Urban and architectural design for the young mind: An ecological investigation of the relationship between urban form and adolescent mental health

by

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Each integrated article within this dissertation has been published in, is currently being revised and resubmitted to, or will soon be submitted to a peer-reviewed journal. With respect to each of the integrated articles found in this dissertation (i.e., Chapters 2-6; not Chapters 1 and 7), I, Adrian Buttazzoni, was the lead author who was responsible for writing and submitting the respective ethics applications, leading the conceptual development of the manuscripts, undertaking the principal duties of data collection and data analysis, and eventually leading the writing of the articles. I was also the sole author of Chapters 1 and 7. While the integrated articles have previously been or will be structured to the formatting guidelines of the different journals to which they are or have been submitted to, each manuscript in this dissertation has been formatted to APA 7th edition citation style.

Of the integrated articles, the first two chapters of the dissertation have been published. Chapter 2 was co-authored by Dr. Sean Doherty and Dr. Leia Minaker who contributed to the conceptualization, writing, and revision processes of the paper. A version of Chapter 2, which contains a review and subsequently presents two original frameworks, has been published in *Public Health Reports*. Chapter 3 co-authors include Dr. Jennifer Dean and Dr. Leia Minaker who assisted with the conceptualization, analysis, writing, and revising of the manuscript. A version of Chapter 3, which presents the qualitative investigation of the relationships between adolescents and different design concepts, has been accepted and is now in press in the journal *Health & Place*. Publication citations for these two articles are as follows:

Chapter 2 reference:

> Buttazzoni, A., Doherty, S., & Minaker, L. (2022). How do urban environments affect young people's mental health? A novel conceptual framework to bridge public health, planning, and neurourbanism. *Public Health Reports, 137*(1), 48-61.

Chapter 3 Reference:

> Buttazzoni, A., Dean, J., & Minaker, L. (2022). Urban design and adolescent mental health: A qualitative examination of adolescent emotional responses to pedestrian- and transit-oriented design and cognitive architecture concepts. *Health & Place*. Online ahead of print. DOI: https://doi.org/10.1016/j.healthplace.2022.102825

Chapters 4, 5, and 6 were co-authored by Dr. Leia Minaker who contributed to the conceptualization, analysis, writing, and revising of the articles. Chapters 4 and 5, the two online survey-based manuscripts examining a national sample of Canadian adolescents regarding their responses to different urban environments, have been submitted to two separate academic journals and are currently under review (as of June 2022). Chapter 6, which presents the results of an ecological momentary assessment survey study exploring adolescents' real-world responses to different designs, is being finalized for submission to an academic journal. These three manuscripts appear in this dissertation in a version that may not necessarily be the same as a future potential publication. Working references for these three manuscripts are as follows:

Chapter 4 reference:

> Buttazzoni, A., and Minaker, L. (Submitted). Exploring the relationships between specific urban design features and adolescent mental health: The case of imageability, enclosure, human scale, transparency, and complexity. *Landscape and Urban Planning*.

Chapter 5 reference:

> Buttazzoni, A., and Minaker, L. (Submitted). Associations between adolescent mental health and pedestrian- and transit-oriented design quality: Evidence from a national-level online Canadian survey. *Urban Studies*.

Chapter 6 reference:

> Buttazzoni, A., and Minaker, L. Investigating the in-situ emotional responses of adolescents toward pedestrian- and transit-oriented designs and cognitive architecture for adolescents: An ecological momentary assessment study.

Abstract

Around 50% of lifetime mental illnesses begin at or prior to the age of 14 years old—or roughly halfway through adolescence (10-19 years old)—with contemporary trends from multiple geographical and cultural contexts indicating upward trends in various conditions (e.g., anxiety, depression). Concomitant to these developments in adolescent mental health trends, the global population continues to urbanize portending that a higher proportion of adolescents will experience these critical developmental years in such environs. Together the coalescing of these health and migration trends suggests that the role and influence of urban environments in the mental health and well-being of adolescents will be especially important in the coming years. Common paths of research regarding the mental health of younger populations, however, have tended to focus on individual psychosocial issues and physiological factors, subsequently leaving comparatively little knowledge about the specific urban design influences of adolescent mental health and well-being. Further research investigating more robust associations between precise urban environment design characteristics and adolescent mental health outcomes, along with a greater diversity of methods, is warranted for both advancing scholarship on this topic and informing professional practice in relevant fields such as urban planning and public health.

This dissertation provides an exploratory mixed methods evaluation of the relationships between specific urban and architectural designs and adolescent mental health indicators (i.e., emotional responses). Guiding this evaluation is the overarching question: “What is the nature of the relationship between specific urban built and natural design concepts and adolescent mental health indicators (i.e., emotional responses)?” Overall, seven chapters comprise this dissertation with five featuring as integrated articles. After the introduction (Chapter 1), the first of the integrated articles (Chapter 2) reviews and synthesizes literature from across the fields of planning and public health, as well as the emerging transdisciplinary area of neurourbanism. The resulting syntheses of this review highlight how planning and public health have traditionally understood the relationships between health and urban environments, and subsequently how these relationships are being investigated using contemporary methods. From this background, the reviewed literature is then specifically applied to delineate the multilevel nature of the relationship between young people’s mental health and urban environments, and how this topic may be studied and supported through future inter/transdisciplinary research and practice collaborations. To this end, the review offers two novel, socioecological model-

based frameworks that include a new fifth level (i.e., the digital level) for both practice and research to consider in future endeavours.

Building from the review of the previous chapter and narrowing in more specifically on urban design and adolescent mental health, the following four integrated articles are primary research manuscripts that are framed within the ecological perspective of the Theory of Affordances (ToA). This framing consequently facilitated the development of insights that take into account and explore a variety of influences including social, psychological, physiological, relational, and environmental factors that may be relevant to the relationships under study. Using this approach three separate primary research studies were conducted to explore the relationships between specific urban designs (i.e., pedestrian- and transit-oriented designs (PTOD), cognitive architecture (CA) concepts) and adolescent mental health indicators (i.e., the emotional responses of: positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand).

The first primary research integrated article, Chapter 3, submits the results of 23 qualitative go-along interviews that were conducted with adolescents in settings throughout downtown Kitchener, Ontario, Canada. Findings from the qualitative analysis illustrate the considerably different perceptions that adolescents hold regarding a variety of PTODs—for instance, natural versus built *enclosure* and *imageability*—and their generally positive perspectives pertaining to the CA concepts examined. The second and third primary research articles, Chapters 4 and 5, present the findings of an online survey featuring a nationally representative sample of 1,500 Canadian adolescents. The former manuscript (i.e., Chapter 4) explores the associations between overall environmental design quality (i.e., areas scored for PTOD quality) and adolescent mental health indicators and finds that, generally, as the aggregated PTOD quality of a setting increased, positive emotional responses also tended to increase while negative responses typically decreased. The latter online survey paper (i.e., Chapter 5) examines associations between specific PTOD concepts (i.e., complexity, enclosure, human scale, imageability, transparency) and adolescent emotional responses. Results from this chapter indicate that the specific design concepts of *transparency* (increases in positive affect, calmness, and restorativeness), *scale* (increase in positive affect decrease in negative affect) and *complexity* (increase in positive affect, decrease in negative affect) may be particularly effectual design concepts for adolescents. Chapter 6, the final integrated article, presents the findings of the EMA survey study which was conducted with 70 adolescent participants also in the downtown area of Kitchener, Ontario, Canada. This study concludes by reiterating the potential of natural forms *imageability* and

enclosure and instances of biophilic architecture (i.e., urban gardens) in environmental design (as noted in Chapter 3), while also suggesting that the potential benefits of PTODs in auto-oriented spaces (e.g., public transit areas) may be offset by a lack of opportunity for adolescents to develop symbolic and stylistic attachments in these settings.

Chapter 7 summates the methodological and research contributions of the five integrated articles contained within the dissertation via a triangulation of key shared ideas and points among their collective findings. Contextualized within the ToA, the final chapter's synthesis suggests two important contributions from this scholarship. First, is that it provides a detailed documentation of the mental health implications of design quality and composition with respect to affording positive social contexts and interaction opportunities, emotionally engaging public spaces, and active use experiences. Discussions of this contribution are expanded to note its implications with respect to adolescent place attachment. And second, this dissertation offers a comprehensive exploratory investigation of the mental health implications of adolescent perceptions of and emotional responses to urban designs which resulted in the identification of trends suggesting a seeming emphasis regarding usage opportunities, safety, distinctiveness, visual richness, and positive affect experiences. The implications of this contribution are connected to better understanding and designing for adolescent place preferences. Future research opportunities are detailed for additional mixed methods studies, environment-based interventions, work with practitioners, and policy analyses.

