bad* = 4);
- and Item 5) “How is the external condition of the address relative to other residential properties in the area?” (*Better* = 1, *About the same* = 2, *Worse* = 3).

Initially, to examine the cumulative effect of exposure to poor standards of residential maintenance and physical disorder, the index was simply the sum of these five items from the ARF.

Since three of the selected variables had been coded so that 1 represented the presence of the negative characteristic, and 0 represented the alternative, with the remaining two variables coded 1-4 and 1-3 respectively, the initial iteration of the index simply dichotomized these remaining items to make a uniform scoring scale (with *mainly good*/*mainly fair* coded as 0 and *mainly bad*/*mainly very bad* coded as 1 for item 4, and *better* and *about the same* coded as 0 and *worse* coded as 1 for item 5). Thus, the MI was a measure of how many of the adverse characteristics the participant was exposed to (0-5).

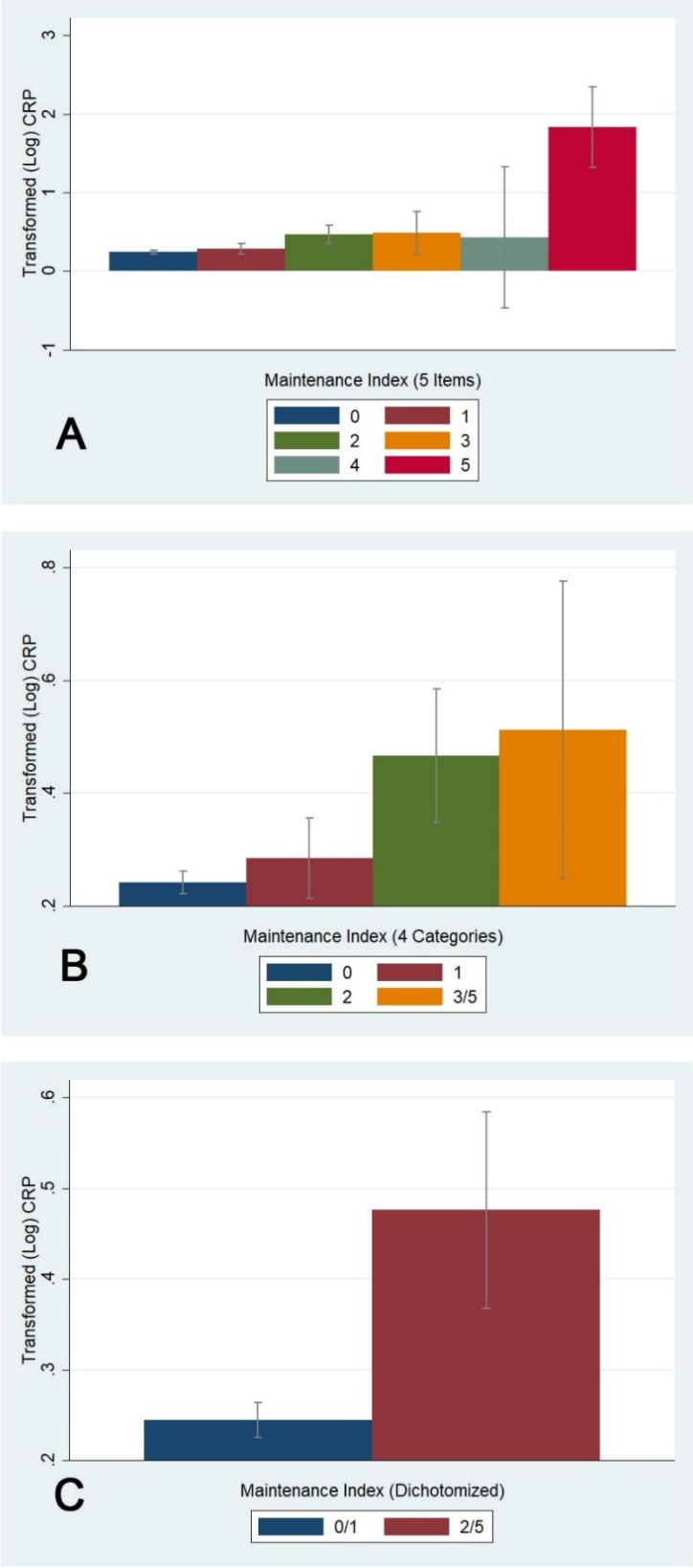
One nuance to this method of computing the final score was the instance where the response to item 4 regarding the condition of residential properties in the area was coded 1 (*Mainly bad* or *Mainly very bad*), and item 5 was initially coded 2 (*About the*

same) and would thus be coded 0 in the proposed scheme. In this case, as the condition of being “about the same” as properties in poor condition is clearly a negative state, a property with this combination of scores would receive an additional negative score to capture its relative condition.

Due to small cell sizes at the upper end of the scale, and overlapping confidence intervals across the range, for analytical purposes it was necessary to truncate the scale. After initial assessments of different numbers of categories determined by cell sizes (creating categories with at least 20 entries; see diagnostic graph B in Figure 4.1), it was decided that the scale should be dichotomised (see graph C in Figure 4.1).

It was not deemed substantively valid to collapse all MI categories into one; clearly, experiencing a single MI factor is more similar to not experiencing any, than to experiencing all five. On examining the diagnostic descriptive graphs (Figure 4.1), it was clear that the overlapping categories confidence intervals fall into two; so, we dichotomised the scale 0 and 1. Thus, a score of 0 or 1 maintenance issues results in an MI of 0 – the absence of issues regarding maintenance, and a score of 2 or more results in an MI of 1 – the presence of issues regarding maintenance (See Table 4.1 for descriptive statistics of the MI).

Figure 4.1 *Descriptive Diagnostic Graphs for the Maintenance Index (MI)*



Note. Maintenance Index (MI) computed from 5 metadata items recorded on the Address Record Forms by UKHLS interviewers prior to contact with household. Error bars show standard errors

Table 4.1 *Maintenance Index (MI) Descriptives (weighted)*

	MI = 0		MI = 1	
	n	%	*n*	%
Litter				
Present	115	1.25	181	45.46
Absent	9093	98.75	218	54.54
Unkempt Garden				
Present	351	3.82	298	74.6
Absent	8856	96.18	101	25.4
Dilapidated Buildings				
Present	44	0.47	90	22.45
Absent	9164	99.53	309	77.55
Neighbourhood Built Env.				
Fair	9132	99.18	317	79.44
Poor	75	0.82	46	20.56
Relative Condition				
Better	878	9.54	17	4.16
About the Same	8156	88.57	139	34.91
Worse	174	1.89	243	60.93
n	9208	95.85	399	4.15
	Mean	SD	Mean	SD
C-reactive Protein (CRP) mgL	2.01	2.00	2.42	2.18
CRP log transformed	0.23	1.02	0.44	1.01
Age		SD (min/max)		SD (min/max)
	50.38	16.95 (20/95)	43.27	14.87 (20/94)

Note. N= 9,607 (weighted). Neighbourhood Built Env. = Neighbourhood Built Environment.

Control variables

Clair and Hughes (2019) have found that living in the private rented sector or a home other than one that is detached is associated with higher CRP levels. I therefore include housing tenure and housing typology as controls in the present study, along with a binary measure regarding whether the respondent would like to remain in their current home.

To measure socioeconomic position (SEP) I used two variables, highest educational qualification, and an indicator of income. Following the method adopted by Clair and Hughes (2019), for statistical analysis, the indicator of income was equivalised by age and divided into quartiles, where income reflected gross household income in the month before survey response, equivalised using the modified Organisation for

Economic Co-operation and Development equivalence scale (OECD, n.d.), adjusted for inflation (inflation data from https://data.oecd.org/price/inflation-cpi.htm.).

Further, as the planned analysis echoed the approach adopted more generally by Clair and Hughes (2019), we also included those control variables they had selected in order to adjust for established associations with CRP; namely, age and sex (Benzeval et al., 2014); ethnicity and employment status; smoking status and BMI (categorised using standard WHO classifications, World Health Organisation, 2022); and a binary self-report indicator of longstanding illness. Descriptive statistics for these control variables appear in Table 4.2.

We excluded participants with any of the control variables missing, leaving an analytical sample of *N* = 9,607 (weighted; *N* = 10,775 unweighted). Weighting was applied using the combined Understanding Society (General Population Sample) and BHPS cross-sectional weights. All models apply inverse-probability weights to address differential sampling and response probabilities.

Table 4.2 *Control Variables Descriptives (weighted)*

	MI = 0		MI = 1		p-value*
	n	%	n	%	
Gender					0.925
Female	5018	54.46	208	52.23	
Male	4193	45.54	191	47.77	
Employment status					<0.001
Employed	5624	61.08	216	54.15	
Unemployed	408	4.43	62	15.58	
Retired	2332	25.33	42	10.42	
Maternity/caring	561	6.1	44	10.95	
Long-term sick/disabled	282	3.06	35	8.89	
Ethnicity					<0.001
White British	8097	87.93	307	77.04	
Other White	443	4.81	34	8.43	
Asian	388	4.21	36	9.05	
Other	280	3.04	22	5.48	
Highest Qualification					<0.001
Degree	2225	24.16	64	16.05	
Other (higher education)	1152	12.51	46	11.74	
A-level and similar	1720	18.68	69	17.31	
GCSE and similar	1803	19.58	90	22.53	
Other qualifications	1017	11.04	39	9.7	
No qualifications	1291	14.02	90	22.67	
Income Quartile (equiv.)					<0.001
1	2397	26.03	214	53.55	
2	2342	25.44	88	22.14	
3	2252	24.46	52	13.09	
4	2217	24.07	45	11.22	
Long-standing illness					<0.001
Yes	3245	35.24	170	42.6	
No	5963	64.76	229	57.4	
Smoking Status					<0.001
Smoked or Smoker	5465	59.36	269	67.41	
Never smoked	3742	40.64	130	32.59	
BMI					<0.001
18.5 to under 25	2854	31	118	29.49	
25 to below 30	3669	39.85	141	35.43	
30 to below 40	2432	26.41	120	30.14	
40 and above	253	2.75	20	4.94	
Dwelling type					<0.001
Detached	2409	26.16	26	6.62	
Semidetached	3006	32.64	107	26.81	
Terrace	2580	28.02	176	44.13	
Flat	1214	13.18	89	22.44	
Tenure					<0.001
Owned outright	3117	33.85	43	10.83	
Owned with mortgage	3639	39.52	106	26.64	
Social rent	1331	14.46	154	38.55	
Private rent	1121	12.18	96	23.99	
Prefer to move home					<0.001
Yes	3251	35.31	197	49.38	
No	5957	64.69	202	50.62	
Age	Mean	SD (min/max)	Mean	SD (min/max)	
	50.38	16.95 (20/95)	43.27	14.87 (20/94)	<0.001

Note. *Student's *t*-tests for continuous variables and chi-square test for categorical
BMI = body mass index (categorised); GCSE = General Certificate of Secondary Education;
equiv. = equivalised gross household income, standardised by age.
N = 9,607 (weighted)

4.3. Results

Within our sample the mean CRP was 2.03 (untransformed) with *SD* of 2.01, minimum 0.1 and maximum 10.0. Over a fifth of the analytical sample (22.17 percent, weighted) had raised CRP (above 3 mg/L). CRP was positively skewed and so was log transformed for the analysis.

Prior to proposing the series of hierarchical multiple regression models outlined here, an assessment of potential bias at the interviewer level was conducted. As the metadata of the ARF used to compute the maintenance index was harvested from the observations of interviewers (*N* = 677), it is plausible that some characteristic at this level of the data structure could introduce bias into our results (e.g., interviewer's perceptual appraisal of the built environment might be systematically biased by their developmental history). To examine if there was any significant effect of clustering at the level of the interviewer, we first ran an analysis using the interviewer ID as the absorbed categorical factor and compared it to the equivalent hierarchical multiple regression. The results were not substantively different, F (676, 10074) = 0.984, p = 0.607. Thus, we proceed with a single-level analysis strategy.

In model one of Table 4.3 I report the associations between the MI and our inflammatory marker, controlling for the housing characteristic already identified as being significantly associated with the measure by Clair and Hughes (2019). I then introduce further controls in blocks; demographic and socioeconomic (model 2) and health and health behaviours (model 3). Interactions between tenure, housing type, sex, and the MI were examined, but none were found to be significant (they are not reported here). All reported coefficients are unstandardized (on account of the

complex survey data structure not facilitating the computation of standardized results).

Table 4.3 *Hierarchical Multiple Regression Models Predicting Log of C-reactive protein*

	B SE	B SE	B SE
	Model 1	Model 2	Model 3
Maintenance Index	0.157*	0.161*	0.130*
	(0.071)	(0.069)	(0.062)
Dwelling Type (ref: Detached)			
Semi-detached	0.105***	0.093**	0.064*
	(0.029)	(0.029)	(0.027)
Terrace	0.163***	0.159***	0.124***
	(0.033)	(0.034)	(0.031)
Flat	0.107*	0.136**	0.149***
	(0.048)	(0.045)	(0.043)
Housing Tenure: (ref: Owned outright)			
Owned with a mortgage	-0.221***	0.028	-0.012
	(0.027)	(0.033)	(0.031)
Social rent	0.093*	0.145**	0.057
	(0.043)	(0.046)	(0.043)
Private rent	-0.123*	0.151**	0.112*
	(0.050)	(0.054)	(0.051)
Prefer to stay	0.091**	0.030	0.045
	(0.028)	(0.027)	(0.025)
Demographic and SEP controls included	N	Y	Y
Health and health behaviour controls included	N	N	Y

Note. Demographic and socioeconomic position controls: Age, gender, ethnicity, employment status, highest educational qualification, and income quartile (age standardised).

Health and health behaviour controls: Smoking status, body mass index (categorised), long-standing illness or disability.

N= 9,607 (weighted).

*P<0.05; **P<0.01; ***P<0.001

Results of regression analysis indicate that, with housing characteristics, demographic and socioeconomic, and health and health behaviours controlled for, participants resident in properties where the immediate built environment is in a poor state of maintenance, have significantly higher CRP than those whose households are resident in areas where maintenance is not considered an issue (B = .130, *p* = .035). Regarding the housing characteristics identified by Clair and Hughes (2019) as predicting levels of CRP, and therefore introduced here as controls, significantly,

a substantively similar pattern of results were returned as in their original study (Table 4.3). This finding is evidence that the effect of maintenance on CRP is largely independent of these other household-level characteristics.

4.4. Discussion

This thesis's proxy for physical health, the inflammatory marker CRP, is significantly associated with the maintenance condition of the immediate residential area participants live in, after controlling for the established individual-level and household-level factors (Benzeval et al., 2014; Clair & Hughes, 2019). This result, which is consistent with the growing series of studies examining the effect of the residential built environment on both physical and mental health from an evolutionary perspective (Brosschot et al., 2018; Corcoran et al., 2018; Kruger et al., 2011), highlights why residential maintenance should matter to public health agencies.

The present study represents the first attempt to integrate O'Brien and Wilson's work on community perception with Brosschot and colleagues GUTS construct, towards unpacking the black box of the causal pathways from the neighbourhood context to individual-level physical health; a project that is widely recognised as crucial in the neighbourhood effects literature (Glaster, 2012; Prior et al., 2018; Ribeiro, 2018; van Ham & Manley, 2012). Whilst most would agree with King George V, that the housing and health are "indissolubly connected", clearly, what is less settled is the nature of this relationship.