Acknowledgements

"Just keep on trucking." I begin by presenting this simple thought in order to appropriately contextualize my acknowledgments as, despite the ongoing uncertainty I felt regarding where I was headed when I initially began this degree, the aforementioned thought (or some variation of it) ran through my mind seemingly every day as some sort of guiding principle. It is principally thanks to my supervisor, Dr. Leia Minaker, to whom I am incredibly indebted, who helped me to sort through this uncertainty, refocus my energy, and ultimately keep on trucking through this degree. Your patience, first-rate humour, and general ability to deal with my many diversionary paths over the past four years have all been immensely appreciated and ultimately made this degree a truly gratifying experience. Similarly, I would like to thank my committee members—Dr. Jennifer Dean, Dr. Sean Doherty, Dr. Colin Ellard, and Dr. Rob Feick—for your commitment to my work both in this dissertation and beyond. Your time, candor, and helpful feedback on earlier drafts of the integrated articles and chapters of this dissertation, as well as other ventures outside of this dissertation, has been most sincerely appreciated.

Several other individuals in my University of Waterloo (UW) network, as well as many former PhD and academic mentors going back several years, were also instrumental to the completion of this work. From UW, and the UW Survey Research Centre in particular, I would like to thank Beth McLay and Arianne Manary for all of their work with the online survey study, as well as Dr. Christian Boudreau for his statistical consultations on our CIHR grant that supported this work. I would also like to acknowledge and extend my thanks to the University of Waterloo librarians who were wonderful sources of knowledge and helpful guides for me throughout this degree. Regarding former academic and PhD mentors whose innumerable conversations, bits of advice, and anecdotes have undoubtedly got to me to this point, I say thank you. I want to begin by acknowledging those who gave me first opportunity to conduct research as a part of my undergraduate thesis, Dr. Evan Cleave and Dr. Godwin Arku at the University of Western Ontario (UWO). As a part of my following experiences at both UWO and UW, I would also like to thank Dr. Stephanie Coen, Dr. Tayyab Shah, Dr. Carri Hand, Dr. Andrew Clark, Dr. Jason Gilliand, and Dr. Andrea Rishworth for their assistance and advice over the years which helped me to get to this point.

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Finally, to all those behind the scenes—those at the dinner table, the sporting events, family functions, and everyday gatherings; those who are too many to name, but hopefully know who you are—my friends near and far, lab colleagues, aunts, uncles, cousins, and family I humbly say: *grazie, continua a progredire e ci parliamo tra poco* (thank you, keep moving forward and we'll talk soon). Your support has always been evident in the conversations that challenged me, small daily experiences that calmed and reassured me, and offered anecdotes that inspired me. It is because of all of you that I can continue to roll forward and "just keep on trucking" into the future.

Dedication

"I have striven not to laugh at human actions, not to weep at them,
not to hate them, but to understand them."

—Baruch Spinoza, *Tractatus Politicus*, 1676

This dissertation is dedicated to my four grandparents and many educational mentors who, together, inspired me to always first seek to understand.

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List of Abbreviations[1]

ART	Attention Restoration Theory
CA	Cognitive Architecture
CFCs	Child Friendly Cities
CIHR	Canadian Institutes of Health Research
EC	Embodied Cognition
EEG	Electroencephalography
EMA	Ecological Momentary Assessment
GI	Green Infrastructure
LMM	Linear Mixed Models
PTOD	Pedestrian- and Transit-Oriented Design
ToA	Theory of Affordances
SDG(s)	Sustainable Development Goal(s)
SEM	Socio-ecological model
SES	Socioeconomic Status
SRC	Survey Research Centre
SRT	Stress Reduction Theory
SSS	Subjective Social Status
UW	University of Waterloo
WHO	World Health Organization

[1] This is a list of commonly used abbreviations in this dissertation; it is not exhaustive in its documentation.

Chapter 1

Introduction

1.1 Research Context: The Adolescent Mental Health and Urban Environment Issue

Rates of adolescent (10-19 years old) (World Health Organization, 2020) mental health issues continue to increase globally (e.g., Gunnell et al., 2018; WHO Regional Office for Europe, 2005) with current estimates indicating that around one in five individuals will experience a mental health disorder during their adolescence (Kessler et al., 2005). Experiences of mental infirmities during this developmental period can be especially consequential for life trajectory as, for instance, the onset of mental illnesses during this time have been linked to long-term disability (Kapungu et al., 2018), poor economic and social outcomes, and an enhanced risk for multiple chronic conditions (e.g., heart disease, stroke) (Scott et al., 2016). Over the life course, the aggregate impacts of mental health issues incurred during adolescence can result in an increased risk for all causes of early age mortality (Kessler et al., 1995).

By 2050 it is estimated that around 70% of the global population will live in cities (United Nations, 2018), amplifying the importance of urban environments as a determinant of human health. Urban environments, which can be broadly defined as the human-made features of the external lived environment (e.g., buildings, streets), characteristics (e.g., lighting, ambient pollution), and natural spaces (i.e., parks, rivers) of an inhabited area, have been correlated with a number of mental health phenomena. Notably, relative to rural areas, urban living is associated with a higher risk of paranoia (Gruebner et al., 2017), distress, and anxiety (Prina et al., 2011). Much of the existing research pertains to adult populations, however, and linking this knowledge to adolescents has proved problematic as research into and support for adolescent mental health has remained largely underfunded (Lu et al., 2018) and unsupported (Dubicka & Bullock, 2017).

1.1.1 Defining and Situating Adolescent Mental Health

For the purposes of this dissertation, it is important to first define "mental health" as a concept. Galderisi et al. (2015) offer a nuanced and multifaceted definition that describes the complexity of the concept through outlining different specific domains, explaining mental health as:

> …a dynamic state of internal equilibrium which enables individuals to use their abilities in harmony with universal values of society. Basic cognitive and social skills; ability to recognize, express and modulate one's own emotions, as well as empathize with others; flexibility and ability to cope with adverse life events and function in social roles; and harmonious relationship between body and mind represent important components of mental health which contribute, to varying degrees, to the state of internal equilibrium (p. 231-232).

Mental health thus refers to cognitive and social skills, self-regulation and emotions, coping abilities, and/or the body-mind relationship which contribute to an internal state that affects their functioning.

Positive mental health is especially important during early life as rapid brain development renders adolescents particularly vulnerable to the development of chronic emotional, neurological, and social issues (Dahl, 2004). External environments are a noted influence of brain development during these years as exchanges between adolescents and various environmental stimuli can alter brain structure (Dahl, 2004). Interactions between adolescents and their environments have many pathways. For example, environmental toxins have been linked to neurobehavioural disorders (Weiss & Landrigan, 2000) such as attention deficit hyperactivity disorder (Woodruff et al., 2004), as well as been noted to contribute to antisocial behavior (Needleman et al., 1996). Meanwhile, environments which induce consistent stress in early-life, for example growing up in low socioeconomic status (SES) areas, can inhibit cognitive function (Farah et al., 2006) and are linked with reduced prefrontal cortical grey matter which is important for allowing and enabling individuals to control movement, memory, and emotions (Gianaros et al., 2007). Much of this scholarship, however, has been undertaken in medical and life science bodies of literature. Consequently, the work exploring the links between features of urban environments and adolescent brain development, or mental health more broadly, from behavioural science perspectives has only begun to emerge in recent years.

1.1.2 Current Study of Urban Environments and Adolescent Mental Health

Social science research into adolescent mental health and urban environments can perhaps be better understood by breaking down the latter into more specific categories. First, built features (i.e., human made structures) such as the presence of neighbourhood facilities (e.g., community centre, library) have been linked with social competence benefits that can bolster mental health (Christian et al., 2015). Built environments can also be designed to increase physical activity, which has been connected to improved mental health (Ahn & Fedewa, 2011). For instance, opportunities to encourage adolescent physical activity can be promoted via street connectivity (Giles-Corti et al., 2011), narrow street width (Nasar et al., 2015), playgrounds (Pagels et al., 2014), pedestrian crossovers (Rothman et al., 2014), and sidewalk presence (Rothman et al., 2018). Conversely, the spatial distribution of such characteristics (e.g., poor pedestrian route directness) may increase the risk of depressive symptoms (Duncan et al., 2013), while large scale designs such as auto-dependent environments can produce excess noise leading to increased sleeping issues (Tiesler et al., 2013).

Second, the resultant soundscapes can also have significant impacts as environments with elevated noise levels have the potential to also lessen social cohesion and the restorative quality of areas. This may consequently contribute to adolescent mental health issues (Dzhambov et al., 2018) such as depression, anxiety (Stansfeld et al., 2000), and impaired cognitive function (Haines et al., 2001).

Natural features and aesthetics are similarly important determinants. Broadly, adolescent engagement with nature has been positively linked with a number of behavioral improvements including cognitive development (Dadvand et al., 2015), as well as reductions in ADHD symptoms (Amoly Elmira et al., 2014; Markevych et al., 2014). Urban areas with higher greenness have additionally been correlated with reduced depressive symptoms (Mavoa et al., 2019) and internal and external behavioral issues (Madzia et al., 2019). Other natural features such as urban blue spaces (e.g., rivers, creeks, ponds) can help adolescents better manage their emotions (Djohari et al., 2018), while green spaces (e.g., parks) can reduce stress (Feda et al., 2015) and depressive symptoms (Madzia et al., 2019), as well as facilitate opportunities for social interactions (Kaźmierczak, 2013). Similarly, gardens/gardening have been linked with lower levels of depressive symptoms and enhanced emotional well-being (van Lier et al., 2017). Particular features such as increased tree cover density have been associated with lower air pollution and subsequently improved mental health (Dzhambov et al., 2018) and overall quality of life (Kim et al., 2016). In the long-term, early life exposure to nature has been correlated with improved later-life mental health (Engemann et al., 2019). As such lines of inquiry continue to gain traction the impacts of these environmental exposures have begun to be explored in a variety of different sociocultural and geographical contexts, subsequently allowing for the identification of emergent trends.