In Schulz and Northridge's (2004) ambitious attempt to identify the pathways through which social factors contribute to different environmental exposures and

consequently health inequalities, they conceptualised the built environment as “all of the buildings, spaces, and products that are created or significantly modified by people” (p. 456). As such, the built environment is clearly an area of our lives which is both physically malleable and policy amenable, and therefore an area which, if studied, can be manipulated to improve outcomes. Furthermore, I agree with Ribeiro (2018) that, if variations in health outcomes depend on contextual factors, then “interventions toward residential, social, and physical environments become essential” (p. 1).

I propose that community perception, with a minor reframing from a construct where disorder in the built environment functions as an index of ambient threat, broadly defined, to one where disorder in the built environment functions both as a cue of threat and as an index of the availability of reliable social partners, provides a theoretical approach, once integrated with Brosschot’s GUTS (2019) construct, to better understand the disease vector the disorderly built environment constitutes, and a toolkit to assist in the creation of therapeutic area-level interventions.

Inside the Black Box

As I foregrounded in the General Introduction, in my view, Brosschot and colleagues’ GUTS framework (2018) is a corollary of Coan and colleagues’ (Beckes & Coan, 2011) social baseline theory (SBT). GUTS builds on SBT to recognise that the safety signalled by proximity to trustworthy conspecifics in and of itself is a critical cue, and is thus among the most salient information in the visual and auditory environment of our residential neighbourhoods. It is the absence of such unambiguous signals of safety that leads, if Brosschot and colleagues are correct, to the chronic stress exposures that are widely recognised as leading to negative health consequences

across the life course (Brosschot et al., 2017, 2018; McEwen, 1998; Prior et al., 2018). To adopt a behavioural ecologist's approach suggested by this framework, the absence of the evidence of effort expended in the upkeep of a neighbourhood's built environment functions as a cue of the local bioenergetic burden residents find themselves under, and leads to the heuristic; people around here do not have the time, or the energy, to take care of even their own neck of the woods, let alone engage in prosocial behaviour with others.

Additionally, I speculate that the material evidence of such benign neglect itself, together with the ambient levels of malign denigration, may further tax the already chronically stressed resident still further on account of the embodied "call to action" such a dilapidated environment presents to a territorial and ultra-social species (Taylor, 1988; Wilson, 2012).

This latter speculation is consistent with a stigmergic, or more precisely sematectonic, account of the potential impact the residential built environment, as a medium, has on humans; primed as we are to attend to the solicitations of affordances, both physical and social, in our environment (Heylighen, 2016; Rietveld & Kiverstein, 2014; Wilson, 1975, 2012). Hence, with this minor reframing of community perception, to a construct where maintenance levels in the residential built environment functions both as a cue of threat and as an index of the availability of reliable social partners, we believe the theory has great potential utility to intervention-minded public bodies.

Building on the Evidence

Thus, the built environment sector; from the commissioning of architectural services, through the planning and construction phases, and beyond to long-term

maintenance scheduling, is a field where both societal and health benefits may accrue if an objective evidential basis for community perception can be secured. For instance, we can imagine, in an echo of the quote with which we started the present study, community perception researchers working productively with various local government departments to inform both day-to-day practices (e.g., identifying the priorities for the maintenance of both the public realm and the residential properties managed by the local authorities, as a function of their relative impact on community perception), as well as longer term projects and priorities (e.g., the commissioning of buildings considered, from concept to completion, relative to their function as assets to community perception – specifying materials, construction techniques, and maintenance schedules that stimulate prosociality, trust, and thus a health promoting public realm).

As we have already learnt, in encouraging work being led by Michelle Kondo and Charles Branas in the US, teams comprising academic and federal government researchers, regional and local governmental agencies, and residents' associations, are already remediating vacant lots and abandoned buildings as sustainable, evidence-led, solutions to both crime reduction and improving mental and physical health (Branas et al., 2016; Branas et al., 2018; Kondo et al., 2015). They have found that these remediation interventions can dramatically reduce violent crime rates — with a reduction of 30-40% in cases of gun violence; improve the well-being of residents — a 46% decrease in self-reported depression and 16% decrease in self-reported mental illness; and in the process save significant state and federal expenditure on both crime prevention and public health spending — for every $1 spent on the interventions, it was calculated that between $25 and $300 was saved

from police, social care and health care state and federal budgets (Branas, 2018; MacDonald et al., 2019).

Limitations

There are at least four potential limitations concerning the results of this study. Firstly, for pragmatic reasons we extrapolate a number of variables from one wave to the other on account of them only being recorded at one point – a reasonable process given the data assets available, but not one without its drawbacks. For instance, we assume a continuity of health behaviours such as smoking status across the two waves.

Secondly, although the present study leverages two waves of the UKHLS, it is a cross sectional design, and thus we only report the association between the maintenance index and CRP at a single point in time, and do not have evidence of a causal relationship. That said, given the experimental and quasi-experimental work of Kondo, Branas, and colleagues, it appears reasonable to assume that a causal relationship does exist between disorderly neighbourhoods and their residents' physical health (Branas, 2018; MacDonald et al., 2019; South et al., 2018).

Thirdly, the other factors commonly considered as contributing to the causal mechanisms of the neighbourhood effect (e.g., air pollution) are not included in our analysis (Galster, 2012) due to their absence from the UKHLS data asset.

Finally, the relatively small sample size of our exposure group (n = 399, weighted) is also an artefact of the data assets available. Future work should search internationally for data assets that can address all, or some, of these shortcomings.

Conclusion

Residential maintenance matters to peoples' physical health. Different fields across the social sciences are looking to influence public policy by leveraging such findings to design interventions that promote better health outcomes in deprived neighbourhoods. Adopting a nuanced approach to community perception, one informed by generalised unsafety theory of stress (Brosschot et al., 2018; O'Brien & Wilson, 2011; O'Brien et al., 2019), I proposed a novel pathway to account for how a disordered and dilapidating built environment is associated with elevated CRP. Future work will look to further elucidate the proximate mechanisms that underlie this process, in the hope that it will lead to still more impactful evidence-based policy proposals.

5. General Discussion

> Various forms of storage are used: gradients of pheromones, material structures (impregnated or not by chemical compounds), or spatial distribution of colony elements. Such structures materialize the dynamics of the colony's collective behavior and constrain the behavior of individuals through a feedback loop. (Theraulaz & Bonabeau, 1999, p. 111)

> The perception that others are not trusting and do not help spreads from person to person through the cues they leave in the environment. Those cues are not just in the broken windows and litter on the streets. (Daniel Nettle, 2015, p. 122)

This thesis is focused on better understanding how aspects of the social environment are crystallised in the residential built environment, and in particular the proximate environmental, behavioural, and perceptual mechanisms that account for how our interaction with the residential built environment modulates both our social behaviour and physical health.

Building on O'Brien and Wilson's construct of community perception, in the General Introduction we first reviewed the emerging literature that examines life in the urban environment from an evolutionary perspective (Corcoran et al., 2018; O'Brien & Wilson, 2011; Nettle, 2015) before turning our attention to recent intervention-focused experimental (Keizer et al., 2008; Keizer et al., 2013) and applied work (Branas et al., 2011; Branas et al., 2018; Kondo et al., 2015; Kondo et al., 2016; MacDonald et al., 2019; MacDonald et al., 2022). Both strands of research, evolutionary and intervention-focused, acknowledged the need for a better

understanding of the proximate processes that account mechanistically for their respective results; a project often characterised as unpacking the black box in the neighbourhood effects literature (Prior et al., 2018; van Ham & Manley, 2012).

We then proceeded to a review of, firstly, the relevant neuroscientific literature (Barrett, 2017a; Coan & Beckes, 2011; Delgado et al., 2005; Fouragnan et al., 2013; Freedberg & Gallese, 2007; Frith & Frith, 2006; Gallese, 2015; Gallese & Gattara 2015; Singer et al., 2006), and a recent innovation in stress research (Brosschot et al., 2018), before considering relevant consilience programmes (Malafouris, 2015; Mallgrave, 2015; Penn & Turner, 2018), in search of the constituent elements of an inchoate candidate mechanism.

Once this was completed, we specified a theoretical framework informed by the foregoing review and subsequently designed an empirical approach to test it that comprised both experimental and observational studies; following the advice of Stulp et al. (2016). Thus, this thesis's investigation was undertaken through three principal studies, two experimental (Chapters 2 and 3) and one observational (Chapter 4), which together developed our understanding of the attitudinal, behavioural and physiological consequences of attending to, and residing in, places with differing levels of residential maintenance. Whilst the experimental studies built directly upon the established literature reviewed, the observational study grew out of an interrogation of the opportunities afforded from the available data assets.

To conclude this thesis, I first summarise the results for each of the three empirical chapters and situate the findings within the established, motivating, literature. Next, I assess the overall contribution of this thesis and its implications for the established literature. Finally, I consider its limitations, make some intervention-focused

recommendations, and look to the future to identify opportunities to build on the groundwork established herein.

5.1. Summary of the Empirical Chapters

5.1.1. Chapter 2

In Chapter 2 I employed an eye tracking paradigm to examine the first of my research questions: How do we epistemically forage unmaintained (disorderly) vs. maintained (orderly) urban environments, and what impact, if any, does a poorly maintained environment have on our assessment of trustworthiness of the unknown others who reside there?

I reported that, consistent with my predictions, participants gazed for longer at regions of disorder in images of the residential built environment and gave correspondingly lower social trust ratings to residents imagined to be from the streets depicted. These results represented the first direct demonstration of community perception using an eye tracking paradigm and were consistent with O'Brien and Wilson's foundational work (2011).

Interpreting these findings through a Bayesian model of selective attention based on active inference (Mirza et al., 2016; Mirza et al., 2019;) and a psychometric approach to life history strategies (Figueredo et al, 2014), I suggest that participants conditioned their attitude towards the trustworthiness of imagined residents of the depicted neighbourhoods based on the maintenance level, and those participants with a slower life history strategy (as indicated from the Mini-K results) were significantly more trusting than those who had fast strategies. Dwell duration, our

proxy for the resolution of Friston's prediction error (Friston, 2010), was significantly longer in the unmaintained condition, and the duration of the gaze at disorderly areas of the stimulus was negatively associated with social trust; the longer prediction errors take to resolve, the lower the level of social trust participants ascribe to those imagined to reside therein. And, finally, whilst it was only a small effect, participants were also significantly *quicker* to attend to regions of disorder in the viewing session, evidence that these cues were salient to the task of assessing social trust, as our scan-paths are, from an active inference perspective (see Mirza et al., 2019), optimised to epistemically forage a given scene for the most task-relevant information.

5.1.2. Chapter 3

Chapter 3 used the stimuli generated in Chapter 2 and a behavioural economics paradigm to address research question 2: Are our attitudes towards an unknown other affected by mere exposure to the affective prime of images of unmaintained versus maintained environments?

I predicted that participant's social economic behaviour would be affected by mere exposure to the prime, with maintenance-primed people being more trusting, and trustworthy, than those primed with the unmaintained condition. This prediction was motivated by the finding in Chapter 2 regarding maintenance level and elevated social trust ratings, and the growing literature that has demonstrated that brief exposures to environmental cues associated with deprivation and low neighbourhood social quality (i.e., the physical disorder of an unmaintained residential environment) can influence attitudinal states and behavioural choices (Haushofer & Fehr, 2014).

In its first iteration, where we tested if mere exposure to the affective prime in a neutral social framing would impact social behaviour, contrary to my prediction, we found no association between levels of residential maintenance and the behavioural probe for social trust and trustworthiness, a null result that we reviewed in light of multiple theoretical and methodological considerations. Subsequently, I redesigned the methodology of the study to reflect my view of the most experimentally relevant methodological limitations identified in the initial study's Discussion section and returned to the lab (see COVID 19 Impact Statement and Appendix A).

The redesigned study is now predicated on the conviction that maintenance levels function as a cue but not a prime. A position that holds that an explicit association between the maintenance cue and the identity of the prospective interactant is crucial if the information latent in the built environment is to affect decision-making.

5.1.3. Chapter 4

Chapter 4 leveraged the metadata from the UKHLS regarding the maintenance condition of the built environment in the vicinity of a focal household, to answer research question 3: Adjusting for the established individual-level and household-level factors that affect physical health, is the ambient maintenance level of the immediate vicinity of a domestic dwelling predictive of its residents' physical health status?

I created a novel scale of maintenance from these metadata items, the maintenance index (MI), to explore the relationship between this measure, and a biomarker for physical health. Consistent with my prediction, I found a significant association between the maintenance level of the focal property and its immediate built environment and the measure of the resident's level of chronic inflammation (CRP),

our proxy for physical health. I considered this result in the context of Jos Brosschot and colleague's GUTS framework (2018) and the stigmergic process of sematectonics (Heylighen 2016; Wilson, 1975, 2012), before briefly considering these two construct's implications for community perception as originally specified by O'Brien and Wilson (2011).

5.1.4. Conclusion of the Summary of the Empirical Chapters

Taken together, the results from Chapter 2 and Chapter 4 provide support for both the community perception construct as proposed by O'Brien and Wilson, and my proposed mechanistic account of the proximate pathway from the built environment to physical health. Further, to the best of my knowledge, Chapter 4 is the first empirical test of a prediction explicitly derived from Brosschot and colleagues' GUTS framework.

These results also provide researchers like Branas and colleagues, who have designed and delivered successful cleaning and greening interventions, with further evidence towards specifying the actual proximate processes that account for how a place "gets under the skin" to affect peoples' behaviour, health, and wellbeing. Evidence that should thus afford further refinements to the remediation protocols they institute with, one hopes, concomitant improvements in the intervention's efficacy.

5.2. Implications for the Established Literature

> More than that, SBT suggests that the group level model of "self" is the default—that our baseline estimate of resource availability assumes embeddedness in a social system, treating departures from the social system as inherently threatening and requiring an obligatory stress response. (Wilson & Coan, 2021, p. 7)

Community perception was proposed a little over a decade ago by two evolutionary minded social scientists, Dan O'Brien and David Sloan Wilson, building on cognate constructs from sociology and criminology (O'Brien & Wilson, 2011; Sampson et al., 1997; Wilson 2011; Wilson & Kelling, 1982). During the same year, James Coan and Lane Beckes introduced the social baseline theory (Beckes and Coan, 2011), building on findings from the attachment literature (Ainsworth et al., 1978; Bowlby, 1969); and the emerging field of social neuroscience (Clore & Ortony, 2000; Coan, 2008).

Recently, two of the architects of these two constructs, James Coan and David Sloan Wilson, have collaborated on a paper entitled *Groups as organisms* (2021), which ostensibly explores the value of SBT and multilevel selection thinking[1] in the therapeutic context, but which also proposes a radical restructuring of our approach to mental and physical health more broadly, and beyond to the regulatory effects our

[1] Multilevel selection theory (Wilson et al., 2008) is a framework for understanding how natural selection operates at different levels of organization, including individual and group levels. It contends that social behaviour can evolve through selection at multiple levels, with traits that benefit individuals often conflicting with those that benefit groups. This theory is important for understanding how social interactions and group dynamics can shape the evolution of complex behaviours such as social trust, co-operation, and altruism, and it provides a way to explain the emergence of social systems and their adaptations to changing environments.

relationships with family, friends, and community, have on our daily lives and senses of agency and wellbeing.

Beyond providing the first eye tracking evidence regarding the distribution of visual attention, and its consequences for social judgement, in support of the community perception construct, and a successful examination of the physical health consequences of residing in a neighbourhood with poor maintenance through a study motivated by both the community perception theoretical framework and Brosschot and colleagues GUTS proposal, I think the principal implication of the present thesis for the established literature is that it demonstrates the value of the theoretical integration of community perception and social baseline theory for our understanding of the built environment from a biosocial perspective.