1.1.3 Global Trends in Urban Environments and Adolescent Mental Health Study

Although much of the existing literature on this topic comes from industrialized western nations, similar trends have been observed in additional contexts. For example, general trends of urban populations, relative to rural groups, reporting higher rates of anxiety has been documented in various Latin American countries (Prina et al., 2011) while evidence from India similarly suggests adolescents in urban areas have a higher prevalence of mental disorders (Pillai et al., 2008). Comparable developments have also been reported in Bangladesh where children in urban slums were found to be significantly more likely to have serious behavioural problems relative to other urban and rural dwelling groups (Mullick & Goodman, 2005). In South Africa, meanwhile, the prevalence of

ADHD and disruptive behavior disorders was observed to be significantly higher in urban dwelling children relative to rural and peri-urban children (Pillay et al., 1999). And more broadly, in a separate multi-city (Baltimore, US; New Delhi, India; Ibadan, Nigeria; Johannesburg, South Africa; and Shanghai, China) study across three continents, it was found that adolescents specifically living in the economically distressed areas of their respective urban region registered high levels of depression and posttraumatic stress (Cheng et al., 2014). Overall, the continued coalescing of global trends pertaining to urban living and environments as an increasingly important determinant of adolescent mental health further reinforces the need for more scholarship on this topic.

1.2 Conceptualizing the Relationship Between Adolescent Mental Health and Place

Having outlined the general scholarship and cross-context trends present within relevant literature regarding adolescent mental health and urban environments, a conceptual outline of the relationship is presented next to help frame the research in this dissertation. Two fields central to the topic of study in this dissertation, planning and public health, are among those that have historically addressed conceptualizing the larger relationship between health and place (Corburn, 2004). Over the past century, however, diverging priorities, scholarly influences, and professional values have resulted in the development of different conceptualizations of the health and place relationship. Central ideas of early *planning* conceptualizations were captured in the views of leading thinkers such as Frederick Law Olmstead, who sought to apply specific spatial land use-based solutions such as combining residential neighborhoods with parks and open spaces to address 19th century urban pollution issues (Szczygiel & Hewitt, 2000). Such early ideas and developments ushered in an era of spatially-based, hierarchical, and specialized health and place concepts in planning (e.g., euclidean zoning techniques) (Corburn, 2004) which divided cities into distinct and unyielding residential and industrial areas to promote urban sanitation and reduce the harmful effects of pollution (Frank et al., 2003). Meanwhile, early *public health* conceptualizations tended toward individual level understandings, specifically drawing on biological pathways of germ theory and the identification and tracking of specific agents of infectious disease (Tesh, 1990), as medical experts saw interventions targeting individuals (i.e., their health behaviours and biological vulnerabilities) to be more effectual strategies for promoting population health than urban infrastructure policies (Krieger, 2000; Porter, 1999). Addressing the individual risk factors in one's lifestyle such as diet, exercise, and smoking were accordingly promoted to prevent chronic illnesses across populations (Susser & Susser, 1996). However, conceptualizations in both fields failed to account for a range of interactional dynamics

between individuals and their environments, and as a result underwent considerable paradigmatic evolutions towards the end of the century.

Around the turn of the 21st century planning and public health began to expand their conceptual bases to engage the social and spatial contexts of health (Corburn, 2004; Frank & Kavage, 2008). The field of planning began to shift from static views of health and place to social-relational perspectives wherein space was reconceptualized to represent momentary coexistences of trajectories and processes of meaning making (Massey, 2000). Concomitant to this move away from euclidean geography was the flourishing of interdisciplinary perspectives of place within planning which have produced conceptualizations that recognize the interplay of built and social environment, economic, political, and socio-cultural forces in shaping health (Healey, 2007)—conceptualizations which are now often acknowledged in many planning institutions (e.g., Royal Town Planning Institute, 2009). Public health conceptualizations of place and health likewise expanded their scope near the turn of the last century (Rosen, 2015). Systems thinking, socio-ecological, behavioural science, and social determinants of health (SDH) ideas were incorporated as fundamental aspects of the evolved conceptualizations (Krieger, 2000; Northridge et al., 2003). Traditionally rigid areas such as epidemiology, for instance, were developed into more modern areas like ecosocial epidemiology which stressed two crucial concepts reflecting this evolution: first, that the combination of biological, sociological, economic, and psychological phenomena influence distributions of health; and second, the notion of 'embodiment' which suggests that individuals biologically absorb the material and social worlds in which they live (Krieger, 2001). Much like planning, these more recent evolutions led to the development of public health conceptualizations adopting socio-ecological perspectives (Sallis et al., 1998) and concepts like 'health-promotive environments' (Stokols et al., 2003) which support spatial and multi-scale environments as enablers/disablers of health across places. Taking heed of inputs from both modern public health and planning perspectives, this dissertation conceptualizes the relationship between adolescent mental health and place as dynamic, socio-relational, and multi-level (intrapersonal, interpersonal, community, policy).

1.3 Situating the Dissertation

1.3.1 Theoretical Framework Selection and Implications

Theoretical frameworks are a central means through which research processes engage in the analysis of collected data and, eventually, the construction of knowledge deriving from the

contributing scholarship (Osanloo & Grant, 2016). Accordingly, the selection of a guiding theoretical framework for research has implications for decisions across the larger research process (Mertens, 1998), and should therefore consider its applicability, appropriateness, and usefulness as it relates to a topic under study (Lysaght, 2011). Applying these considerations with respect to this dissertation's overarching aim of exploring the nature of the relationship between urban and architectural designs and adolescent mental health indicators, this work has been framed within an ecological or environmental psychology approach, and specifically the Theory of Affordances (ToA). A brief overview of the Theory of Affordances is provided in the summary Figure 1.3.1. Put very generally, the ToA is a transactional ecological or environmental psychology framework which is centrally positioned on the notion that what is physically present in an environment (e.g., shapes, objects, events), along with one's perceptions of what an environment affords (e.g., capabilities to use objects, intentions within an environment), are what drives human-environment interactions. The use of the ToA is explained within each integrated article (e.g., to frame research questions, frame the interpretation of study findings); however, a more expanded background outline is presented here.

Figure 1.3.1 Background Summary of the Dissertation's Theoretical Framework

Chapters	Background Summary Description of the ToA
3,4,5,6	The ToA was developed by American experimental psychologist James J. Gibson in the late 1960s. Laying out the central tenets of the ToA, Gibson (1986, 143) explains: > The medium, substances, surfaces, objects, places, and other animals have affordances for a given animal. They offer benefits or injury, life or death. This is why they need to be perceived. The possibilities of the environment and the way of life of the animal go together inseparably. The environment constrains what the animal can do, and the concept of a niche in ecology reflects this fact. Within limits, the human animal can alter the affordances of the environment but is still the creature of his or her situation […] There is information in stimulation for the physical properties of things, and presumably there is information for the environmental properties […] Affordances are properties taken with reference to the observer. Contemporary scholars expanding on this perspective have further theorized that affordances capture both *real* (objective) and *perceivable* (subjective) aspects contributing to a relationship or interaction between an individual and an environment—thus they are ***relations*** between particular aspects of individuals and particular aspects of situations (see Chemero, 2003). It is this understanding of affordances (relations) that is applied to the study of urban design and adolescent mental health in this dissertation.

Selection of the ToA, and not a traditional planning theory, for this dissertation was made for a few strategic reasons. These considerations generally break down into two general points: the primary focus of much planning theory being to investigate planning practice while this dissertation foremost focuses on exploring a behavioural phenomenon relevant to planning practice, and the fit between the dissertation's topic and the ontological (i.e., nature of reality) tenets of this ecological approach consequently offering more explanatory power for the undertaken primary research. Regarding the first point, planning has historically been defined in a number of ways from "… the application of scientific methods—however crude—to policy-making" (Faludi, 1973, p. 1) to processes wherein "… power lies in the formal allocation of rights and responsibilities, in the politics of influence, the practices through which 'bias' is mobilised, and in the taken-for-granted assumptions embedded in cultural practices" (Healey, 1997, p. 84), but generally done consistently in a practice-oriented manner. Moreover, bibliographic accounts regarding the uses of planning theory have argued that theoretical frameworks within the field should be centred on informing practice through adapting practice to real-world constraints, and principally scale, complexity, and time (Friedmann, 2008). Planning theories have consequently focused their efforts on grappling with and applying their distinct perspectives to an array of professional issues. Eminent examples of this include the role and status public participation, development of communication networks, approaches to economic development, and establishment of strategies regarding conflict resolution becoming the basis of different planning theory perspectives (Friedmann & Hudson, 1974). While these approaches do reflect different perspectives which have been instrumental in supporting the "…several research traditions which have become established" in planning (Friedmann & Hudson, 1974, p. 13), the general state of planning theory has been such that, despite this perceived diversity of perspectives, it has struggled to meaningfully engage with matters like emotions (Baum, 2015).