The proximate mechanism proposed in this thesis, which is based on the active inference framework, extends and integrates the community perception and SBT frameworks by incorporating the work of Barrett on TEC (2017a, 2017b), Broschott and colleagues on GUTS (2018), as well as Turner on stigmergy (and sematectonics) and niche construction (Turner, 2000; Penn & Turner, 2018).

An extension which, I think, provides a blueprint for dissolving the common-sense but artificial boundaries between people, their social behaviour and physical health, and the place in which they reside. And, as foregrounded above, and in the Discussion sections of Chapters 2 and 4, the results reported in this thesis also contribute to the growing evidence base for advocating area-level interventions focused on addressing residential maintenance as a method of tackling both individual-level and community-level social and health issues (MacDonald et al., 2019; Ribeiro, 2018).

Trust as the Reduction of Uncertainty (and Free Energy)

As foregrounded in the General Introduction (p.32), from an active inference perspective, trust, whether it be social or personal, is fundamentally about the reduction of uncertainty about future states of the world (Schoeller et al., 2021).

According to Bayesian theory, our brain places “bets” on the reliability of a social resource based on a prior probability distribution of past social experiences, and the deployment of personal resources are in turn based on this prediction (Gross & Medina-DeVilliers, 2020). Trust, and the gradient of affect we experience towards its opposite, mistrust, is the psychological construct we use to give meaning to this embodied calculation.

Again, from within the active inference framework, trust can be understood as the extent to which two or more agents have aligned generative models, and it functions as a measure of the focal agent’s confidence in the other’s likely conduct in a given domain of common interest. In situations of personal trust, this usually results in both parties extending the boundaries of their agentic self to envelope the trusted other, or others, to the extent that the pooled bioenergetic, or actual, resources of the trusted dyad or group are experienced as available to all (see the *groups as organisms* proposal advocated by Wilson & Coan, 2021).

In this context, crucially, I propose that positive affect corresponds to a decrease in free energy, while negative affect aligns with an increase (Badcock et al. 2017). Consequently, negative moods motivate an organism to adaptively respond to unforeseen changes by accelerating the rate at which evidence is gathered. This involves prioritising recent sensory inputs over past experiences, enhancing sensitivity to environmental shifts, and minimizing prediction error. Therefore, in

situations of uncertainty concerning the trustworthiness of potential interactants, whether in personal or social circumstances, we increase our epistemic foraging (Mirza et al., 2016; Mirza et al., 2019).

5.3. Thesis Limitations

The empirical studies that constitute the present thesis are, by necessity, modest in their ambition. However, the hope is that by examining these somewhat simpler cases we may see more clearly aspects of the causal pathway from our perception of the effort expended on maintenance in residential built environment to physical health via the proximate mechanism this thesis proposes.

In the limitation subsections of Chapters 2 and 4's respective Discussion sections, I identified the distinct methodological limitations of the paradigms employed: this is one of the reasons for adopting Stulp and colleagues (2016) triangulation approach, however modest the methodological means at my disposal.

For instance, the ecological validity of the eye tracking paradigm, as well as its external validity given the composition of the sample (a limitation of both of this thesis's experimental studies) were foregrounded, with recommendations made to address these limitations should I, or another researcher, pursue these methodological lines of enquiry further.

However, the generalizability concerns of the experimental study of Chapter 2 are to some degree mitigated by the observational study of Chapter 4, predicated as it is on the same theoretical framework, but conducted using a the nationally representative subsample of the UKHLS.

A major limitation not addressed in any of the three empirical chapters' Discussion sections, however, is the absence from the present thesis's methodological approaches of an examination of the immediate or long-term bioenergetic consequences of exposures to environments with different levels of maintenance; the mechanism central to the framework this thesis is proposing. A shortcoming I will return to in the future research section below.

A theoretical limitation of the present thesis is the limited development of the implications of niche construction for the proposed framework, beyond its initial introduction via the work of Turner and Penn, and a recognition of its place among the theoretical considerations of Malaofouris's MET. This absence is a consequence of not having any empirical basis upon which to make any plausible claims from the results of the studies that constitute the present thesis. Future work will need to address this empirical and theoretical lacuna.

Despite these limitations, the empirical research this thesis does report can be seen as a first step towards integrating the two principal lines of research that motivated this research project, community perception and social baseline theory, constructs that, to my knowledge, have not been directly linked previously, despite the burgeoning collaboration between two of their respective architects.

5.4. Thesis Implications

> The built environment is where the symptoms and solutions to societies most complex challenges are played out.
>
> Public Practice, *Approach*.

As stated in Chapter 2's Discussion section, the selection of residential properties from the areas identified as the most deprived by the *English Indices of Deprivation* (2015) as experimental stimuli was primarily motivated by the recognition that if the margins between a compromised social environment and a healthy social environment can be bridged through a systematic maintenance intervention, then evidence to that effect from these neighbourhoods would be significant for future intervention-focused policy recommendations. The results reported in this thesis, and the studies conducted by Branas and colleagues that we have reviewed, are consistent with this supposition. However, the simple remediation of the residential built environment in these neighbourhoods, in and of itself, will, obviously, not a be a panacea.

This thesis contends that cues of maintenance function as a sematectonic store of the bioenergetic expenditure of conspecifics. The effort expended, following the logic of *Embodied Simulation*, being indexed in the visual diet of the built environment by the crystallised consequences of the goal-directed activity.

Maintenance thus conceived works in a graduated manner as a form of storage. It does so as a function of the material properties of the medium maintained, the legibility of the effort expended (determined by the idiosyncratic generative model of the agent making the assessment), and the public availability of the consequences of the maintenance in the visual diet. In such a scheme, people should value most that which is most time and effort intensive to maintain; for instance, a garden (see Taylor for an account of the significance of “high-demand gardening” as element of human territorial functioning, 1988). Critically, the known, or imagined (*predicted*, from an active inference perspective), identity of the conspecific responsible for conducting

the maintenance is crucially important, too. For it is from our assessment of whether our social system would benefit from their inclusion, whether through a single interaction or over a long-term relationship, that the positive behavioural, attitudinal, bioenergetic, and thus health, consequences follow.

For a multiplicity of reasons, the residents of neighbourhoods classified as experiencing the greatest concentration of deprivation, irrespective of the nature of their residential tenure, are likely to often find themselves close to “the edge” regarding the management of their bioenergetic reserves (Nettle, 2018), with multiple demands on their time, attention, and resources, both energetic and economic. In such circumstance, it is unlikely that expending energy and money on residential maintenance will be perceived to be a priority.

Additionally, dependent of tenure, residents in these neighbourhoods may simply be unable to undertake residential maintenance, or, should they have one, maintain a garden in a manner of their choosing, due to tenancy agreements or contractual arrangements between housing associations, private providers, or local council’s and their subcontractors.

In the absence of residents’ taking care of their neighbourhood themselves, for whatever reason, municipal authorities and their agents should intervene, but, I predict, with a calibrated attenuation of the benefits outlined above, as the conspecific responsible for the work will not necessarily be perceived as bioenergetically available to the focal agent’s social system (see Kondo et al., 2016, for evidence consistent with this prediction, as they found the most consistent significant reductions in more serious crimes around *community reuse* lots,

comprised of projects initiated and maintained by community groups, compared to local government initiated, contractor-maintained, *stabilisation* lots).

Thus, I recommend that not only the future design of residential housing and the specification of the materials from which they are constructed, as well as the ongoing maintenance schedules of the extant residential built environment, be considered from the perspective this thesis proposes (see the Discussion section of Chapter 4 for more on this), but that the design of tenancy agreements, and the provisions of subcontracted maintenance contracts, should be too.

For instance, the widespread policy of denuding both communal greenspaces and public sector housing of the hedges, “high-demand” planting, and tree-cover on account of either budgetary concerns regarding maintenance, or safety concerns regarding loitering and criminal behaviour, should be considered through the lens of the framework this thesis advances. For whilst local government agencies, and their sub-contractors, save time and thus resources from these policies, the residential communities they serve lose both the cues of long-standing (sometimes generational) maintenance “investments”, and contemporaneous, real-time, updates of information regarding the bioenergetic resources at the disposal of the neighbourhood’s residents.

Structural Inequalities and the Quality of Structures

I consider these recommendations regarding interventions across various policy areas a valuable contribution to the ongoing academic discourse. However, unless national and local governmental departments engage with these proposals, their true potential will not be realised, as many of the levers that can fundamentally affect the

spatial development and maintenance of the constructed environment are under their control, rather than individuals and their communities.

Proportionate universalism is a policy approach, introduced by Sir Michael Marmot (2010), that aims to reduce health inequalities by providing universal services, but with a greater scale and resource to those who need them most. It is based on the principle that everyone deserves access to quality public services, but that some people may need more support than others to achieve health and wellbeing.

In his report, Marmot (2010) argued that health inequalities are not inevitable, but are rather the result of social and economic injustices. He called for a proportionate universal approach to reducing health inequalities, by addressing the underlying structural inequalities, whereby everyone would have access to the same basic services, across social, economic, health, and cultural domains, but that those who need them most would receive additional support.

I contend that a genuinely proportionate universalism would relieve the majority of communities in disadvantaged areas of the daily burden of living close to, or actually on, “the edge” (Nettle, 2018), and thus free them to be able to gradually recalibrate their generative models, and thus their bioenergetic expenditure, towards more prosocial and sustainable habits of behaviour.

Furthermore, in my view, planning policy, at both national and local levels, could play a critical role in the delivery of proportionate universalism, and its ambition to tackle the wider social determinants of health. It could do so by setting clear expectations regarding proportionate levels of investment in our least advantaged wards, towns, and regions, as part of long-term spatial development plans designed to address longstanding structural inequalities. In the UK context, this could be achieved at a

local government level through the mechanism of the Local Plan, with the integration of insight from the Joint Strategic Needs Assessments produced by local public health departments (see Chang et al., 2022). However, this would require the national government to reverse the funding-cuts to local government, and public services and infrastructure more broadly, of the past 13 years, which have disproportionately affected councils serving the most disadvantaged areas (Fahy et al., 2023).

Additionally, both national and local government have a duty to act on biodiversity and climate change, across scales commensurate to their jurisdiction, maximise physical and mental wellbeing across the population, and protect and promote cultural and heritage assets, all of which are aspects of our common public realm which are beyond the scope of an individual household, and their neighbourhood, to affect. It is hoped that the modest proposals identified in this thesis will contribute towards achieving these aims.

5.5. Directions for Future Research

Adapting paradigms developed by Proffitt and colleagues to examine perceptions of the physical environment as a function of the participant's bioenergetic state (e.g., varying states of physical fitness [Bhalla & Proffitt, 1999], or taxed by a heavy backpack [Bhalla & Proffitt, 1999], or energized by a glucose drink [Schnall et al., 2010]), I propose the use of both mediated and in situ experimental protocols that expose participants to urban environments with manipulated states of maintenance, in order to explicitly examine the relationship between community perception and bioenergetic state.

Further, with the recent release of a proteomic panel (*N* 6180) of Understanding Society (2022), future studies should be designed, with the same methodology as the one conducted in Chapter 4, to leverage this data asset to assess the proteomic consequences of exposures to poor residential maintenance, using the MI I developed.

I believe that by adopting these two approaches, one experimental and one observational, I would begin to address the major methodological lacune identified in the Limitation subsection regarding the examination of the bioenergetic consequences of both acute and chronic exposures to disorderly built environments.

Additionally, and as signposted in the General Introduction, I think there are opportunities to contribute to the work that Corcoran and colleagues have been engaged in on specifying the community wellbeing construct (Atkinson et al., 2017; Atkinson et al., 2020). Particularly in light of Coan and Wilson's recent agenda setting paper regarding social systems, at all scales, as potential units of functional analysis (2021), and the growing interest in examining the built environment's place in the community wellbeing construct's theoretical framework (Lach et al., 2022).

Nettle (2017) has recently explored the phenomenon of hunger, and its consequences for both behavioural and psychological outcomes, in people with low socioeconomic status. He has observed that whilst there is a well-established social gradient in many of these phenotypes, for instance impulsivity-hyperactivity, irritability-aggression, and anxiety, no causal mechanism had been established to account for it. The hunger hypothesis is his proposal to address this deficiency.

The hunger hypothesis simply proposes that the chronic state of hunger prevalent in people from lower socioeconomic backgrounds is linked to the issues of financial

insecurity they face and may contribute to their observed behavioural and psychological patterns of response (Nettle, 2017). Nettle argues that addressing issues related to poverty and food insecurity could thus be an effective way to improve the mental and emotional wellbeing of those from lower socioeconomic backgrounds.

Hence, a further hypothesis that future work could test, which is a corollary of Nettle's hunger hypothesis, is whether the consequences of living in a residential neighbourhood where a focal agent's bioenergetic budget always has the burden of a "pending withdrawal", on account of a daily visual diet of unmaintained residential buildings, leads to a dysregulation of appetite. I would predict that, on account of the pending order-creating work the focal agent perceives as necessary to re-establish an ordered environment (Turner, 2000), additional caloric intake occurs, or is desired, even in the absence of any subsequent energetic expenditure occurring (which would be subjectively experienced as always feeling hungry).

This would lead to both a potentially unhealthy pattern of food consumption, with negative health consequences across the life course, and contribute to the negative social gradients in behavioural and psychological outcomes, that Nettle predicts (2017).

And finally, whilst the index of effort as a resource gradient has been the focus of this thesis, and maintenance the term used to describe it, future work could also explore other bioenergetically relevant indices of resource conditions, particularly, evidence of the socioeconomic context. Many researchers, including Corcoran (2018), and more recently Nettle (Boon-Falleur et al., 2023), have shown that cues related to

affluence influence social judgments, with social trust increasing with evidence of financial wealth.

Following the logic of the present thesis, and the framework it proposes, this relationship might not simply be a result of the psychosocial consequences of learnt associations (Marmot & Wilkinson, 2001), but also grounded in a sociomateriality (Rietveld & Kiverstein, 2014), where the properties of the materials, and functional designs, that constitute the visual diet of an affluent household or neighbourhood, and the affordances they offer in the quotidian tasks of life, via the focal agent's generative model, positively impact bioenergetic budgeting on account of the salubrious circumstances they furnish for action. Again, adopting paradigms developed by Proffitt and colleagues (Bhalla & Proffitt, 1999; Schnall et al., 2010) I can foresee a series of studies that explore the bioenergetic consequences of exposure in situ, or through mediation, to affluent interior and exterior environments.

Conclusion

This thesis has demonstrated that, as a measure of the energy expended in the residential built environment, maintenance plays a crucial mediating role in the pathway from places to people. It has argued that the integration of the constructed environment into the social system of the focal agent, and thus their bioenergetic budgeting, via an extended but transiently assembled cognitive system, represents a continuation of evolutionarily conserved adaptive strategies. Future work will endeavour to both confirm these results and leverage this insight to contribute to innovative area-level interventions that promote flourishing at all levels of our social systems, from the individual to the community, and beyond.

References

Abson, D. J., Von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., ... & Walmsley, D. (2014). Ecosystem services as a boundary object for sustainability. *Ecological Economics*, *103*, 29-37.

Ainsworth, M. D., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A Psychological study of the strange situation. Hillsdale*, NJ: Erlbaum.

Alós-Ferrer, C., & Farolfi, F. (2019). Trust Games and Beyond. *Frontiers in neuroscience*, *13*, 887. https://doi.org/10.3389/fnins.2019.00887

Ambady, N., Bernieri, F. J., & Richeson, J. A. (2000). Toward a histology of social behavior: Judgmental accuracy from thin slices of the behavioral stream. *Advances in Experimental Social Psychology, 32*, 201-271.