Examination of the traditionally prominent "SITAR" (i.e., synoptic, incremental, transactive, advocacy, radical) planning theories is instructive with respect to assessing the potential fit between the dissertation topic and planning theories as a guiding framework. SITAR traditions have typically contended with matters of defining the public interest; development of public interventions in economic, political, and social processes; establishing of consistent normative theory/prescriptions; and outlining the duties, responsibilities, and ethical standards of professional practice (Hudson et al., 1979). Each particular theory delineates its own perspective of the human dimension in planning (i.e., a focus on the personal implications of policy enactment) which necessarily deals with issues of

ontology. Ontological perspectives within these traditions have been documented to range from the synoptic (or rational-comprehensive model), which emphasizes the need to develop frameworks that derive from objective data inputs and statistical models examining ends (objectives) to means (resources and constraints), to the advocacy model, which eschews objectivist conceptions and instead highlights the role of subjective forms of knowledge and the principles of equity and justice in planning practice (Hudson et al., 1979). While these theories and some of their recent iterations (e.g., 'Just Cities' in Fainstein, 2014) have much to offer on relevant issues of ontology concerning societal and governing institutions and their attendant processes, they are relatively limited regarding the transactive properties of person-place interactions and the behavioural processes that may be linked to an individual's actualization of their local environment.

Conducting exploratory research regarding human-environment interactions, this dissertation is thus better served being guided by a theory with a more behavioural focus. Several behavioural theories outlining the relationships between human health and place have been used in research areas similar to this dissertation's work. Frameworks such as 'place effects on health' have importantly illuminated the health consequences of neighbourhood collective properties (e.g., social identities, socio-cultural features of a place) (Macintyre et al., 2002), while 'healthy cities' perspectives have added that area-specific local grassroots coalitions and land-uses as well as access can have significant implications for individual health (e.g., Corburn, 2009), and 'relational geographies' have brought to light the influence of socio-relational distance (i.e., physical distance isn't the foremost determinative health factor) and dynamic place characteristics (i.e., area features can advance/decline, are not static) in relation to a variety of health topics (Cummins et al., 2007). Such health and place frameworks, however well positioned to analyze place impacts on human physical and/or mental health, possess limited explanatory power regarding potentially relevant embodied cognitive and psychological processes related to human emotional responses to external urban designs and environments. Pairing the previously outlined lack of explanatory power provided by planning theories, as well as the limitations of contemporary health and place theories, this dissertation applies the ToA to 1) appropriately and sufficiently engage with the relationship under study as it concerns providing a robust theoretical explanation of the results observed in the primary research manuscripts and the final synthesis (i.e., Chapter 7), 2) present urban planning research with a new perspective that offers insights regarding a topic of importance, and 3) aid in structurally facilitating an interdisciplinary investigation via linking concepts and ideas from multiple areas of study.

1.3.2 Background of the Theory of Affordances (ToA)

In line with the interdisciplinary structure of this scholarship, this dissertation employs the ecological perspective of the ToA which importantly recognizes embodied cognition (i.e., cognition is shaped sensory and motor systems of one's body) and its attendant processes in order to contextualize the primary research findings of this work. The following section outlines the background of this theoretical framework, some of its central tenets, and how it will be linked to the topic of adolescent mental health and urban design.

The ToA initially emerged during the latter half of the 20th century as a critique of the then dominant but highly individualistic behaviourism psychological paradigm, one which theorized individuals as more mechanized entities that were essentially bounded by their responses to environmental stimuli (Gibson, 1979). In its critique, the ToA separated itself by importantly suggesting that the environment of an individual consists of different action possibilities (i.e., affordances; e.g., floors afford ambulation, water affords drinking, chairs afford sitting etc.) which one may or may not respond to (Gibson, 1986). This original perspective of affordances was derived from the larger idea of direct realism, a philosophical concept premised on the notion that what an individual sees in an environment is what there is, and that the resultant relationship between perception and action is therefore not indirect (i.e., mediated by internal representations) but is instead *direct* (Gibson, 1979). In other words, rather than actions being guided by some form of internalized knowledge structures, as was previously theorized in the earlier behaviourist paradigms, the ecological approach argued for a circular relationship between perception and action by emphasizing the role of information in the external environment with respect to shaping human action (Gibson, 1979). Gibson summarily explained this relational dynamic through the simple tautology "We must perceive in order to move, but we must move in order to perceive" (Gibson, 1979, p. 223). Therefore, in the ToA, an individual's decision-making or cognitive response process is the result of directly perceiving affordances from an environment at any given moment of time defined by the local sources of information which, eventually, culminate in the selection of a prospective action given the set of environmental conditions and the action capabilities of the individual (Gibson, 1979).

Recent theorizing about the perspective, however, has sought to move beyond this original conception of affordances as mere action possibilities, and has suggested that affordances constitute *relations* that can invite behaviour (Chemero, 2003; Withagen et al., 2012). The individual–

environment relationship is posited to exist in multiple dimensions that comprise *relations* between particular aspects of individuals and particular aspects of situations (Chemero, 2003) which can include, among other things, the physical environment properties, capabilities of the individual (e.g., physical abilities), relative importance of an affordance (e.g., affordances important for survival), culture (e.g., multiple uses for an affordance based on cultural responsiveness), and personal history (e.g., preferences, dislikes) (Withagen et al., 2012). It is this contemporary perspective of affordances as multidimensional relations between individuals and their environments wherein individuals, albeit most often unreflectively (Withagen et al., 2012), act upon the affordances of an environment in ways that either attract or repel them, that will be used to contextualize this dissertation's topic.

While the ToA offers considerable potential to support this dissertation, there have also been noteworthy criticisms levelled against it. One common criticism of the approach has been how it addresses the notion of learning or memory. Lacking any internal knowledge structures, it has been broadly argued that it isn't clear how an individual moves from using one information source to another if, in order for one to learn, the process must involve a transition. Importantly, such transitions are typically argued to require moving from using nonspecifying lower order perceptual variables (i.e., those typically closer to traditional psychophysics like wavelength, extent, intensity[2]) to using specifying higher order variables (i.e., those used by the perceptual system as efficacious combinations of lower order variables[3]) (e.g., in Withagen & van der Kamp, 2010). While the original ToA framework would suggest that affordances are perceivable directly without an excessive amount of learning, more recent work on the topic such as Jacobs and Michaels' (2007) theory of Direct Learning suggests that learning can be direct because there is information for learning in the environment. In essence, for any action that an individual wants to perform, it is suggested that there are a set of possible nonspecifying lower order information sources that the person can use to calculate how informative that particular combination of variables are with respect to their action (Jacobs & Michaels, 2007). This dynamic effectively creates "information spaces" where combinations of variables that are not informative repel an individual while combinations that are

[2] Definitions come from Hochberg (1998, p. 81) who also notes that other distinctions have been used in this regard such as extrinsic-intrinsic. For example, nonspecifying variables have been defined as a variable that "… correlates with an environmental property but does not relate one-to-one to it" (Withagen & van der Kamp, 2010, p. 154); specifying variables can also be conceptualized as information sources that directly specify an environmental property without any additionally needed explanation (e.g., time to contact in a collision or tau).
[3] Ibid.

informative attract them, and thus the process of learning over time is a continuous movement through this information space toward stable attractors which represent higher order variables (Jacobs & Michaels, 2007). More broadly, in the ecological approach it is theorized that learning or memory function through *mere changes* that reflect one's changed relationship with an environment in which the perceived variables, or the calibration between information and action, become more attuned. These *mere changes* ultimately change behaviour as the attuned perceived variables or calibrations are remembered in relation to how one previously related to an environment and linked information and action—learning is thus a mere change in the way one relates to an environment.[4]

In sum, the ToA originated as a critique of the deterministic behaviourism psychological theories of the 20th century, and specifically posited that the environment exists as an array of opportunities in which "… affordances do not cause behaviour but constrain or control it" (Gibson, 1982, p. 411). Recent theorizing has suggested that the capabilities of an individual or specific organismal factors (e.g., muscle strength) (Chemero, 2003), potential variance in the importance of affordances (e.g., prioritizing of essential affordances) (Withagen & Chemero, 2009), and the role of culture (e.g., pursuit of joint activities) (Ingold, 2000) and personal history (Withagen & van der Kamp, 2010) also factor into these interactional relationships by influencing what information is exploited by an individual or the types of bodily responses they may have to perceived environmental information. While the ToA has been criticized for its clarity regarding certain long-term phenomena, contemporary perspectives of the ToA offer this dissertation's planning-oriented work considerable potential to explore a relevant topic in a novel manner and with significant explanatory power.

1.3.3 Using the ToA to Frame Urban Environment and Adolescent Mental Health Links

Connecting the contents of the last section to the relationship between urban environments and adolescent mental health, Table 1.3.1 outlines the adaptation of the ToA across the points of the nature of perception, interaction, the decision-making or response process, learning or memory, and an overarching outline of the person-place relationship, as well as some connections between these points and relevant planning functions. Having briefly covered the diversity of definitions and traditions associated with the field planning in section 1.3.1, this dissertation has elected to adopt a more pragmatic outline of the field of planning, specifically that planning broadly comprises the

[4] This conversation on learning/experience is not intended to be comprehensive as it's not central to this work; it is intended to show that arguments have been made in support of the ToA's potential to address these concerns.

"Technical and political process concerned with the welfare of people, control of the use of land, design of the urban environment including transportation and communication networks, and protection and enhancement of the natural environment" (McGill University, 2020). This particular definition of planning importantly offers room for discussion concerning the social processes, equitable considerations, responsibilities, and communicative tasks with which planning scholarship and practice are said to engage (i.e. helps frame contributions and implications sections in Chapter 7).

Table 1.3.1 Application of the Theoretical Framework to Dissertation Topic, Planning

	ToA/Ecological Approach	**Adolescent MH and Design**	**Planning Links**
Perception	Perception to action follows the notion of direct realism	Adolescents' observations of urban designs inform their emotional responses	Support the development of transportation and communication networks that include adolescent perspectives
Interaction	Environmental information can directly specify *surfaces* (e.g., the level or grade of a field), *objects* (e.g., other individuals), and *events* (e.g., an approaching object) that an individual perceives	Urban designs and their attendant features (e.g., accessibility, street furniture, pedestrian activity) inform adolescent emotional responses	
Decision-Making or Response Process	Decisions emerge from the continual regulation of action where, in a setting, an individual is behaving through a continuous cyclical perception-action relationship	Interactional relationships between urban designs and adolescent mental health indicators include cycles of design perceptions and emotional responses	Enhance practitioner knowledge regarding adolescent-friendly designs, adolescent-specific emotional responses to designs
Learning or Memory	Combinations of lower order perceptual variables inform actions via uninformative and informative combinations that either repel or attract an agent; *mere changes* occur as a result of attunement over time	Adolescents attune to combinations of lower order perceptual variables (e.g., intensity, extent) in an urban environment that negatively or positively affect their emotions	
Current Outline of Relationship	Multidimensional *relations* between particular aspects of an individual (e.g., agent capabilities, culture) and particular aspects of environments (e.g., importance of affordance, history) (Chemero, 2003) wherein one acts upon the affordances of an environment in ways that either attract or repel them	In addition to, for example, characteristics like street furniture, accessibility, and pedestrian activity, an adolescent's capabilities, value assessments, culture, and personal history influence their emotional responses to an environment	Inform design and land use policy in support of designs that target improved mental well-being

Based on the outlined usages of the theoretical framework for the purposes of this dissertation, there are a couple of points that bear further mention when noting the potential for scholarly contributions by applying the ToA in the context of planning research. First, recent review has observed the integration of the ToA in planning-specific conversations pertaining to related topics such as urban green spaces (UGS) and health, and consequently suggested there is legitimate explanatory potential for the approach with respect to delineating the spatial *quality* of spaces and moving beyond the unifocal concerns of the spatial distributions of and access to UGS (Lennon et al., 2017). And second, the application of the ToA to specific topics related to younger populations has demonstrated its value in an array of contexts by facilitating research that highlights the unique relational dynamics of those in younger cohorts. For instance, affordances have been used to study the experiences of young people in relation to UGS (Nissen et al., 2020), identify potential activity features in local urban designs (Lopes et al., 2018), investigate links germane to nature-based play spaces (Herrington & Brussoni, 2015) and children's connections to nature (Giusti et al., 2018), explore children's mobilities (Kyttä, 2004), and examine child-friendly environmental designs (Clark & Uzzell, 2002; Heft, 1988; Horelli, 2007). Recognizing the opportunity to continue this work connecting the ToA with research specifically on younger cohorts, while also connecting the Theory with the central points of the field of planning (and specifically urban design), the aim of this dissertation's framework-field combination is threefold: 1) to conduct a coherent multi-study investigation of a planning-related topic that is theoretically informed by an appropriate behavioural/ecological approach; 2) to explore and interpret the nature of a person-place phenomenon/relationship with an explanatorily powerful tool (i.e., the framework) to theorize about precise embodied cognitive and perceptual processes potentially affecting the relationship under study in service of offering novel insights to the field of planning; and 3) to systematically link together the results of the primary research with the larger field of planning practice in a manner that is consistent in how it informs scholarship, practice, and policy.

1.4 The Value of an Interdisciplinary and Ecologically Based Planning Investigation of Adolescent Mental Health and Urban Design

Drawing on the earlier mental health definition provided by Galderisi et al. (2015) in section 1.1.1, this dissertation focuses on the self-regulation and emotions, and by proxy the relationship between body and mind, that contribute to an internal state affecting overall function through

recognizing and investigating the dynamic, socio-relational, and multi-level aspects of the adolescent mental health and urban design relationship (section 1.2). By applying an ecological frame, adapting this theory to the topic and field via a pragmatic outline of planning, and contextualizing the relationship between adolescent mental health and place (section 1.2) in a manner that draws on planning and public health scholarship, this dissertation endeavours to offer an interdisciplinary (i.e., an interactive perspective that seeks to analyze, synthesize, and harmonize links between disciplines/fields/methods into a coordinated and coherent whole (Choi & Pak, 2006)) investigation of the aforementioned relationship. As presaged in the previous section, the interdisciplinary structure and the accompanying theoretical frame of this dissertation allows for this work to contribute novel empirical insights to the larger field of planning in a couple of important ways.

First, given that one of the field of planning's primary concerns is the identification of issues and developing contingent strategies (Schurch, 1999), an interdisciplinary approach affords the opportunity to conduct coordinated and continuously integrated research that pursues the development of coherent and multifaceted findings and strategies (Choi & Pak, 2006). Applied to this investigation, the structure of this dissertation will present such research for both planners and other interested audiences further afield. As it relates to understanding the links between human emotion and planning practice, a review of conceptualizations of "emotion" in planning contexts observed that the concept has tended to be understood in a more rationalist perspective that elides a deeper engagement with a host of socio-relation factors that other disciplines and fields suggest are at play (e.g., cultural influences) in various emotional phenomena (Baum, 2015). Explicitly conceptualizing the relationship between urban environments and adolescent mental health in an interdisciplinary manner not only moves the associated analyses of this work past the relatively reductive perspective that has ostensibly predominated much planning scholarship in the past, but also offers the field of planning an multifaceted investigation that discusses the implications of its research from a perspective that explores multiple socio-relational factors and multi-level influences relevant to adolescent mental health, recognizes the somatic and embodied cognitive inputs of emotions (in this case, as they relate to adolescents), and takes into account these considerations when recommending potential changes for policy and practice. Ultimately, this interdisciplinary structure allows for this scholarship to bring to bear a more comprehensive understanding of the adolescent mental health and urban environment relationship for those in the field of planning through discussing a greater variety of explanations for and implications of the undertaken research (i.e., Chapter 7).

Second, regarding the application of an adapted ecological approach to scholarship undertaken in the field of planning, this theoretical framing allows for the ensuing research and synthesis to draw from and engage with ecological and perceptual concepts that have been charted in related areas of scholarship but are typically omitted in planning work. For example, affordances, like several other human geography concepts that have not always been considered in planning, highlight that emotions can take on social forms of expression (Clark & Uzzell, 2006; Pile, 2010) and can take the form of affective relations that shape the ways individuals see their world and elect to live in it (Anderson & Smith, 2001; Navarro et al., 2017). Affording the opportunity for this dissertation's synthesis to engage with such concepts from bodies of scholarship typically beyond the scope of planning is particularly advantageous for this research topic for two central reasons. The first is that this dissertation's topic works with adolescents, who have often failed to be considered in urban design deliberations (e.g., Dunnett et al., 2002), thus the resulting policy and practice discussions of this dissertation's synthesis will benefit from perspectives that further *personalize* the experiences of this group to professional audiences. And second, this group is quite unique in that it is experiencing a maturation process characterized by significant cognitive, physical, psychological, social changes (Dahl, 2004; Dahl et al., 2018), and consequently the relevance of this dissertation will be enhanced for planning audiences by presenting discussions framed within the ToA that consider a wide array perspective, sensory, and environmental inputs (via affordance analyses and discussions) which emphasize different relational, social, and developmental concerns specific to this cohort.