Anderson, M. L. (2010). Neural reuse: A fundamental organizational principle of the brain. *Behavioral and Brain Sciences*, *33*(04), 245-266.

Anderson, M. L. (2014) After phrenology: Neural reuse and the interactive brain. Cambridge, MA: MIT Press.

Anderson, M. L. (2015). Précis of after phrenology: neural reuse and the interactive brain. *Behavioral and Brain Sciences*, *16*, 1-22.

Anderson, M. L., Richardson, M. J., & Chemero, A. (2012). Eroding the boundaries of cognition: implications of embodiment (1). *Topics in Cognitive Science*, *4*(4), 717–730. https://doi.org/10.1111/j.1756-8765.2012.01211.x

Andreoni, J., & Miller, J. (2002). Giving according to GARP: An experimental test of the consistency of preferences for altruism. *Econometrica*, *70*(2), 737-753.

Atkinson, S., Bagnall, A., Corcoran, R., & South, J. (2017). What is community wellbeing? Conceptual review. *What Works*

Wellbeing. https://whatworkswellbeing.org/resources/what-is-community-wellbeing-conceptual-review/.

Atkinson, Sarah, Bagnall, Corcoran, R, Anne-Marie, South, Jane and Curtis, Sarah (2020) Being Well Together: Individual Subjective and Community Wellbeing. *Journal of Happiness Studies*, 21 (5). pp. 1903-1921.

Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science*, 211, 1390-1396.

Badcock, P. B., Davey, C. G., Whittle, S., Allen, N. B., & Friston, K. J. (2017). The Depressed Brain: An Evolutionary Systems Theory. *Trends in Cognitive Sciences*, *21*(3), 182–194. https://doi.org/10.1016/j.tics.2017.01.005

Bakker, M., van Dijk, A., & Wicherts, J. M. (2012). The rules of the game called psychological science. *Perspectives on Psychological Science, 7*, 543–554. doi:10.1177/1745691612459060

Barrett, L. F. (2017a). *How emotions are made: The secret life of the brain*. Pan Macmillan.

Barrett, L. F. (2017b). The theory of constructed emotion: an active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience*, *12*(1), 1-23.

Barrett, L.F., Wilson-Mendenhall, C.D., Barsalou, L.W. (2015). The conceptual act theory: a road map. In: Barrett, L.F., Russell, J.A., Editors. *The Psychological Construction of Emotion*. New York: Guilford.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype-activation on action. *Journal of Personality and Social Psychology*, 71(2), 230–244. doi:10.1037//0022-3514.71.2.230

Barsalou, L. W. (2008). Grounded cognition. *Annu. Rev. Psychol.*, *59*, 617-645.

Barsalou, L. W. & Sewell, D. R. (1984). Constructing representations of categories from different points of view. Emory Cognition Project Report #2, Emory University

Beckes, L., & Coan, J. A. (2011). Social baseline theory: The role of social proximity in emotion and economy of action. *Social and Personality Psychology Compass*, *5*(12), 976-988.

Beckes, L., Coan, J. A., & Hasselmo, K. (2013). Familiarity promotes the blurring of self and other in the neural representation of threat. *Social Cognitive and Affective Neuroscience*, *8*(6), 670–677. https://doi.org/10.1093/scan/nss046

Becker, S., Moscovitch, M., Behrmann, M., & Joordens, S. (1997). Long-term semantic priming: A computational account and empirical evidence. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*(5), 1059–1082. https://doi.org/10.1037/0278-7393.23.5.1059

Benzeval, M., Davillas, A., Kumari, M., & Lynn, P. (2014). Understanding society: the UK household longitudinal study biomarker user guide and glossary. *Institute for Social and Economic Research, University of Essex*.

Berg, J., Dickhaut, J. and McCabe, K. (1995) Trust, Reciprocity and Social History. *Games and Economic Behavior, 10*, 122-142. http://dx.doi.org/10.1006/game.1995.1027

Bhalla, M., & Proffitt, D. R. (1999). Visual-motor recalibration in geographical slant perception. *Journal of experimental psychology. Human Perception and Performance*, *25*(4), 1076–1096. https://doi.org/10.1037//0096-1523.25.4.1076

Black, C. J., Figueredo, A. J., & Jacobs, W. J. (2017). Substance, history, and politics: An examination of the conceptual underpinnings of alternative approaches to the life history narrative. *Evolutionary Psychology*, *15*(1), 1474704916670402.

Blais, A. R., & Weber, E. U. (2006). A domain-specific risk-taking (DOSPERT) scale for adult populations. *Judgment and Decision Making*, *1*(1), 33-47.

Boon-Falleur M, André J, Baumard N, & Nettle, D. (2023). Perceived wealth matters for stereotypes about trustworthiness, a cross-cultural analysis. *PsyArXiv; 2023*. DOI: 10.31234/osf.io/jbzph.

Borkenau, P., Mauer, N., Riemann, R., Spinath, F. M., & Angleitner, A. (2004). Thin slices of behavior as cues of personality and intelligence. *Journal of Personality and Social Psychology, 86*, 599-614.

Boyd, R., & Richerson, P. J. (1996, January). Why culture is common, but cultural evolution is rare. In *Proceedings-British Academy* (Vol. 88, pp. 77-94). Oxford University Press.

Bowlby, J. (1969). *Attachment and loss, Vol. 1: Attachment. Attachment and loss*. New York: Basic Books.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, 53(1), 371-399.

Branas, C. C., Cheney, R. A., MacDonald, J. M., Tam, V. W., Jackson, T. D., & Ten Have, T. R. (2011). A difference-in-differences analysis of health, safety, and greening vacant urban space. *American Journal of Epidemiology*, *174*(11), 1296-1306.

Branas, C. C., Kondo, M. C., Murphy, S. M., South, E. C., Polsky, D., & MacDonald, J. M. (2016). Urban blight remediation as a cost-beneficial solution to firearm violence. *American Journal of Public Health*, *106*(12), 2158-2164.

Branas, C.C. (2018, June 5). *Charles Branas: The Disease of Gun Violence.* [Video] Icahn School of Medicine. https://youtu.be/LtkVTpeCt_4

Branas, C. C., South, E., Kondo, M. C., Hohl, B. C., Bourgois, P., Wiebe, D. J., & MacDonald, J. M. (2018). Citywide cluster randomized trial to restore blighted vacant land and its effects on violence, crime, and fear. *Proceedings of the National Academy of Sciences*, *115*(12), 2946-2951.

Brosschot, J. F., Verkuil, B., & Thayer, J. F. (2016). The default response to uncertainty and the importance of perceived safety in anxiety and stress: An evolution-theoretical perspective. *Journal of Anxiety Disorders*, *41*, 22-34.

Brosschot, J. F., Verkuil, B., & Thayer, J. F. (2017). Exposed to events that never happen: Generalized unsafety, the default stress response, and prolonged autonomic activity. *Neuroscience and Biobehavioral Reviews*, *74*(Pt B), 287–296. https://doi.org/10.1016/j.neubiorev.2016.07.019

Brosschot, J., Verkuil, B., & Thayer, J. (2018). Generalized unsafety theory of stress: unsafe environments and conditions, and the default stress response. *International Journal of Environmental Research and Public Health*, *15*(3), 464.

Burks, S. V., Carpenter, J. P., & Verhoogen, E. (2003). Playing both roles in the trust game. *Journal of Economic Behavior & Organization*, 51(2), 195-216

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. New York: Routledge.

Camerer, C. F., Dreber, A., Holzmeister, F., Ho, T. H., Huber, J., Johannesson, M., Kirchler, M., Nave, G., Nosek, B. A., Pfeiffer, T., Altmejd, A., Buttrick, N., Chan, T., Chen, Y., Forsell, E., Gampa, A., Heikensten, E., Hummer, L., Imai, T., Isaksson, S., … Wu, H. (2018). Evaluating the replicability of social science experiments in

Nature and Science between 2010 and 2015. *Nature Human Behaviour*, *2*(9), 637–644. https://doi.org/10.1038/s41562-018-0399-z

Chang, M., Green, L., & Petrokofsky, C. (2022). *Public health spatial planning in practice: improving health and wellbeing*. Policy Press.

Chivers T. (2019). What's next for psychology's embattled field of social priming. *Nature*, *576*(7786), 200–202. https://doi.org/10.1038/d41586-019-03755-2

Clark, A. (1997). Being there: Putting brain, body and world together again. Cambridge MA: MIT Press.

Clark A. (1998) Embodied, situated, and distributed cognition. In A companion to cognitive science (eds., W Bechtel, G Graham), pp. 506–517. Malden, MA: Blackwell Publishing.

Clark, A. (2012). Dreaming the Whole Cat: Generative Models, Predictive Processing, and the Enactivist Conception of Perceptual Experience. *Mind*, *121*(483), 753–771. http://www.jstor.org/stable/23321783

Clark, A. (2015). *Surfing uncertainty: Prediction, action, and the embodied mind*. Oxford University Press.

Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis*, *58*(1), 7-19.

Clair A, & Hughes, A. (2019) Housing and health: new evidence using biomarker data. *J Epidemiol Community Health*; 73:256-262.

Clore, G. L., & Ortony, A. (2000). Cognition in emotion: Always, sometimes, or never? In L. Nadel, R. Lane & G. L. Ahern (Eds.), The Cognitive neuroscience of emotion (pp. 24–61). New York: Oxford University Press.

Coan, J. A. (2008). Toward a neuroscience of attachment. In J. Cassidy & P. R. Shaver (Eds.), Handbook of attachment: Theory, research, and clinical applications, 2nd edn (pp. 241–265). New York: Guilford Press.

Coan, J. A., & Sbarra, D. A. (2014). Social Baseline Theory: The Social Regulation of Risk and Effort. *Current Opinion in Psychology*, *1*, 87–91. doi:10.1016/j.copsyc.2014.12.021

Collins, N. L., & Feeney, B. C. (2004). Working models of attachment shape perceptions of social support: evidence from experimental and observational studies. *Journal of Personality and Social Psychology*, *87*(3), 363.

Conger, R. D., & Donnellan, M. B. (2007). An interactionist perspective on the socioeconomic context of human development. *Annual Review of Psychology*, *58*, 175.

Corcoran, R (n.d.) Professional Profile. https://www.prosocialplace.co.uk/professional-profiles/

Corcoran, R., & Marshall, G. (2016). Planning for wellbeing. *The Prosocial Place Programme: Institute of Psychology Health and Society and Heseltine Institute of Public Policy & Practice, University of Liverpool, UK*.

Corcoran, R., Mansfield, R., Giokas, T., Hawkins, A., Bamford, L., & Marshall, G. (2017). Places change minds: Exploring the psychology of urbanicity using a brief contemplation method. *SAGE Open, 7*(2), 429. doi:10.1177/2158244017707004.

Corcoran, R., Mansfield, R., de Bezenac, C., Anderson, E., Overbury, K., & Marshall, G. (2018). Perceived neighbourhood affluence, mental health and wellbeing influence judgements of threat and trust on our streets: An urban walking study. *PloS one*, *13*(8), e0202412.

Corcoran, R., Richardson, A., Marshall, G. & de Bezenac, C. (2019). To dwell or not to dwell? Attentional and emotional responses to residential places, differing in subjective desirability. *Journal of Biourbanism*,*1*(7). https://journalofbiourbanism.org/2019/01/19/jbu-volume-vii-1-2018/

Cosmides, L. and Tooby, J. and Barkow, J. H. (1992). Introduction: Evolutionary Psychology and Conceptual Integration. In J. H. Barkow, L. Cosmides and J. Tooby (eds), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 3-15). New York: Oxford University Press.

Cox J. C. (2004). How to identify trust and reciprocity. *Games Econ. Behav.* 46, 260–281. 10.1016/S0899-8256(03)00119-2

Churchill, W. (1943) *House of Commons Rebuilding: 28 October 1943*. Retrieved from http://hansard.millbanksystems.com/commons/1943/oct/28/house-of-commons-rebuilding

Croll, D. A., Maron, J. L., Estes, J. A., Danner, E. M., & Byrd, G. V. (2005). Introduced predators transform subarctic islands from grassland to tundra. *Science*, *307*(5717), 1959-1961.

Curtis, S., Congdon, P., Atkinson, S., Corcoran, R., MaGuire, R., & Peasgood, T. (2020). Adverse conditions for wellbeing at the neighbourhood scale in England: Potential and challenges for operationalising indicators relevant to wellbeing in and of places. *Wellbeing, Space and Society*, *1*, 100009-100009.

Damasio, H., Tranel, D., Grabowski, T., Adolphs, R., & Damasio, A. (2004). Neural systems behind word and concept retrieval. *Cognition*, *92*(1), 179-229.

Davis, D. D., & Holt, C. A. (2021). *Experimental economics*. Princeton University Press.

Dehaene, S. (2005). Evolution of human cortical circuits for reading and arithmetic: The “neuronal recycling” hypothesis. In S. Dehaene, J.-R. Duhamel, M. D. Hauser, & G. Rizolatti, (Eds.), *From monkey brain to human brain* (pp. 133-57). Cambridge, MA: MIT Press.

Delgado, M. R., Frank, R. H., & Phelps, E. A. (2005). Perceptions of moral character modulate the neural systems of reward during the trust game. *Nature Neuroscience*, *8*(11), 1611-1618.

Demekas, D., Parr, T., & Friston, K. J. (2020). An investigation of the free energy principle for emotion recognition. *Frontiers in Computational Neuroscience*, *14*, 30.

Duncan, G. J., Magnuson, K., Kalil, A., & Ziol-Guest, K. (2012). The importance of early childhood poverty. *Social Indicators Research*, *108*(1), 87-98.

Earls, F. J., Brooks-Gunn. J, Raudenbush, S.W., & Sampson, R.J. (1994) Project on Human Development in Chicago Neighbourhoods: Community Survey, 1994-1995. Instrument. Retrieved from https://www.icpsr.umich.edu/files/PHDCN/community-survey.pdf

Eizenman, M., Yu, L.H., Grupp, L., Eizenman, E., Ellenbogen, M., & Gemar, M. (2003). A naturalistic vision scanning approach to assess selective attention in major depressive disorder. *Psychiatry Research, 118*, 117–128. doi: 10.1016/SO165-1781(03)00068-4.

Ekman, P. (1972). Universal and Cultural Differences in Facial Expression of Emotions. In J. Cole (Ed.), Nebraska Symposium on Motivation (pp. 207-283). Lincoln: University of Nebraska Press.

Ellis, B. J., Bianchi, J., Griskevicius, V., & Frankenhuis, W. E. (2017). Beyond risk and protective factors: An adaptation-based approach to resilience. *Perspectives on Psychological Science*, *12*(4), 561-587.

Eyelink II [Apparatus and software]. (2004) Mississauga, Ontario, Canada: SR Research

Fahy, K., Alexiou, A., Mason, K., Bennett, D., Egan, M., Taylor-Robinson, D., & Barr, B. (2023). Inequalities in local government spending on cultural, environmental and planning services: a time-trend analysis in England, Scotland, and Wales. *BMC Public Health*, *23*(1), 408. https://doi.org/10.1186/s12889-023-15179-9

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2013). G*Power Version 3.1.7 [computer software]. Uiversität Kiel, Germany. Retrieved from

http://www.psycho.uniduesseldorf.de/abteilungen/aap/gpower3

Figueredo, A. J., Wolf, P. S. A., Olderbak, S. G., Gladden, P. R., Fernandes, H. B. F., Wenner, C., ... & Rushton, J. P. (2014). The psychometric assessment of human life history strategy: A meta-analytic construct validation. *Evolutionary Behavioral Sciences*, *8*(3), 148.