1.5 Research Overview and Questions: Connecting the Integrated Articles

In addition to the contribution prospects laid out above, studies have only recently begun to connect urban environments and adolescent mental health (Gascon et al., 2015; Krabbendam et al., 2020), resulting in an opportunity to undertake more comprehensive studies that specifically aim to explain this complex relationship (Suglia, 2019). Suggestions to improve this body of literature have been made regarding both conceptual issues such as focusing on environmental justice principles (e.g., vulnerable group access to infrastructure) (Kieling et al., 2011), as well as methodological considerations such as conducting more assessments of space affect and quality (Madzia et al., 2019). To address these gaps, this dissertation seeks to explore the precise relationships between adolescent mental health indicators and urban environments by assessing their emotional responses to two particular design paradigms: pedestrian- and transit-oriented design (PTOD) and cognitive architecture (CA). As these particular design paradigms are explained in greater detail in the

manuscripts comprising Chapters 3 through 6, only a more cursory explanation is offered here in the introduction. Broadly, the PTOD paradigm is a planning model that focuses on reducing the vehicular dominance of many modern urban areas through promoting active lifestyles that can be supported by interventions and changes to urban form (e.g., design scale, visual richness, area distinctiveness) (Dittmar & Ohland, 2012; Renne, 2016); for example, those that improve wayfinding and pedestrian safety (Ewing, 2013; Ewing & Handy, 2009). CA, meanwhile, is a set of architectural concepts (e.g., symmetries, fractal patterns, biophilic architecture) that have been suggested to comprise specific links between physical exterior architecture designs (as external stimuli) and certain brain activity, mood states, etc. and which may possess benefits related to human health and well-being (Goldhagen, 2017). Importantly, though, both paradigms offer sets of specific design concepts that are present in many urban contexts and can consequently move analyses beyond the investigation of coarser operationalizations such as simply examining greenspaces, dense urban areas, or suburban spaces.

The overarching objective of this dissertation is to therefore present a comprehensive interdisciplinary, mixed methods, and theoretically informed evaluation of the relationships between a range of adolescent mental health indicators (i.e., emotional responses) and specific PTOD and CA concepts. To accurately and appropriately fulfil this objective, the following list of questions were asked to explore these relationships from a range of research perspectives:

1. What is the nature of the relationship between specific urban built and natural design concepts and different adolescent mental health indicators (i.e., emotional responses)? (**Overarching**)
2. What is the state of the literature regarding the relationship between the mental health of young people and urban design? (*Manuscript 1*, **Chapter 2**)
3. What emotional responses do adolescents articulate in reference to different real-world PTOD and CA concepts (and why)? (*Manuscript 2*, **Chapter 3**)
4. What are the relationships between PTOD exposures, as reflected in six different urban settings, and adolescent mental health indicators (i.e., positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand)? (*Manuscript 3*, **Chapter 4**)
5. What are the relationships between each of the five specific PTOD concepts (i.e., imageability, enclosure, scale, transparency, complexity) and adolescent mental health indicators (i.e., positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand)? (*Manuscript 4*, **Chapter 5**)

6. What are the in-situ associations between specific PTOD (e.g., imageability) and CA concepts and adolescent mental health indicators? (*Manuscript 5*, **Chapter 6**)

With respect to the selection of emotional responses as indictors of overall mental health and well-being, to be clear, the six specified outcomes of interest listed above were selected for three central reasons. First, the selection of the three sets of distinct dimensions of mental health were made based on the assumption that are mutually opposite or exclusive; that is to say, for example, it's unclear how one might be both very positively affected and negatively affected at the same time. Second, emotions have previously been used as indicators for emotional development and mental health in demographically similar groups such as children (Guhn et al., 2020), and thus are appropriate for assessing adolescent mental health. And third, the use of emotions as indictors—including internalizing symptoms (e.g., negative affect, anxiety)—of overall mental health have been shown to be relevant in predicting early-onset (6-14 years) mental health conditions (Thomson et al., 2019), which is precisely the proxy being inferred in this dissertation.

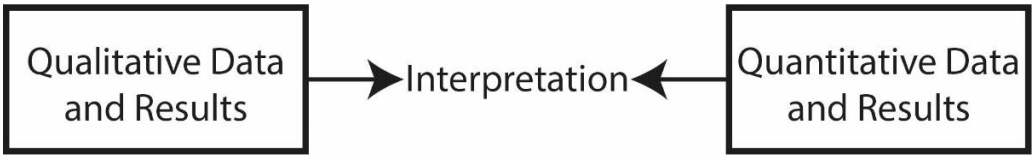
1.6 Dissertation Mixed Methods Structure: Fitting it all Together

As alluded to previously, this dissertation features a mixed methods structure. Discrepancies and inconsistencies pertaining to the concept of "mixed methods" and its true function in larger research conversations have been well detailed (Hesse-Biber & Johnson, 2013); however, several arguments have been extended in support of mixed methods. Substantive arguments have been made that advocate mixed methods not only enhance research explanations about the social world through the qualitative perspective's more holistic approach to "data" or "cases" (i.e., qualitative study considers the finer details of each data point or case, rather than just controlling for them) complementing larger-scale quantitative work (Mason, 2006), but that the combination of methods also facilitates the development of emergent perspectives (Greene et al., 1989; Hesse-Biber & Johnson, 2013).

Seeking to undertake a comprehensive analysis of this dissertation's topic, the overarching structure used is a combination of exploratory sequential and triangulation mixed methods designs (see Figure 1.6.1) where qualitative and quantitative approaches are used in different phases to inform the interpretation of findings that contribute to exploring a common research objective (i.e., research question #1 in section 1.5). Descriptions of triangulation and exploratory mixed methods designs used here come from Creswell et al.'s (2006) outline of mixed methods approaches. Creswell et al. (2006)

explain that the triangulation design is a one-phase mixed methods structure in which both quantitative and qualitative methods are employed within roughly the same time frame to support a common aim, while exploratory mixed methods are a two-phase design wherein the separate approaches are used in a complementary (i.e., building) fashion. This dissertation makes use of the triangulation design specifically in the summative interpretation of the cross-study results in Chapter 7 (i.e., discussion), and the exploratory sequential design in its structure of having the qualitative research (i.e., Chapter 3)—and to an extent the synthesis in Chapter 2—build into and frame the subsequent quantitative work of the latter research chapters (i.e., Chapters 4-6). There are a few rationale for applying this particular mixed methods approach: 1) to have the different research arms of the dissertation corroborate or otherwise advise the findings of the others; 2) to allow for adolescent voices and perspectives to guide the development of the qualitative findings, which then help guide the ensuing research chapters and recommendations presented in the final synthesis; and 3) to undertake a coordinated and comprehensive assessment of the potential links between adolescent mental health and urban design by implementing a coordinated complementary cross-study design linked by a relevant overarching aim that each study systematically contributes to.

Figure 1.6.1 The Exploratory and Triangulation Mixed Methods Design



As this dissertation isn't structured as either necessarily qualitatively or quantitatively driven mixed methods scholarship, the interpretations presented in the final synthesis follow a more general logic that has been argued in support of mixed methods research as a general enterprise. To this end, the overarching structure and eventual synthesis of this dissertation subscribes to the same logic espoused by Mason (2006) who explains that social phenomena and social life is neither essentially subject to macro- meso- or micro-approaches or perspectives, nor is it fundamentally quantitatively or qualitatively defined. This perspective regarding social life is admittedly foremost pragmatic in orientation as it reiterates the sentiments of other mixed methods positions like Sandelowski (2000) who notes that, at the paradigmatic level, mixed methods approaches cannot truly reconcile the differences between the worldviews of positivism, post-positivism, critical theory, constructivism etc. (Sandelowski, 2000). Therefore, the mixed method structure of this dissertation is strategically

applied to allow the final synthesis to more appropriately discuss the topic of urban environments and adolescent mental health through specific concomitant, but pragmatic, theorizing about adolescent *understandings* (qualitative) and theorizing about adolescent *behaviours* (quantitative) in the same work,[5] and not through a wholly outlined and reconciled mixed methods paradigm.

Combining the different integrated articles of this dissertation at the interpretive level, Chapter 7 presents an aggregated discussion of the research and methodological contributions, as well as the policy implications, of the dissertation. This structure strives to create a fuller picture of the nature of the relationship between urban design and adolescent mental health through synthesizing the contributing mixed methods papers in a manner where they converge on key shared points (Tashakkori & Teddlie, 1998). Such structures have sometimes been criticized as being "simple-minded 'triangulation'" which occurs when no attention is given to the situated nature of the different accounts collected across methods (Silverman, 1993); however, the complementary nature of the integrated articles in the dissertation are meant to structurally guard against this. Perhaps most obvious is that the four primary research articles of this dissertation share a similar theoretical framework which informed the development of the studies and the discussions of their findings. Meanwhile, as it relates to Chapters 3 and 6, these two sections share similar data collection protocols (e.g., similar route, environmental exposures) and ecological validity in their methods (i.e., both *in-situ*) which helps to minimize discrepancies in adolescent responses while also aiding in the consistency of the discussions. Likewise, concerning the quantitative manuscripts (i.e., Chapters 4-6), these three papers are buoyed by their exploration of the same set of emotional response outcomes and demographic group (adolescents aged 9-17). While there are variances with respect to the different aspects of each research chapter's protocols and analyses, the synthesis of Chapter 7 takes advantage of mixed methods structure outlined here by acknowledging these commonalities between manuscripts but still outlining the unique and complementary contributions of each study to the larger discussions offered.