Figueredo, A. J., Garcia, R. A., Menke, J. M., Jacobs, W. J., Gladden, P. R., Bianchi, J., ... & Li, N. P. (2017). The K-SF-42: A new short form of the Arizona Life History Battery. *Evolutionary Psychology*, *15*(1), 1474704916676276.

Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, *10*(2), 171-178.

Foulsham, T., & Kingstone, A. (2017). Are fixations in static natural scenes a useful predictor of attention in the real world?. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale*, *71*(2), 172.

Fouragnan, E., Chierchia, G., Greiner, S., Neveu, R., Avesani, P., & Coricelli, G. (2013). Reputational priors magnify striatal responses to violations of trust. *The Journal of Neuroscience*, *33*(8), 3602-3611.

Freedberg, D. and Gallese, V. (2007) Motion, Emotion and Empathy in Aesthetic Experience. *Trends in Cognitive Science*. Vol. 11 (5): 197-203.

Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron*,*50*(4), 531-534.

Friston, K. J. (2010). The free-energy principle: A unified brain theory? *Nature Reviews Neuroscience*, *11*, 127–138.

Friston, K., Mattout, J., & Kilner, J. (2011). Action understanding and active inference. *Biological Cybernetics*, *104*(1-2), 137–160. http://doi.org/10.1007/s00422-011-0424-z

Friston, K., Schwartenbeck, P., Fitzgerald, T., Moutoussis, M., Behrens, T., & Dolan, R. J. (2013). The anatomy of choice: active inference and agency. *Frontiers in Human Neuroscience*, *7*, 598. https://doi.org/10.3389/fnhum.2013.00598

Friston, K., FitzGerald, T., Rigoli, F., Schwartenbeck, P., & Pezzulo, G. (2017). Active inference: a process theory. *Neural Computation*, *29*(1), 1-49. https://doi.org/10.1162/NECO_a_00912

Friston, K., Da Costa, L., Sajid, N., Heins, C., Ueltzhöffer, K., Pavliotis, G. A., & Parr, T. (2022). The free energy principle made simpler but not too simple. *arXiv preprint arXiv:2201.06387*.

Fumagalli L, Knies G and Buck N (2017) *Understanding Society The UK Household Longitudinal Study Harmonised British Household Panel Survey (BHPS) User Guide*. Colchester: University of Essex.

Gallese V. (2007). Embodied simulation: from mirror neuron systems to interpersonal relations. *Novartis Foundation Symposium*, *278*, 3–221.

Gallese, V. (2014). Bodily selves in relation: embodied simulation as second-person perspective on intersubjectivity. *Phil. Trans. R. Soc. B*, *369*(1644), 20130177.

Gallese, V. (2015). Embodied simulation and the space around us: The perspective of cognitive neuroscience. *Keynote at the ICSC Rome*.

Gallese, V., Fadiga, L., Fogassi, L., Rizzolatti, G., (1996). Action recognition in the premotor cortex. *Brain 119*, 593–609.

Gallese, V., Keysers, C., & Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in Cognitive Sciences*, *8*(9), 396-403.

Gallese V., & Gattara A. (2015). Embodied simulation, aesthetics and architecture: an experimental aesthetic approach. In S. Robinson & J. Pallasmaa J. (Eds.), *Mind in Architecture: Neuroscience, Embodiment, and the Future of Design* (pp. 161–179). Cambridge, MA: MIT Press.

Galster, G. C. (2012). The mechanism (s) of neighbourhood effects: Theory, evidence, and policy implications. In: van Ham, M., Manley, D., Bailey, N., Simpson, L., Maclennan, D. (eds) *Neighbourhood effects research: New perspectives.* Springer, Dordrecht. https://doi.org/10.1007/978-94-007-2309-2_2

Gattara, A., & Gallese, V. (2015). The space around our workplace. The notion of embodiment within the everyday office environment. *Cognitive Processing*, *16*, S54-S54.

Gilbert, P. (1992). *Depression: The evolution of powerlessness*. New York: Guildford Press.

Goldberg, D. P., & Williams, P. (1988). A User's Guide to the General Health Questionnaire (NFER-NELSON, Windsor). *Goldberg A User's Guide to the General Health Questionnaire1988*.

Goldberg, D. P., Gater, R., Sartorius, N., Ustun, T. B., Piccinelli, M., Gureje, O., & Rutter, C. (1997). The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychological Medicine*, *27*(1), 191-197.

Gong Y., Palmer S., Gallacher J., Marsden T., & Fone D. (2016). A systematic review of the relationship between objective measurements of the urban environment and psychological distress. *Environment International 2016*; 96: 48-57. https://doi.org/10.1016/j.envint.2016.08.019 PMID: 27599349

Google (n.d.). [Athol_St_Burnley]. Retrieved February 17, 2018, from https://goo.gl/maps/rKF7JkHLS3zzwZ1B6

Google (n.d.). [Beresford_Rd_Liverpool]. Retrieved February 17, 2018, from https://goo.gl/maps/d6Z4kuan4ox6f26h7

Google (n.d.). [Burnley_Rd_Blackburn]. Retrieved February 17, 2018, from https://goo.gl/maps/7X9ZpgjpAV1grqnP9

Google (n.d.). [Carshalton_Rd_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/8KmZt2JyoD9sSvon9

Google (n.d.). [Cocker_St_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/svNjtG2z6R7ke6B4A

Google (n.d.). [Elizabeth_St_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/kwqdmm6zY6XUhMDk9

Google (n.d.). [Erdington_Rd_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/b3Zz9cd8yJixVBGZ8

Google (n.d.). [Fell_St_Liverpool]. Retrieved February 17, 2018, from https://goo.gl/maps/dBtXvvKHPEJboyqS9

Google (n.d.). [George_St_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/rcHsQrzSiKMfyZQx8

Google (n.d.). [Lilley_Rd_Liverpool]. Retrieved February 17, 2018, from https://goo.gl/maps/EK2VfnfPgxrSkB1t9

Google (n.d.). [Lorne_St_Liverpool]. Retrieved February 17, 2018, from https://goo.gl/maps/nt3kAar9mazW5oG36

Google (n.d.). [Lovett_St_Cleethorpes]. Retrieved February 17, 2018, from https://goo.gl/maps/7WaqQY2Wi6cDomndA

Google (n.d.). [Mansel_St_Grimsby]. Retrieved February 17, 2018, from https://goo.gl/maps/HxYTsVJEmKBLFdhn6

Google (n.d.). [Milbourne_St_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/nfAjsgfhSi9wRjfh7

Google (n.d.). [Park_St_Cleethorpes]. Retrieved February 17, 2018, from https://goo.gl/maps/gbuHrjZiUVWpdgxRA

Google (n.d.). [Prescot_Rd_Liverpool]. Retrieved February 17, 2018, from https://goo.gl/maps/5ppfzdmt6YX3pz3i8

Google (n.d.). [Rydal_Ave_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/iPUrjchRGp2zPZe17

Google (n.d.). [Selbourne_Rd_Blackpool]. Retrieved February 17, 2018, from https://goo.gl/maps/XtYGEXpgGX6m1iKT9

Google (n.d.). [Sutton_Place_Liverpool]. Retrieved February 17, 2018, from https://goo.gl/maps/ZLf8TwGbwRLKW3CGA

Google (n.d.). [Toft_St_Liverpool]. Retrieved February 17, 2018, from https://goo.gl/maps/1BQANsZuScZYC8Bf7

Grassé, P. P. (1959). La reconstruction du nid et les coordinations interindividuelles chez *Bellicositermes natalensis* et *Cubitermes sp.* la théorie de la stigmergie: Essai d'interprétation du comportement des termites constructeurs. *Ins. Soc* **6**, 41–80 https://doi.org/10.1007/BF02223791

Gross, E. B., & Medina-DeVilliers, S. E. (2020). Cognitive processes unfold in a social context: a review and extension of social baseline theory. *Frontiers in Psychology*, *11*, 378.

Haahr, M. (2020, March 4). RANDOM.ORG: True Random Number Service. Retrieved from https://www.random.org

Hair, J., Black, W. C., Babin, B. J. & Anderson, R. E. (2010) *Multivariate data analysis* (7th ed.). Upper Saddle River, New Jersey: Pearson Educational International.

Harrison, N. R., Youssef, F. F., & Lyons, M. (2019). Brief exposure to pictures depicting poor environments leads to increased consumption of beer in adult social drinkers. *Substance Use & Misuse, 54*(4), 681–691. https://doi.org/10.1080/10826084.2018.1536151

Haselton, M. G., & Buss, D. M. (2000). Error management theory: a new perspective on biases in cross-sex mind reading. *Journal of Personality and Social Psychology*, *78*(1), 81.

Haushofer, J., & Fehr, E. (2014). On the psychology of poverty. *Science (New York, N.Y.)*, *344*(6186), 862–867. https://doi.org/10.1126/science.1232491

Hargreaves Heap, S. P., & Zizzo, D. J. (2009). The value of groups. *American Economic Review*, *99*(1), 295-323.

Heins, R. C., Mirza, M. B., Parr, T., Friston, K., Kagan, I., & Pooresmaeili, A. (2020). Deep active inference and scene construction. *Frontiers in Artificial Intelligence*, *3*, 509354.

Heyes C. (2001). Causes and consequences of imitation. *Trends in cognitive sciences*, *5*(6), 253–261. https://doi.org/10.1016/s1364-6613(00)01661-2

Heyes C. (2010). Where do mirror neurons come from?. *Neuroscience and biobehavioral reviews*, *34*(4), 575–583. https://doi.org/10.1016/j.neubiorev.2009.11.007

Heylighen, F. (2016). Stigmergy as a universal coordination mechanism I: Definition and components. *Cognitive Systems Research*, *38*, 4-13.

Hill, J. Pollet, T.V, & Nettle, D. (2014) Disorder affects judgements about a neighbourhood: police presence does not. *PeerJ* 2:e287

Holmqvist, K., & Andersson, R. (2017). Eye tracking: A comprehensive guide to methods. *paradigms and measures*. Lund, Sweden: Lund Eye-Tracking Research Institute.

Iwanaga, K., Blake, J., Yaghmaian, R., Umucu, E., Chan, F., Brooks, J. M., Rahimi, M., & Tansey, T. N. (2018). Preliminary Validation of a Short-Form Version of the Attachment Style Questionnaire for Use in Clinical Rehabilitation Counseling Research and Practice. *Rehabilitation Counseling Bulletin, 61(*4), 205-216. https://doi.org/10.1177/0034355217709477

James, D., Yates, J., & Ferguson, E. (2013). Can the 12-item General Health Questionnaire be used to identify medical students who might 'struggle' on the medical course? A prospective study on two cohorts. *BMC medical education*, *13*, 48. https://doi.org/10.1186/1472-6920-13-48

Jay, J., Miratrix, L. W., Branas, C. C., Zimmerman, M. A., & Hemenway, D. (2019). Urban building demolitions, firearm violence and drug crime. *Journal of behavioral medicine*, *42*, 626-634.

Johnson, N. D., & Mislin, A. A. (2011). Trust games: A meta-analysis. *Journal of Economic Psychology, 32*(5), 865–889. https://doi.org/10.1016/j.joep.2011.05.007

Jones, K. (1996). Trust as an affective attitude. *Ethics 107*.1 4-25.

Juster, R. P., McEwen, B. S., & Lupien, S. J. (2010). Allostatic load biomarkers of chronic stress and impact on health and cognition. *Neuroscience & Biobehavioral Reviews*, *35*(1), 2-16.

Kahneman, D. (2012). A proposal to deal with questions about priming effects (open letter via email).

Kahneman, D. (2017, February 14). Re: Reconstruction of a train

wreck: How priming research went off the rails [Blog comment]. Retrieved from: https://replicationindex.com/2017/02/02/reconstruction-of-a-train-wreck-how-priming-research-went-of-the-rails/comment-page-1/#comments.

Kaplan, S. (1992). Environmental preference in a knowledge-seeking, knowledge using organism. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 581-598). New York, NY: Oxford University Press.

Keizer K, Lindenberg S, Steg L. (2008). The spreading of disorder. *Science* 322:1681–1685 DOI 10.1126/science.1161405.

Keizer K, Lindenberg S, Steg L. (2013). The importance of demonstratively restoring order. *PLoS ONE* 8:e65137 DOI 10.1371/journal.pone.0065137.

Kellough, J. L., Beevers, C. G., Ellis, A. J., & Wells, T. T. (2008). Time course of selective attention in clinically depressed young adults: An eye tracking study. *Behaviour Research and Therapy, 46*(11), 1238–1243. doi: 10.1016/j.brat.2008.07.004.

Keysers, C. (2009). Mirror neurons. *Current Biology*, *19*(21), R971-R973.

Kilner, J. M., Friston, K. J., & Frith, C. D. (2007). Predictive coding: an account of the mirror neuron system. *Cognitive processing*, *8*(3), 159–166. https://doi.org/10.1007/s10339-007-0170-2

Klauer, K. C. (1997) Affective Priming, *European Review of Social Psychology*, 8:1, 67-103, DOI: 10.1080/14792779643000083

Klauer, K. C., & Musch, J. (2003). Affective priming: Findings and theories. *The psychology of evaluation: Affective processes in cognition and emotion*, *7*, 49.

Klinenberg, E. (2018). *Palaces for the people: How to build a more equal and united society*. Random House.

Kondo, M. C., Keene, D., Hohl, B. C., MacDonald, J. M., & Branas, C. C. (2015). A difference-in-differences study of the effects of a new abandoned building remediation strategy on safety. *PloS one*, 10(7), e0129582.

Kondo, M., Hohl, B., Han, S., & Branas, C. (2016). Effects of greening and community reuse of vacant lots on crime. *Urban Studies*, *53*(15), 3279-3295.

Krieger, J., & Higgins, D. L. (2002). Housing and health: time again for public health action. *American Journal of Public Health*, *92*(5), 758-768.ribe

Kruger, D. J., Munsell, M. A., & French-Turner, T. (2011). Using a life history framework to understand the relationship between neighborhood structural deterioration and adverse birth outcomes. *Journal of Social, Evolutionary, and Cultural Psychology*, 5(4), 260.

Kruger, J., Wirtz, D., Van Boven, L., & Altermatt, T. W. (2004). The effort heuristic. *Journal of Experimental Social Psychology, 40*(1), 91–98. https://doi.org/10.1016/S0022-1031(03)00065-9

Lach, N., McDonald, S., Coleman, S., Touchie, M., Robinson, J., Morgan, G., ... & Jakubiec, A. (2022). Community wellbeing in the built environment: towards a relational building assessment. *Cities & Health*, 1-19.

Lakoff, G. & Johnson, M. (1980) *Metaphors we live by*. Chicago, IL: University of Chicago Press.

Laland, K. N. (2001). The Extended Organism: The Physiology of Animal-Built Structures. *Perspectives in Biology and Medicine, 44*, 2, 297-300.

Laland, K., Matthews, B., & Feldman, M. W. (2016). An introduction to niche construction theory. *Evolutionary ecology*, *30*, 191-202.

Le, A. T., Payne, J., Clarke, C., Kelly, M. A., Prudenziati, F., Armsby, E., ... & Wilkins, A. J. (2017). Discomfort from urban scenes: Metabolic consequences. *Landscape and Urban Planning*, *160*, 61-68.

Lefebvre, H. (1991). *The production of space* (Vol. 142). Oxford: Blackwell.

Lindenberg, S., & Steg, L. (2007). Normative, gain and hedonic goal frames guiding environmental behavior. *Journal of Social issues*, *63*(1), 117-137.

Lindenberg, S., & Steg, L. (2013). Goal-framing theory and norm-guided environmental behavior. In H. C. M. van Trijp (Ed.), *Encouraging sustainable behaviour* (pp. 37-54). New York: Psychology Press

Linson, A., Clark, A., Ramamoorthy, S., & Friston, K. (2018). The Active Inference Approach to Ecological Perception: General Information Dynamics for Natural and Artificial Embodied Cognition. *Frontiers in Robotics and AI*, *5*, 21. https://doi.org/10.3389/frobt.2018.00021

Liu L, Feng T, Suo T, Lee K, Li H (2012) Adapting to the Destitute Situations: Poverty Cues Lead to Short-Term Choice. *PLoS ONE* 7(4): e33950. https://doi.org/10.1371/journal.pone.0033950

MacDonald, J., Branas, C., & Stokes, R. (2019). *Changing places: The science and art of new urban planning*. Princeton University Press.

MacDonald, J., Nguyen, V., Jensen, S. T., & Branas, C. C. (2022). Reducing crime by remediating vacant lots: the moderating effect of nearby land uses. *Journal of Experimental Criminology*, 1-26.

McElroy, E., Ashton, M., Bagnall, A. M., Comerford, T., McKeown, M., Patalay, P., ... & Corcoran, R. (2021). The individual, place, and wellbeing–a network analysis. *BMC Public Health*, *21*, 1-10.

McElroy, E., McIntyre, J. C., Bentall, R. P., Wilson, T., Holt, K., Kullu, C., ... & Corcoran, R. (2019). Mental health, deprivation, and the neighborhood social environment: a network analysis. *Clinical Psychological Science*, *7*(4), 719-734.

McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and allostatic load. *Annals of the New York Academy of Sciences*, *840*(1), 33-44.

McFall, S. L., Petersen, J., Kaminska, O. and Lynn, P. (2014). *Understanding Society: UK Household Longitudinal Study: Waves 2 and 3 Nurse Health Assessment, 2010-2012, Guide to Nurse Health Assessment*. Colchester: University of Essex.

McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist*, *53*(2), 185.

Malafouris, L. (2015). Metaplasticity and the primacy of material engagement. *Time and Mind*, *8*(4), 351-371.

Mariia, S., Tatiana, K. (2021). Affective Priming and Decision-Making in the Economic Game. In: Velichkovsky, B.M., Balaban, P.M., Ushakov, V.L. (eds) *Advances in Cognitive Research, Artificial Intelligence and Neuroinformatics.* Intercognsci 2020. Advances in Intelligent Systems and Computing, vol 1358. Springer, Cham. https://doi.org/10.1007/978-3-030-71637-0_30

Marmot, M. (2010). Fair society, healthy lives: The Marmot Review: Strategic review of health inequalities in England. Retrieved from https://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review/fair-society-healthy-lives-full-report-pdf.pdf

Marshall, G (n.d.) Professional Profile. https://www.prosocialplace.co.uk/professional-profiles/

Marx, K. (1867/1990). *Capital: A Critique of Political Economy. 1. 1.* London: Penguin.

Menary, R. (2007). *Cognitive integration: Mind and cognition unbounded*. Springer.

Menary, R. (2008). “Embodied Narratives” in the *Journal of Consciousness Studies, 15*(6), 63–84.

Microsoft. (2019). Microsoft Excel [Computer software]. Retrieved from https://www.microsoft.com/en-us/microsoft-365/excel

Microsoft. (2019). Microsoft PowerPoint [Computer software]. Retrieved from https://www.microsoft.com/en-us/microsoft-365/excel

Miyamoto, Y., Nisbett, R. E., & Masuda, T. (2006). Culture and the physical environment holistic versus analytic perceptual affordances. *Psychological Science*, *17*(2), 113-119.

Mirza, M. B., Adams, R. A., Mathys, C. D., & Friston, K. J. (2016). Scene construction, visual foraging, and active inference. *Frontiers in computational neuroscience*, *10*, 56.

Mirza, M. B., Adams, R. A., Friston, K., & Parr, T. (2019). Introducing a Bayesian model of selective attention based on active inference. *Scientific reports*, *9*(1), 1-22.

More, T. (1516/2002) *Utopia*. London: Penguin

Nettle, D. (2009) *Evolution and genetics for psychology*. Oxford: Oxford University Press.

Nettle, D. (2011). Behaviour of parents and children in two contrasting urban neighbourhoods: An observational study. *Journal of Ethology*, *30*, 109–116. http://doi.org/10.1007/s10164-011-0303-z

Nettle D., Colleony A., and Cockerill M. (2011). Variation in cooperative behaviour within a single city. *PLoS ONE* 6(10): e26922.

Nettle, D., R. Coyne and A. Colleony (2012). No country for old men: Street use and social diet in urban Newcastle. *Human Nature 23*: 375-85.

Nettle, D., Pepper, G. V., Jobling, R., & Schroeder, K. B. (2014). Being there: a brief visit to a neighbourhood induces the social attitudes of that neighbourhood. *PeerJ*, 2, e236. http://doi.org/10.7717/peerj.236

Nettle, D. (2015). *Tyneside Neighbourhoods: Deprivation, Social Life and Social Behaviour in One British City*. Cambridge: Open Book Publishers.

Nettle, D., & Frankenhuis, W. E. (2019). The evolution of life-history theory: a bibliometric analysis of an interdisciplinary research area. *Proceedings of the Royal Society B*, *286*(1899), 20190040.

Nettle, D., & Frankenhuis, W. E. (2020). Life-history theory in psychology and evolutionary biology: one research programme or two?. *Philosophical Transactions of the Royal Society B*, *375*(1803), 20190490.

Mallgrave, H. F. (2013). *Architecture and embodiment: the implications of the new sciences and humanities for design*. London: Routledge.

Mallgrave H. F. (2015a). Embodiment and enculturation: the future of architectural design. *Frontiers in Psychology*, *6*, 1398. https://doi.org/10.3389/fpsyg.2015.01398

Mallgrave H. F. (2015b). "Know thyself": or what designers can learn from the contemporary biological sciences. In Robinson, S., & Pallasmaa, J. (Eds.), *Mind in architecture: Neuroscience, embodiment, and the future of design*. (pp. 9–31) MIT Press.

Mehmetoglu, M., & Jakobsen, J. V. T. (2016). *Applied statistics using stata: A guide for the social sciences*. Thousand Oaks, CA: SAGE Publications

Molden, D. (2014). Understanding priming effects in social psychology: What is "social priming" and how does it occur? *Social Cognition, 32*(Supplement), 1–11. doi:10.1521/soco.2014.32.supp.1

Montgomery, B. W., & O'Brien, D.T. (2014). *Investigating the Psychological Effects of Growth* [Abstract]. Paper presented at the Eighth Annual Conference of Northeastern Evolutionary Psychology Society. New Paltz, NY.

O'Brien, D. T. (2013). An evolutionary model of the environmental conditions that shape the development of prosociality. *Evolutionary Psychology*. 12(2), 386-402.

O'Brien, D. T. (2015). Disorder perception is the adaptive interpretation of social cues, not just a sensitivity to randomness. *Frontiers in Psychology*, 6, 124.

O'Brien, D. T., Wilson, D. S., Eldakar, O. T., & Carpenter, J. P. (2007). [Experimental economics at Binghamton High School]. Unpublished raw data.

O'Brien D. T., & Wilson D. S. (2011). Community perception: the ability to assess the safety of unfamiliar neighbourhoods and respond adaptively. *J. Pers. Soc. Psychol*. 100, 606–620. 10.1037/a0022803

O'Brien, D. T., Gallup, A. C., & Wilson, D. S. (2012). Residential mobility and prosocial development within a single city. *American Journal of Community Psychology*. 50, 26-36.

O'Brien, D. T., & Kauffman Jr, R. A. (2013). Broken windows and low adolescent prosociality: Not cause and consequence, but co-symptoms of low collective efficacy. *American Journal of Community Psychology*, *51*(3-4), 359-369.

O'Brien, D. T., Norton, C. C., Cohen, J., & Wilson, D. S. (2014). Local adaptation in community perception how background impacts judgments of neighborhood safety. *Environment and Behavior*, 46(2), 213-240.

O'Brien, D. T., & Montgomery, B. W. (2015). The other side of the broken window: A methodology that translates building permits into an ecometric of investment by community members. *American Journal of Community Psychology*, *55*(1-2), 25-36

O'Brien, D. T., & Sampson, R. J. (2015). Public and private spheres of neighborhood disorder: Assessing pathways to violence using large-scale digital records. *Journal of Research in Crime and Delinquency*, *52*(4), 486-510.

O'Brien, D. T., Farrell, C., & Welsh, B. C. (2019). Broken (windows) theory: A meta-analysis of the evidence for the pathways from neighborhood disorder to resident health outcomes and behaviors. *Social Science & Medicine*, *228*, 272-292.

Odling-Smee, F. J., Laland, K. N., & Feldman, M. W. (1996). Niche construction. *The American Naturalist*, *147*(4), 641-648.

Odling-Smee, J., & Turner, J. S. (2011). Niche construction theory and human architecture. *Biological Theory*, *6*, 283-289.

OECD. (n.d.). Inflation (CPI). OECD Data. Retrieved April 7, 2023, from https://data.oecd.org/price/inflation-cpi.htm

Orquin, J. L., & Holmqvist, K. (2018). Threats to the validity of eye-movement research in psychology. *Behavior Research Methods*, *50*(4), 1645-1656.

Pallasmaa, J., Mallgrave, H. F., Robinson, S., & Gallese, V. (2015). Architecture and empathy. *Finland: Tapio Wirkkala Rut Bryk Foundation*.

Park, R. E., & Burgess, E. W. (1925). *The City*. Chicago, IL: University of Chicago Press.

Partridge, L., & Harvey, P. H. (1988). The ecological context of life history evolution. *Science*, *241*(4872), 1449-1455.

Pearlin, L. I., Schieman, S., Fazio, E. M., & Meersman, S. C. (2005). Stress, health, and the life course: Some conceptual perspectives. *Journal of Health and Social Behavior*, *46*(2), 205-219.

Peters, A., McEwen, B. S., & Friston, K. J. (2017). Uncertainty and stress: Why it causes diseases and how it is mastered by the brain. *Progress in Neurobiology*, 156, 164-188. https://doi.org/10.1016/j.pneurobio.2017.05.004[4]

Pearson, T.A., Mensah, G.A., Alexander, R.W., Anderson, J.L., Cannon, R.O., Criqui, M., et al. (2003) 'Markers of inflammation and cardiovascular disease: application to clinical and public health practice: A statement for healthcare professionals from the Centers for Disease Control and Prevention and the American Heart Association', *Circulation*, Vol. 107, pp. 499–511.

Penn, A., & Turner, J. S. (2018). Can we identify general architectural principles that impact the collective behaviour of both human and animal systems? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1753), 20180253.

Pezzulo, G., Parr, T., & Friston, K. (2022). The evolution of brain architectures for predictive coding and active inference. *Philosophical Transactions of the Royal Society B*, *377*(1844), 20200531.

Photoshop (CS) [Computer software] San Jose, CA: Adobe Inc

Pinter-Wollman, N., Penn, A., Theraulaz, G., & Fiore, S. M. (2018). Interdisciplinary approaches for uncovering the impacts of architecture on collective

behaviour. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1753), 20170232.

Plato., Lee, D. (1987). *Republic*. London: Penguin.

Price, M. E. (2011). Cooperation as a classic problem in behavioural biology. In V. Swami, Ed., *Evolutionary Psychology: A Critical Introduction* (pp. 73-106). London: BPS Blackwell

Prior, L., Manley, D., & Jones, K. (2018). Stressed out? An investigation of whether allostatic load mediates associations between neighbourhood deprivation and health. *Health & Place*, *52*, 25-33.

Prior, L., Manley, D., & Sabel, C. E. (2018). Biosocial health geography: New 'exposomic' geographies of health and place. *Progress in Human Geography*, 0309132518772644.

Proffitt, D. R. (2006). Embodied Perception and the Economy of Action. *Perspectives on Psychological Science*, *1*(2), 110–122. https://doi.org/10.1111/j.1745-6916.2006.00008.x

Propper, C., Jones, K., Bolster, A., Burgess, S., Johnston, R., & Sarker, R. (2005). Local neighbourhood and mental health: evidence from the UK. *Social Science & Medicine (1982)*, *61*(10), 2065–2083. https://doi.org/10.1016/j.socscimed.2005.04.013

Qualtrics. (n.d.). Qualtrics XM Platform. Retrieved from https://www.qualtrics.com/

Reid, C. R., Latty, T., Dussutour, A., & Beekman, M. (2012). Slime mold uses an externalized spatial 'memory' to navigate in complex environments. *Proceedings*

of the National Academy of Sciences of the USA, 109, 17490–17494. https://doi.org/10.1073/pnas. 1215037109

Rachele, J. N., Wood, L., Nathan, A., Giskes, K., & Turrell, G. (2016). Neighbourhood disadvantage and smoking: Examining the role of neighbourhood-level psychosocial characteristics. *Health & Place*, *40*, 98-105.

Reid, C. R., Beekman, M., Latty, T., & Dussutour, A. (2013). Amoeboid organism uses extracellular secretions to make smart foraging decisions. *Behavioral Ecology, 24*, 812–818.

Renfrew, C. (2003). *Figuring it Out: What are We? Where Do We Come From? : The Parallel Visions of Artists and Archaeologists.* London: Thames and Hudson.

Renfrew, C., Frith, C., & Malafouris, L. (2008). Introduction. The sapient mind: archaeology meets neuroscience. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1499), 1935-1938.

Ribeiro, A. I. (2018). Public health: why study neighborhoods?. *Porto biomedical journal*, *3*(1).

Ribeiro, A. I., Gullón, P., & Murray, E. T. (2022). Neighbourhood Influences on Population Health: Time to Unpack the Black Box. *Public health reviews*, *43*, 1605053. https://doi.org/10.3389/phrs.2022.1605053

Rietveld, E., & Kiverstein, J. (2014). A rich landscape of affordances. *Ecological Psychology*, *26*(4), 325-352.

Ross, C. E., & Mirowsky, J. (2001). Neighborhood disadvantage, disorder, and health. *Journal of Health and Social Behavior*, 258-276.

Richerson, P. J., & Boyd, R. (1998). The evolution of human ultra-sociality. *Indoctrinability, ideology, and warfare: Evolutionary Perspectives*, 71-95.

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research*, *3*(2), 131-141

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annu. Rev. Neurosci.*, *27*, 169-192.

Sampson, R. (2011). Neighborhood effects, causal mechanisms and the social structure of the city. In P. Demeulenaere (Ed.), *Analytical sociology and social mechanisms* (pp. 227-249). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511921315.012

Sampson, R. J. (2012). *Great American city: Chicago and the enduring neighborhood effect.* Chicago, IL: University of Chicago Press.

Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science*, *277*(5328), 918-924.

Satpute, A. B., & Lindquist, K. A. (2019). The default mode network's role in discrete emotion. *Trends in Cognitive Sciences*, *23*(10), 851–864. https://doi.org/10.1016/j.tics.2019.07.003

Saxbe, D. E., Beckes, L., Stoycos, S. A., & Coan, J. A. (2020). Social Allostasis and Social Allostatic Load: A New Model for Research in Social Dynamics, Stress, and Health. *Perspectives on Psychological Science : a Journal of the Association for Psychological Science*, *15*(2), 469–482. https://doi.org/10.1177/1745691619876528

Sbriscia-Fioretti, B., Berchio, C., Freedberg, D., Gallese, V., & Umiltà, M. A. (2013). ERP modulation during observation of abstract paintings by Franz. *PloS one*, *8*(10), e75241.