1.6.1 Linking Mixed Methods Structure to the ToA Framework

To illustrate the links of this mixed methods structure with the theoretical framing of the dissertation, Table 1.6.1 presents summaries of the links between each chapter's main aim, the

[5] It should be noted that this general approach to mixed methods is not exceptionally specific to this dissertation or area of scholarship, and has been detailed in different forms before (e.g., Greene et al., 1989).

theoretical framing of the aim, the applied method, and the section's contribution to the synthesis (this is re-visualized in section 7.2 of Chapter 7). Chapter 3 uses qualitative methods to explore the relational nature of the urban design and emotional response relationship, and the related rationale, as articulated by adolescents. Chapters 4 and 5 employ quantitative methods to identify and examine group-level trends among adolescents regarding their emotional responses to urban design quality and individual design prominence, respectively. Chapter 6 contributes an in-situ assessment of adolescent emotional responses to different real-world examples of urban design concepts.

Table 1.6.1 Summary Links of the Dissertation Primary Research, Mixed Methods Design

Chapter, Aim	Theoretical Frame of Aim	Method	Role in Triangulation
Chapter 3: Investigating adolescent in-situ emotional responses to urban and architectural design concepts	Exploring the interactional relationships of what emotional responses adolescents report in relation to distinct urban and architectural designs, and the reasons why these emotions are suggested	Go-along interviews	Understanding the nature of the interactional relationship between urban and architectural designs and adolescent emotional responses from the adolescent perspective
Chapter 4: Quantifying the associations between overall environment quality and adolescent emotional responses	Evaluating how the aggregate quality of different combinations of urban design concepts in distinct areas either support positive or negative emotional responses	Online surveys	Identifying population-level trends in adolescent emotional responses to the overall design quality of distinct urban areas
Chapter 5: Quantifying the associations between specific design concepts and adolescent emotional responses	Evaluating how the prominence of specific urban design concepts in different areas either support positive or negative emotional responses	Online surveys	Identifying population-level trends in adolescent emotional responses to the varying prominence of specific urban design concepts
Chapter 6: Evaluating the in-situ links between overall environment quality and specific architectural designs and adolescent emotional responses	Assessing how the aggregate quality of different combinations of urban design concepts, as well as real-world architectural concept examples, either support positive or negative emotional responses	Ecological momentary assessment surveys	Examining the direct associations between real-world examples of urban and architectural design concepts and adolescent emotional responses

1.7 Organizing the Dissertation's Contents: Outlining the Conceptualization, Writing, Revising, and Submission Processes

A deliberate and systematic research and writing processes was carried out to complete this dissertation. The review and framework manuscript (Chapter 2) consisted of database searching, literature synthesis, and the development of two frameworks, and was conducted in late 2019/early 2020. This manuscript was accepted in 2021 and officially published in *Public Health Reports* in 2022. Data collection for the qualitative go-along interview manuscript (Chapter 3) began in June 2021 and was completed in August 2021. Following an iterative process of data collection, analysis,

and revisions and writing that was conducted alongside the data collection process, the complete manuscript that comprises Chapter 3 has been accepted for publication in the journal *Health & Place* and is currently in press. Regarding Chapter 4 and 5, data collection for the online survey was conducted with the help of University of Waterloo's (UW) Survey Research Centre (SRC) and the Léger market research firm, began in December 2021, and was completed in January 2022. Analysis and writing of these two manuscripts using the online survey data were completed in April 2022 culminating in their submissions to two different peer-reviewed journals later in April 2022. Finishing the integrated articles in the dissertation, the data collection for the ecological momentary assessment (EMA) manuscript (Chapter 6) began in August 2021, stopped for the winter, and was completed (for the purposes of the article included in this dissertation) in June 2022. Writing and analysis of the manuscript began in February 2022 and was completed in June 2022. This article will soon be submitted to a peer-reviewed journal for publication. Bookends of this dissertation, the introduction and synthesis (i.e., Chapters 1 and 7), were written between April and June 2022.

Chapters within this dissertation are organized and presented in an integrated article format that consists of five stand-alone manuscripts, along with accompanying introduction and synthesis chapters. The integrated articles consist of a review and framework article, a qualitative research manuscript, and three quantitative research papers. The review and framework article serves as the literature review for the dissertation and focuses on synthesizing the contemporary literature pertaining to young people's mental health and urban environments from three relevant fields (planning, public health, and neurourbanis) to frame the topic for research and practice. Picking up on some of the suggestions expounded in the framework manuscript, the qualitative investigation documents adolescent participants completing go-along interviews on a pre-determined walk through a selection of different urban spaces, explaining their emotional responses to each setting and its notable design qualities or real-world examples of CA concepts. Also drawing inspiration from the framework paper, the first online survey manuscript presents a quantitative analysis of the relationships between six different urban settings (trail, bluespace, suburban mall, suburban residential street, urban market area, urban plaza area) that were scored for their PTOD quality and a series of mental health indicators (positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand) among adolescents. The second online survey manuscript examines the associations between the five specific PTOD concepts (imageability, enclosure, human scale, transparency, complexity) as they were scored across six urban settings and the same array of

adolescent mental health outcomes. The final integrated article, the EMA study, involved adolescent participants completing walking surveys on the same route as the qualitative study and providing their in-situ emotional responses to each setting and CA concept example on their smartphones or a tablet.[6]

[6] Chapter 1's references are combined with Chapter 7's at the end of the dissertation.

Chapter 2

How Do Urban Environments Affect Young People's Mental Health? A Novel Conceptual Framework to Bridge Public Health, Planning, and Neurourbanism

With Dr. Sean Doherty and Dr. Leia Minaker

2.1 Abstract

Youth is a crucial period for mental and social development. Currently, mental illness among youth is a global epidemic, and rates of disorders such as depression and anxiety continue to rise. Urban living is linked with higher risk of serious mental illness, which is important since the world is urbanizing faster than ever before. Urban environments and their specific landscapes, designs, and features influence mental health and well-being. However, no conceptual frameworks to date detail the impact of urban environments on youth mental health, nor has much study considered the growing role of digital and social media contexts in this relationship, leading to calls for the development of holistic approaches to describe this relationship. This paper synthesizes existing knowledge on urban places (both built and natural environments) and mental health in the public health and urban planning literature, and points to the emerging field of neurourbanism/cognitive planning to enhance current practice and research. We develop two novel conceptual frameworks (one research-oriented, one practice-oriented) adapted from Bronfenbrenner's socio-ecological model (SEM), which focus on relationships between urban environments and youth mental health. Specifically, a new digital and social media contextual level is added to the SEM, and a multi-layer concept is applied to highlight potential cross-field interactions and collaborations. The proposed frameworks seek to guide professionals and researchers regarding their respective future practice and study in this area.

Role in the Dissertation

This chapter's interdisciplinary review and synthesis is primarily intended to collect and combine the relevant existing literature from planning, public health, and the emerging field of neurourbanism in service of outlining opportunities for practitioners and researchers to better address issues related to young people's mental health and urban environments. In pursuing this aim, Chapter 2's research framework (i.e., Figure 2.4.2) outlines a number of research opportunities specific to unexplored research topics and underutilized methods. Some of these suggestions are taken up in the ensuing primary research chapters of this dissertation. Several suggestions offered to practitioners (i.e., Figure 2.4.1) are expanded upon in the final synthesis of Chapter 7.

Keywords

built environment; mental health; neurourbanism; planning; urban environment; youth

2.2 Introduction

Youth (≤18 years old) is a critical time in human growth and development. Mental illness among youth can arise as a consequence of the myriad physical, emotional, and social changes experienced during these years (World Health Organization, 2018). Prevalence of mental illness among youth continues to rise (Collishaw, 2015; Glied & Cuellar, 2003; Gunnell et al., 2018; Polanczyk et al., 2015), and the onset of internalizing disorders in early life are among the leading causes of disability (Kapungu et al., 2018).

Living in urban areas is linked with higher risk of serious mental illness (Gruebner et al., 2017). Relative to rural living, city dwellers have higher rates of schizophrenia (Frick et al., 2013; Jacobi et al., 2014; Pedersen & Mortensen, 2001), distress, posttraumatic stress disorder, and paranoia (Phillips et al., 2009; Prina et al., 2011; Silove et al., 2014). With migration to cities predicted to intensify in the coming decades (United Nations, Department of Economic and Social Affairs, Population Division, 2018), understanding the influence of urban environments on mental health is important (Okkels et al., 2018). Urban influences on youth mental health is currently understudied due to a lack of funding (Bundy et al., 2018; Hoagwood et al., 2018; Lu et al., 2018) and support (Dubicka & Bullock, 2017; MQ, 2019; Signorini et al., 2018) for youth mental health research. Noting this, interdisciplinary scholars have called for more comprehensive frameworks to clarify the relationship between mental health and the environment (Gunnell et al., 2018; Suglia, 2019) including those that consider how urban environments influence youth mental health (Ruiz & Chaix, 2019; Suglia, 2019).