Schimmack, U., Heene, M., & Kesavan, K. (2017, February 2). Reconstruction of a train wreck: How priming research went off the rails. Replicability Index. Retrieved from https://replicationindex.wordpress.com/2017/02/02/reconstruction-of-a-train-wreck-how-priming-research-went-of-the-rails.

Schnall, S., Zadra, J. R., & Proffitt, D. R. (2010). Direct evidence for the economy of action: glucose and the perception of geographical slant. *Perception*, *39*(4), 464–482. https://doi.org/10.1068/p6445

Schoeller, F., Miller, M., Salomon, R., & Friston, K. J. (2021). Trust as extended control: Human-machine interactions as active inference. *Frontiers in Systems Neuroscience*, *15*, 669810. https://doi.org/10.3389/fnsys.2021.669810

Schroeder, K. B., Pepper, G. V., & Nettle, D. (2014). Local norms of cheating and the cultural evolution of crime and punishment: a study of two urban neighborhoods. *PeerJ*, *2*, e450. https://doi.org/10.7717/peerj.450

Schulz, A., & Northridge, M. E. (2004). Social determinants of health: implications for environmental health promotion. *Health Education & Behavior*, *31*(4), 455-471.

Sear, R. (2020). Do human 'life history strategies' exist?. *Evolution and Human Behavior*, *41*(6), 513-526.

Selye, H. (1976). *The stress of life* (Revised ed.). New York: McGraw-Hill.

Shaw M. (2004) Housing and public health. *Annu Rev Public Health*. 25:397-418. doi: 10.1146/annurev.publhealth.25.101802.123036. PMID: 15015927.

Sherman, J. W., & Rivers, A. M. (2021). There's nothing social about social priming: Derailing the "train wreck". *Psychological Inquiry, 32*(1), 11. https://doi.org/10.1080/1047840X.2021.1889312

Singer, T., Seymour, B., O'Doherty, J.P., Stephan, K.E., Dolan, R.J., Frith, C.D., (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature* 439, 466–469.

Sims, M., & Kiverstein, J. (2022). Externalized memory in slime mould and the extended (non-neuronal) mind. *Cognitive Systems Research*, *73*, 26-35.

Slingerland, E., & Collard, M. (Eds.). (2011). *Creating consilience: Integrating the sciences and the humanities*. Oxford University Press.

Smith, J. M., & Harper, D. (2003). *Animal signals*. Oxford University Press.

Smith, R., Ramstead, M.J.D. & Kiefer, A. (2022). Active inference models do not contradict folk psychology. *Synthese 200*, 81 https://doi.org/10.1007/s11229-022-03480-w

Smith, T., Noble, M., Noble, S., Wright, G., McLennan, D., & Plunkett, E. (2015). The English indices of deprivation 2015. London: Department for Communities and Local Government, 1-94.

South, E. C., Hohl, B. C., Kondo, M. C., MacDonald, J. M., & Branas, C. C. (2018). Effect of greening vacant land on mental health of community-dwelling adults: a cluster randomized trial. *JAMA Network Open*, *1*(3), e180298-e180298.

StataCorp. (2015). Stata Statistical Software: Release 14 [Computer software]. College Station, TX: StataCorp LP.

Stearns, S. C. (1992). *The evolution of life histories*. Oxford: Oxford University Press.

Stearns, S. C. (2000). Life history evolution: successes, limitations, and prospects. *Naturwissenschaften*, *87*(11), 476-486.

Stearns, S. C., & Rodrigues, A. M. (2020). On the use of “life history theory” in evolutionary psychology. *Evolution and Human Behavior*. https://doi.org/10.1016/j.evolhumbehav.2020.02.001

Steen, D. A., Barrett, K., Clarke, E., & Guyer, C. (2017). Conceptualizing communities as natural entities: A philosophical argument with basic and applied implications. *Biology & Philosophy*, *32*, 1019-1034.

Stulp, G., Sear, R., & Barrett, L. (2016). The reproductive ecology of industrial societies, part i. *Human Nature*, *27*(4), 422-444.

Świątkowski, W., & Dompnier, B. (2017). Replicability crisis in social psychology: Looking at the past to find new pathways for the future. *International Review of Social Psychology, 30*(1), Article 111-124. https://doi.org/10.5334/irsp.66

Theraulaz, G., & Bonabeau, E. (1999). A brief history of stigmergy. *Artificial life*, *5*(2), 97-116.

Tinbergen, N. (1963). On aims and methods of ethology. *Zeitschrift fur Tierpsychologie*, 20, 410–433.

Taylor, R. B. (1988). *Human territorial functioning: An empirical, evolutionary perspective on individual and small group territorial cognitions, behaviors, and consequences*. Cambridge: Cambridge University Press.

Tooby, J., & Cosmides, L. (1996). Friendship and the banker's paradox: Other pathways to the evolution of adaptations for altruism. In W. G. Runciman, J. M. Smith, & R. I. M. Dunbar (Eds.), *Evolution of social behaviour patterns in primates and man* (pp. 119–143). Oxford University Press.

Tomasello M. (2014). The ultra-social animal. *European Journal of Social Psychology*, *44*(3), 187–194. https://doi.org/10.1002/ejsp.2015

Tomasello, M & Wyman, E. (2009). The ontogenetic origins of human cooperation. In Dunbar, D & Barrett, L. (eds.), *Oxford Handbook of Evolutionary Psychology*. Oxford: Oxford University Press.

Trivers, R. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology*, 46, 35–57

Turner, J. S. (2000). *The extended organism: the physiology of animal-built structures*. Harvard University Press.

Turner, J. S. (2016). Homeostasis and the physiological dimension of niche construction theory in ecology and evolution. *Evolutionary Ecology*, *30*, 203-219.

Umilta, M. A., Berchio, C., Sestito, M., Freedberg, D., & Gallese, V. (2012). Abstract art and cortical motor activation: an EEG study. *Frontiers in human neuroscience*, *6*, 311.

Understanding Society. (2022, October 11). *New Biological Data from Understanding Society*. Retrieved from

https://www.understandingsociety.ac.uk/2022/10/11/new-biological-data-from-understanding-society

University of Essex. Institute for Social and Economic Research. (2010). *British Household Panel Survey: Waves 1-18, 1991-2009*. [data collection]. 7th Edition. UK Data Service. SN: 5151, http://doi.org/10.5255/UKDA-SN-5151-1

University of Essex and Institute for Social and Economic Research (2014) *Understanding Society: Waves 2 and 3 Nurse Health Assessment, 2010-2012 3rd Edition*. UK Data Service. SN: 7248. Available from: http://doi.org/10.5255/UKDA-SN-7251-3.

University of Essex, Institute for Social and Economic Research, NatCen Social Research, et al. (2018) *Understanding Society: Waves 1-7, 2009-2016 and Harmonised BHPS: Waves 1-18, 1991-2009 10th Edition*. UK Data Service. SN: 6614. Available from: http://doi.org/10.5255/UKDA-SN-6614-1.

Ursin, H. (1978). Activation, coping and psychosomatics. *Psychobiology of stress: A study of coping men*, 201-228.

van Ham, M., & Manley, D. (2012). Neighbourhood Effects Research at a Crossroads. Ten Challenges for Future Research Introduction. *Environment and Planning A: Economy and Space*, 44(12), 2787–2793. https://doi.org/10.1068/a45439

Veissière, S. P., Constant, A., Ramstead, M. J., Friston, K. J., & Kirmayer, L. J. (2020). Thinking through other minds: A variational approach to cognition and culture. *Behavioral and Brain Sciences*, *43*.

Volker, B. (2017). Revisiting broken windows: The role of neighborhood and individual characteristics in reaction to disorder cues. *Sociological Science*, *4*, 528-551.

Wicherts, J. M., & Bakker, M. (2014). Broken windows, mediocre methods, and substandard statistics. *Group Processes & Intergroup Relations*, *17*(3), 388-403.

Wilson-Mendenhall, C. D., Barrett, L. F., Simmons, W. K., & Barsalou, L. W. (2011). Grounding emotion in situated conceptualization. *Neuropsychologia*, *49*(5), 1105–1127. https://doi.org/10.1016/j.neuropsychologia.2010.12.032

Wilson, D.S. (2011) *The neighbourhood project: Using evolution to improve my city, one block at a time.* New York: Little, Brown and Company.

Wilson, D. S., Van Vugt, M., & O'Gorman, R. (2008). Multilevel selection theory and major evolutionary transitions: Implications for psychological science. *Current Directions in Psychological Science*, *17*(1), 6-9.

Wilson, D. S., O'Brien, D. T., & Sesma, A. (2009). Human prosociality from an evolutionary perspective: Variation and correlations at a city-wide scale. *Evolution and Human Behavior*, 30, 190–200.

Wilson, D. S., & Coan, J. A. (2021). Groups as organisms: Implications for therapy and training. *Clinical Psychology Review*, *85*, 101987. https://doi.org/10.1016/j.cpr.2021.101987

Wilson, E. O. (1975). *Sociobiology: The new synthesis.* Belknap Press of Harvard U Press.

Wilson, E.O. (1998) *Consilience: The unity of knowledge*. New York, NY: Knopf.

Wilson, E. O. (2012). *The social conquest of earth*. WW Norton & Company.

Wilson, J. Q., & Kelling, G. L. (1982). Broken windows. *Atlantic Monthly*, *249*(3), 29-38.

Whitham, T. G., Bailey, J. K., Schweitzer, J. A., Shuster, S. M., Bangert, R. K., LeRoy, C. J., ... & Wooley, S. C. (2006). A framework for community and ecosystem genetics: from genes to ecosystems. *Nature Reviews Genetics*, *7*(7), 510-523.

Wolfe, J. M. (2021). Guided Search 6.0: An updated model of visual search. *Psychonomic Bulletin & Review*, *28*(4), 1060-1092.

Wölfflin, H. (1994). Prolegomena to a Psychology of Architecture. In R. Vischer, H. F. Mallgrave, & E. Ikonomou (Eds.), *Empathy, form, and space: problems in German aesthetics, 1873-1893* (pp. 149–192). Santa Monica: Getty Center for the History of Art and the Humanities.

World Health Organization. (2022, March). A healthy lifestyle - WHO recommendations. https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations

Yarbus, A. L. (1967). Eye movements during perception of complex objects. In *Eye movements and vision* (pp. 171-211). Springer, Boston, MA.

Zhang, T., Li, F., Beckes, L., & Coan, J. A. (2013). A semi-parametric model of the hemodynamic response for multi-subject fMRI data. *NeuroImage*, *75*, 136-145.

Zhong, C. B., & Devoe, S. E. (2010). You are how you eat: fast food and impatience. *Psychological Science*, *21*(5), 619–622. https://doi.org/10.1177/0956797610366090

Appendix A: Chapter 3. ESSEXLab Follow-up Study: Study 2

Chapter 3. ESSEXLab Follow-up Study: Study 2

To address the main post hoc explanations that I proposed to account for the null result of Study 1 (outlined in the Discussion section of Chapter 3), a number of modifications were made to the design and delivery of the present study compared to its predecessor.

To be able to replicate O'Brien and Wilson's (2011) explicitly social framing of the target measure by engaging participants in a mediated interaction with residents from a neighbourhood represented by the images used as stimuli in the study, and hence address the first of the two main post hoc explanations for the initial study's null result, prior to data collection for the main phase of the present study a preliminary phase of data collection was conducted by a research assistant on location in Jaywick, Essex.

Jaywick was chosen as the location for this preliminary phase of the study as it both met the area inclusion criteria for the experimental stimuli for Chapter 2 (see Method section Chapter 2), thus satisfying the requirement that the interactant was a resident of a neighbourhood represented by the experimental stimuli, and as it was within an easy commute of the University of Essex and therefore a viable location, given time and budgetary constraints, to visit on two separate occasions. During the first session of this preliminary phase of data collection, an opportunity sample of five residents of Jaywick[2] played a modified version of the trust game protocol (termed an Endowment Game on promotional materials and in the participant instructions)

[2] For administrative reasons, the Jaywick residents who took part in the study were classified and paid as research assistants and not as participants.

used in the Study 1 (mediated in time, and with a 10 GBP initial endowment) with participants to be recruited through the participant pool (psychology department) at the University of Essex (participants in the main phase of the study). One Jaywick resident's mediated game play became the behavioural response used to compute the second-mover endowment for the Qualtrics study undertaken by participants of the main phase of the present study (randomly chosen using RANDOM.ORG, Haahr, 2020). All five of the Jaywick residents involved during this preliminary phase of data collection received their first-mover payment in cash (the sum which remained once they'd transferred the endowment) during the first data collection session. Another one of the five Jaywick residents was then drawn at random (again using RANDOM.ORG, Haahr, 2020) to play a mediated version of the second-mover role; responding to a table of graduated first-mover endowments ranging from 1.50 GBP (constituting an initial endowment by the first-mover of 0.50 GBP, tripled via the trust game protocol to 1.50 GBP) to 30.00 GBP. Finally, this individual Jaywick resident was informed that once their randomly selected interactant from the main phase of the study had made their game play decisions (the first main phase participant selected via the BRIS, see below), they, the Jaywick resident, would receive the sum of their game play proceeds as a second-mover in a subsequent visit from the research assistant (see below for the data collection instructions for this preliminary phase of the study).

The second post hoc explanation to account for the null result was the potentially galvanising effect that undertaking the study in the social context of a group of predominantly university contemporaries might have had on social behaviour (see Discussion Chapter 3); thus, the present study was administered individually and in a laboratory booth designed for a single occupant.

Method

Participants

In total XX participants (XX males, XX females) residing in the UK completed the study in a laboratory setting. Participants were recruited through the University of Essex's (Psychology Department) participant pool or directly via posters distributed around the University's Colchester campus. Participants either received a payment of 5 GBP (Amazon voucher) or course credit for participation. All participants gave informed written consent, and the study received ethical approval from the University of Essex's ethics committee (ETH2122-0760). The majority of the participants were students of the University of Essex. The age of the participants ranged between XX and XX, with mean XX years and standard deviation XX years.

Materials and Procedure

Experimental Stimuli

Once again, the complete set of experimental stimuli from Chapter 2 were animated into two different slideshows by experimental manipulation condition: unmaintained (A) and maintained (B) (for more details about the selection and manipulation of these stimuli, see the Method section of Chapter 2). Again, both slideshows presented the 20 properties in the same sequence, and for the same duration (20 s each stimulus); in total, the presentations lasted for a 7 minutes 15 seconds (see https://osf.io/p5uh2/ Chapter 3 Materials and Stimuli; Study 2 Materials and Stimuli). Thus, again, the only difference between the two experimental conditions was the level of residential maintenance depicted. As this iteration of the study also included a practise trial block, six fillers from Chapter 2 were used to create a practise trial

slideshow for the present study (duration 1 m 40 s). Participants in both experimental conditions saw the same practise trial slideshow.

Covariates Measures

Participants completed the same covariate measures as were administered in Study 1 (see Covariate Measures subsection of Method section, Chapter 3).

Outcome Measure

Using the same protocol, but with a larger initial endowment (10 GBP) and adopting a between-subjects random incentivized system (BRIS) of payment (Clot, 2018) the trust game was administered in the same way as in Study 1, with participants in the experimental stage playing both roles.

The motivation for adopting the BRIS was to be able to increase the value of the endowment and therefore maximise the potential number of participants motivated to enrol, in an effort to meet the sample size computed in the original power calculation (see Sample Size subsection of Methods section Study 1, Chapter 3), whilst remaining within budgetary constraints. Clot's recent study demonstrated that there were no significant differences between participants' behaviour in a similar experimental economics game when different payment procedures were adopted (2017). She found that behaviour was broadly similar whether participants were taking part in a game with a full payment system (as we had used in the initial Study 1) or one with a 10 percent between-subject random chance of receiving payment (termed a BRIS by Clot, 2017). Thus, by adopting a BRIS approach to payments, I was able to budget to recruit a sufficient number of participants to the study without compromising its validity. Additionally, as Johnson and Mislin's (2011) meta-analysis

had found that the size of endowment didn't significantly affect game play in the trust game, I considered this change to the original Study1 protocol a sensible decision from the perspective of maximising participant recruitment.

Additional Outcome Measures

A 7-item social quality scale, adapted from the Project on Human Development in Chicago Neighbourhoods study (Earls et al., 1994) and used by both Hill and colleagues (2015) and O'Brien and Wilson (2011) in their respective studies was also administered. The scale comprised Item 1: "People in these neighbourhoods can be trusted"; Item 2: "If there were a fight in one of these neighbourhoods, residents would intervene"; Item 3: "If children were skipping school and hanging out on a street corner, residents would not take action"; Item 4: "People in these neighbourhoods generally do not get along with each other"; Item 5: "People in these neighbourhoods share the same values"; Item 6: "People in these neighbourhoods are willing to help their neighbours"; and Item 7: "These are close-knit communities". The items were scored on a 7-point scale (-3 = *Disagree Strongly* to +3 = *Agree Strongly*).

This scale was introduced to be able to examine the relationship between behaviour during the experimental economics game and the participants perception and assessment of the social environment of the residential properties depicted in the stimuli.

Practice Trial and Experimental Checks

Additionally, precautionary steps were taken, in light of consideration that arose from the design of Study 1, which, while not being judged as material to the null result of

the initial study, were deemed prudent to include in the present iteration. I introduced a practice trial for the exposure manipulation (prime) and trust game (target) so that I could be confident that participants understood the protocol ahead of the experimental trial. I also included a manipulation check: “To what extent did you accept as fact our preceding statement that we had collected the game play behaviour of residents prior to this session, and used their recorded decision to calculate the results of your Endowment Game?”; a contextual factor check: “To what extent have you been troubled by concerns of contamination since the outbreak of the COVID-19 virus?”; and, an attention check: “If you are paying attention to the questions in this survey, you will answer ‘Somewhat Yellow’ to this one.” The first two items were scored on a 7-point scale (-3 = *Disagree Strongly* to +3 = *Agree Strongly*). The attention check was scored using the same 7-Point Likert Scale as the preceding questions in the Risk-taking and Charity scale it appeared in the midst of, but with the “Somewhat Likely” option substituted for the “Somewhat Yellow” option.

Procedure

The main phase of the study was conducted in the psychology department at the University of Essex, using purpose-built laboratory testing booths designed for single occupancy. The covariate measures, practise trial slide show and trust game, experimental manipulation condition slide show, experimental trust game, social quality scale and experimental checks were all programmed and administered online via Qualtrics (n.d.). During the second period of data collection (03/02/2022 to 31/03/2022) mitigations were introduced to address COVID 19 guidelines for F2F testing.

On arrival, participants were greeted by the experimenter and invited to enter the assigned testing booth. Once seated, participants were invited to read the information sheet and complete the consent form. Once the consent forms had been completed by the participants and collected by the experimenter, participants commenced the survey comprising the covariate measures. All data collection and stimuli presentation were conducted online in Qualtrics on an iMac Retina 4K 21.5-inch display.

Once these measures were complete, participants started the practise trial block. Whilst the initial instructions regarding the presentation were the same as the experimental trial from Study 1, namely; “You are to imagine yourself walking through a neighbourhood where you would expect to encounter the houses depicted in the still images you will see in the following presentation”; there was an additional statement on the same instruction screen which read; “After the presentation, you will play one round of an Endowment Game with a resident from a neighbourhood represented by the presentation.” Participants in both experimental conditions saw the same practice trial slideshow. Stimuli images rendered at a resolution of 850 x 1030 and were viewed at a distance of approximately 50 cm. This was followed by one round of the trust game, where all the participant played only the first-mover role. Once the practise trial was over, participants who had any questions regarding the experimental procedure were given an opportunity to ask the experimenter for clarifications.

Next, participants were given the instruction via an on-screen text message:

> “As with the practise trial, you are to imagine yourself walking through a neighbourhood where you would expect to encounter the houses depicted in the still images you will see in the following presentation.
>
> After the presentation, you will play two rounds of an Endowment Game with different residents from a neighbourhood represented by the presentation. Prior to this experimental session, we collected the Endowment Game play behaviour of residents from a neighbourhood represented by the following presentation. These pre-played responses will be used to calculate the results of this session.”

Subsequently, participants were presented with one of the two experimental manipulation slideshows, dependent on their experimental condition assignment (determined by the chronological sequence of participant timeslots, starting with Condition A, unmaintained). Following this exposure, all participants engaged in consecutive rounds of the trust game to measure if levels of social trust had been affected by the level of residential maintenance. Once this stage was finished, participants completed the social quality scale and the remaining experimental checks.

Finally, at the end of the experiment, as they were leaving the booth, all participants were informed by the experimenter that they would receive their fee (5 GBP Amazon token) or course credit, and the proceeds from their game play should they be selected by the BRIS, within the next five working days. The BRIS was selected by a list of random numbers generated, once again, by RANDOM.ORG (Haahr, 2020).

You have been assigned the role of first mover in an Endowment Game.

You have an endowment of £10.00.

You have been randomly matched with a student from the University of Essex.

You will remain anonymous to one another throughout the game.

Any amount of money you give to this student will be tripled by us.

The student will then get to decide how much of the sum to return to you (they will keep the rest).

How much would you like to give to the student?

Please enter an amount between £0.00 and £10.00

£

You have assigned the role of second mover in an Endowment Game

You have been randomly matched with a student from the University of Essex.

You will remain anonymous to one another throughout the game.

This student has **given** £ (see below)

We have **tripled** this amount, so the sum is £ (see below)

How much would you like to **return** to this student (you will keep the rest)?

Please enter an amount between £0.00 and £ **Tripled** in the **Return** column.

Given	Tripled	Return
£0.50	£1.50	£
£1.00	£3.00	£
£1.50	£4.50	£
£2.00	£6.00	£
£2.50	£7.50	£
£3.00	£9.00	£
£3.50	£10.50	£
£4.00	£12.00	£
£4.50	£13.50	£
£5.00	£15.00	£
£5.50	£16.50	£
£6.00	£18.00	£
£6.50	£19.50	£
£7.00	£21.00	£
£7.50	£22.50	£
£8.00	£24.00	£
£8.50	£25.50	£
£9.00	£27.00	£
£9.50	£28.50	£
£10.00	£30.00	£

Appendix B: Chapter 2. Debrief Script and Guidance

Building Better Than We Know

Debrief Script & Guidance

We want to avoid leading the participant with simple yes/no questions about the study design (which might garner false positives), so only move on to the following question in the script if the participant identifies salient aspects of the design in their answer to the earlier/present question. Make a note on the study notes (where we record the validation data etc.) of the participant's level of awareness regarding the design of the study by recording the question number you exited the script (e.g., 'the participant didn't discern the design' would be an exit on **Q3**, or if 'the participant identified that the pictures appeared twice, but presumed the experiment was about the differences between the scores of the repeated trust measures' would be an exit on **Q6**). Feel free to add detail to your note if you think it relevant.

1) **'In general, what did you think of the experiment?'**

2) **'Did you notice anything about how the experiment worked?'**

3) **'Did you notice anything about the stimuli?'**

4) **'Did you notice any patterns or regularities?'**

5) **'Did you notice that you saw some of the buildings twice?'**

6) **'Did you notice that when you saw them twice, they were different?'**

7) **'Did you notice that when you saw them twice, one version was a cleaned up version?'**

Appendix C: Inferential Analysis for Chapter 2 Excluding the Participants Who Discerned the Manipulation

Table C.1 *Multilevel Regression Analysis for Models Estimating Social Trust Score as a Function of Maintenance, Mini-K Score, and Covariates Following the Exclusion of Participants Who Discerned the Manipulation*

Variable	Null	Model 1	Model 2	Model 3	Model 4
Intercept	4.06*** (0.08)	3.68*** (0.08)	3.68*** (0.08)	3.38*** (0.15)	3.13*** (0.31)
Maintenance		0.75*** (0.03)	0.75*** (0.04)	0.75*** (0.04)	0.75*** (0.04)
Mini-K score				0.27* (0.12)	0.38** (0.12)
Single-parent family					0.25 (0.18)
Age (ref: 18 and 19)					
20 to 29					0.04 (0.17)
30 and over					0.24 (0.26)
Sex (ref: Female)					
Male					-0.00 (0.19)
Dev environment (ref: Urban)					
Suburban					0.01 (0.17)
Rural					-0.28 (0.23)
Ethnicity (ref: White)					
Non-White					0.23 (0.20)
Region (ref: UK)					
EU					0.33 (0.25)
Non-EU					-0.47* (0.21)
SEP (ref: High)					
Medium					-0.07 (0.17)
Low					0.15 (0.21)
Variance components					
Level 1 Variance	0.52*** (0.04)	0.53*** (0.04)	0.54*** (0.04)	0.52*** (0.04)	0.45*** (0.04)
Level 2 Variance	1.04 (0.01)	0.90*** (0.01)	0.89*** (0.01)	0.89*** (0.01)	0.89*** (0.01)
Random slope Maintenance			0.05*** (0.01)	0.05*** (0.01)	0.05*** (0.01)
Correlation of random slope Maintenance and intercept			-0.26 (0.17)	-0.28 (0.17)	-0.31 (0.19)
N^a	3680	3680	3680	3680	3680
AIC	10884.5	10357.0	10348.6	10345.4	10354.7
ICC	0.328	0.363	0.380	0.368	0.339
Log likelihood	-5439.2	-5174.5	-5168.3	-5165.7	-5159.3

Note. Standard errors in parentheses

Dev environemnt = Developmental environment; SEP = Socioeconomic Position.

[a] *N* = Total number of experimental trials. Each participant was exposed to 40 experimental trials (20 unmaintair 20 maintained) and 20 filler trials. The filler trials were not analysed.

*P<0.05; **P<0.01; ***P<0.001

Table C.2 *Multilevel Regression Analysis for Models Estimating Dwell Duration as a Function of Maintenance, Mini-K Score, Mental Health, and Covariates Following the Exclusion of Participants Who Discerned the Manipulation*

Variable	Null	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	34.97*** (0.47)	39.70*** (0.54)	39.70*** (0.65)	39.05*** (1.01)	40.68*** (0.70)	41.70*** (1.41)
Maintenance		-9.45*** (0.52)	-9.45*** (0.61)	-9.45*** (0.61)	-9.45*** (0.61)	-9.45*** (0.61)
Mini-K score				0.58 (0.69)		
GHQ 12 Caseness					-2.82** (0.86)	-2.81*** (0.86)
Age (ref: 18 and 19)						
20 to 29						1.41 (0.93)
30 and over						0.64 (1.37)
Sex (ref:Female)						
Male						-2.23* (1.06)
Dev environ (ref: Urban)						
Suburban						-0.02 (0.94)
Rural						0.14 (1.24)
Ethnicity (ref: White)						
Non-White						-0.79 (1.11)
Region (ref: UK)						
EU						-2.47 (1.37)
Non-EU						-2.33* (1.18)
SEP (ref: High)						
Medium						-0.75 (0.94)
Low						-0.24 (1.14)
Variance Components						
Level 1 Variance	13.80*** (1.48)	14.36*** (1.48)	26.97*** (2.90)	26.33*** (2.87)	24.65*** (2.73)	20.50*** (2.47)
Level 2 Variance	2712.26*** (3.21)	249.34*** (2.94)	246.81*** (2.95)	246.81*** (2.95)	246.81*** (2.95)	246.81*** (2.95)
Random Slope Maintenance			9.86*** (2.56)	9.86*** (2.56)	9.86*** (2.56)	9.86*** (2.56)
Correlation of random slope Maintenance and intercept			-1.67* (0.83)	-1.61* (0.74)	-1.87 (1.18)	-1.94 (1.33)
N [a]	3680	3680	3680	3680	3680	3680
AIC	31183.26	30869.72	30853.15	30854.46	30845.10	30850.64
ICC	0.05	0.05	0.10	0.10	0.09	0.08
Log likelihood	-15588.63	-15430.86	-15420.58	-15420.23	-15415.55	-15408.32

Note. Standard errors in parentheses

[a] *N* = Total number of experimental trials. Each participant was exposed to 40 experimental trials (20 unmaintained and 20 maintained) and 20 filler trials. The filler trials were not analysed.

Dev environ = Developmental environment; SEP = Socioeconomic Position.

*P<0.05; **P<0.01; ***P<0.001

Table C.3 *Robust Linear Regression Analysis for Models Estimating First Fixation Index (Transformed) as a Function of Maintenance, Mini-K Score, Mental Health, and Covariates Following the Exclusion of Participants Who Discerned the Manipulation*

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	2.284*** (0.038)	2.288*** (0.082)	2.304*** (0.045)	2.171*** (0.100)
Maintenance	0.252*** (0.049)	0.252*** (0.049)	0.252*** (0.049)	0.252*** (0.049)
Mini-K Score		-0.004 (0.058)		
GHQ 12 Caseness			-0.057 (0.073)	
Age (ref: 18 and 19)				
20 to 29				0.087 (0.061)
30 and over				0.131 (0.092)
Sex (ref: Female)				
Male				-0.237*** (0.069)
Dev Environment (ref: Urban)				
SubUrban				0.020 (0.069)
Rural				0.131 (0.083)
Ethnicity (ref: White)				
Non-White				0.038 (0.083)
Region (ref: UK)				
EU				0.040 (0.105)
Non-EU				-0.131 (0.096)
SEP (ref: High)				
Medium				0.008 (0.074)
Low				0.337*** (0.079)
N [a]	3680	3680	3680	3680
R^2	0.008	0.008	0.008	0.021
R^2 Adjusted	0.008	0.007	0.008	0.019

Note. Standard errors in parentheses

Dev environmentt = Developmental environment; SEP = Socioeconomic Position

[a] N = Total number of experimental trials. Each participant was exposed to 40 experimental trials (20 unmaintained and 20 maintained) and 20 filler trials. The filler trials were not analysed.

*P<0.05; **P<0.01; ***P<0.001

Appendix D: Chapter 3. Study 1 General Instructions

GENERAL INSTRUCTIONS

Thanks in advance for contributing to our study

Firstly, we invite you to read the **Information Sheet**.

Now, if you are happy to continue, we invite you to read, sign and date the **Consent Form – please note** that you must **initial** the boxes, and not simply tick them.

You'll notice a **three digit number** fixed to your **Consent Form** - this is your **unique participant ID code**, which you'll be requested to enter as you start the on-line survey.

If you could now also write your name in **CAPITALS** on the **Receipt Form**, it will make the process of payment at the end of the study much easier.

There are two stages to this study

The first stage consists of a short online survey that we'll begin in a moment.

Once all of us have completed this (and I would ask you to be patient once you've finished this stage whilst we wait for the others to complete the survey) we'll all begin the next stage of the study which involves us watching a short video and then playing a brief game.

Right, that should be everything, so…

You should **remain seated** from now until you are instructed by one of us that the study is complete.

If you have any questions during the two stages of the study, please raise your hand and one of us will come to your workstation.

At the end

Please wait in your seats whilst we prepare your individual payments – this will be completed as swiftly as possible, and we'll bring your payments to you.

Once you have signed the receipt to confirm that you have received your payments, you may leave the lab.