2.3 Synthesis Objective, Aim, and Theoretical Approach

Studies have only recently begun to connect urban environments and young people's mental health (Gascon et al., 2015; Krabbendam et al., 2020), resulting in an opportunity to develop comprehensive frameworks that specifically aim to explain this complex relationship (Suglia, 2019). Moreover, conceptual critiques aimed at this area of scholarship have recommended the further inclusion of equity considerations (e.g., independent mobility constraints) (Kyttä & Broberg, 2014) and environmental justice principles (e.g., vulnerable group access to infrastructure) (Kieling et al., 2011), while a number of methodological improvements such as conducting more assessments of space affect, quality, and usability (Madzia et al., 2019) have been called for. Posing the question "What is the state of the literature regarding the relationship between the mental health of young

people and urban design," the purpose of this synthesis is to therefore bring together literature from multiple relevant fields (i.e., planning, public health, neurourbanism) to present a multifield conceptual framework for young people's mental health and urban environments. Applying a multifield approach also illuminates the political processes, collective influences, socio-cultural dynamics (Healey, 2007), as well as the social determinants of health (SDH) (Northridge et al., 2003), in urban areas that contribute to varied health outcomes via disparate access, exposure, and network factors.

This paper synthesizes research on the urban influences of youth mental health from three literatures (public health, planning, and neurourbanism/cognitive planning) to develop two novel, comprehensive, interdisciplinary frameworks for research and action regarding youth mental health-urban environment relationships. Our approach is grounded in Schulz and Northridge's (2004) socio-ecological conceptual framework of the social determinants of health and environmental health promotion to recognize the dynamic and multi-level nature of the urban environment-youth mental health relationship. Schulz and Northridge's (2004) framework explicitly focuses on social and environmental mechanisms by which urban environments can produce inequities in mental health outcomes, thereby warranting a multi-field approach. In our novel conceptual frameworks, therefore, we view youth mental health-urban environment relationships as dynamic, socio-relational, and multi-level (individual, interpersonal, environmental, policy). Table 2.3.1 provides a definition, and summary of key features, approaches, and ideas associated with each field to provide the material bases for the later frameworks.

Table 2.3.1 Overview of Fields Contributing to Urban Influences on Youth Mental Health Research

	Public Health	**Planning**	**Neurourbanism/ Cognitive Planning**
Definition	"…the science of protecting and improving the health of people and their communities … achieved by promoting healthy lifestyles, researching disease and injury prevention, and detecting, preventing and responding to infectious diseases" (Centers for Disease Control and Prevention, 2020).	"…technical and political process concerned with the welfare of people, control of the use of land, design of the urban environment including transportation and communication networks, and protection and enhancement of the natural environment" (McGill University, 2020).	"…an interdisciplinary … approach that connects public mental health to urban planning to create better environments that will improve the mental wellbeing of individuals and communities in cities, and strengthen the resilience of high-risk individuals and children" (Adli et al., 2017).
Key Elements	➢ Determining the factors that influence health ➢ Prevention through multiple means ➢ Promotion of health behaviors and lifestyles	➢ Guiding the layout and development of urban areas ➢ Land use, urban design, and transportation decisions ➢ Service provision, political process	➢ Multimethod evaluations of urban mental health topics ➢ Interdisciplinary, transdisciplinary collaborations ➢ Identification of and research on high-risk populations
Key Topic-Specific Approaches and Ideas	➢ Social epidemiology, Ecosocial theory (Krieger, 2001) ➢ Mixed methods, preventive policy positions ➢ Targeted interventions, longitudinal study	➢ Pedestrian- and Transit-Oriented Design (Ewing, 2013) ➢ Relational theory, co-evolutionary approaches (Verbeek & Boelens, 2016) ➢ Social cohesion, mixed land use, health equity	➢ Attention Restoration Theory (Kaplan, 1995) ➢ Critical Neurogeography (Pykett et al., 2020) ➢ Ambulatory assessment, biosocial research methods

Key public health methods and practices pertaining to this topic include ecosocial theory, the use of mixed methods, and targeted interventions. Importantly, ecosocial theory delineates that a combination of biological, sociological, economic, and psychological phenomena influence health

(Krieger, 2001). With respect to planning, pedestrian- and transit-oriented design outlines multiple features that may underlie the relationship: 'imageability,' (i.e., quality of a place that make it distinct (Ewing, 2013), can contribute to 'sense of place' (Cullen, 1995)), 'enclosure,' (i.e., degree to which spaces are visually defined (Ewing, 2013); idea of 'hereness' (Cullen, 1995)), 'linkage' (i.e., physical, visual connections unifying disparate elements (Ewing, 2013)), and 'legibility' (i.e., ease with which the spatial structure of a place can be understood/navigated (Ewing, 2013)). Key neurourbanistic features include attention restoration theory (ART) which hypothesizes about the restorative health impacts of environments (Kaplan, 1995), and 'critical neurogeography,' a biosocial framework which emphasizes a geographical focus during investigations of the brain in social milieus (Pykett et al., 2020).

2.3.1 Public Health

Public health has been one of the foremost fields to consider issues regarding health and the urban environment since the 19th century as industrialization and urbanization, the spread of infectious illnesses, and urban health concerns prompted new perspectives regarding population health (Rosen, 2015). By modern definitions, the urban environment is an important determinant of youth mental health (Clark et al., 2007; Haddad et al., 2015; McCracken et al., 2016) as living in urban environments has been identified as an important risk factor in the development and onset of several mental health issues (Frissen et al., 2018; Reed et al., 2018; Toulopoulou et al., 2017). Public health is critical to the identification of these health issues, prevention of ill health, and promotion of healthy behaviours through means such as education, research, and policy recommendations (Centers for Disease Control and Prevention, 2020). These roles are best understood by breaking down the urban environment in terms of its built and natural features.

Built features of urban environments influence youth mental health (Nordbø et al., 2018). The presence of neighbourhood facilities (e.g., library, recreational center), for instance, can improve social competence (Christian et al., 2015), while the spatial distribution of urban environment characteristics (e.g., pedestrian route directness) can influence the risk of depressive symptoms (Duncan et al., 2013). Urban environments that create auto-dependency can lead to negative emotions (Ramanathan et al., 2014) and produce more worry and stress in child passengers (Westman et al., 2017), while also creating high traffic noise, which has been linked with increased annoyance (Babisch et al., 2012) and sleeping problems (Tiesler et al., 2013) among youth. Such noisy

environments can additionally reduce social cohesion and the restorative quality of neighborhoods, which also increase youth mental health issues (Dzhambov et al., 2018) and are linked to symptoms such as depression, anxiety (Stansfeld et al., 2000), and impaired cognitive function (Haines et al., 2001). Conversely, urban designs that promote opportunities for active transportation and exercise can support youth mental health (Ahn & Fedewa, 2011; Li et al., 2016). For example, street connectivity (Giles-Corti et al., 2011), narrow street width (Nasar et al., 2015), environment aesthetics (e.g., street greenery, tree shading) (Sun et al., 2018), playground features (Pagels et al., 2014), pedestrian crossovers, traffic lights, intersection densities (Rothman et al., 2014), and sidewalk presence (Rothman et al., 2018) can all encourage youth physical activity.

Natural features are also important determinants of youth mental health (Chawla, 2015; Tillmann et al., 2018). Blue spaces (i.e., waterscapes) can help adolescents to manage their emotions and distress (Djohari et al., 2018), provide opportunities for increased social interaction (Ashbullby et al., 2013), and improve restoration and relaxation (J. J. Roe & Aspinall, 2012). Likewise, green spaces such as parks can reduce stress (Feda et al., 2015), while gardens/gardening can lower levels of depressive symptoms and enhance emotional well-being (van Lier et al., 2017). Youths' engagement with natural environments has been positively linked with cognitive development (Dadvand et al., 2015), and reductions in ADHD symptoms (Amoly Elmira et al., 2014; Markevych et al., 2014). In the long-term, childhood exposure to nature has been correlated with improved later-life mental health (Dibben et al., 2017; Engemann et al., 2019). Prevention of ill health can also be supported by spaces with greater tree cover density which can lower air pollution and improve mental health (Dzhambov et al., 2018) and overall quality of life (J.-H. Kim et al., 2016), and areas with higher greenness are associated with reduced depressive symptoms (Mavoa et al., 2019) and internal and external behavioral issues (e.g., conduct problems, anxiety) (Madzia et al., 2019).

An important and emerging public health research opportunity is to consider the role and influence of technology and social media regarding offering new ways of capturing how physical and natural environment pathways may support (or diminish) youth mental health. These ubiquitous media impact adolescents health uniquely (given their propensity for use) and can be leveraged to understand social networks, their values, and impacts on health with greater temporal precision (Ilieva & McPhearson, 2018). To date, social media data has been used to highlight a number of important phenomena such as analyzing park accessibility via visitation trends (Hamstead et al., 2018); determine which aspects of parks and green spaces improve use (Donahue et al., 2018); map the

objective characteristics of place with respect to happiness (Mitchell et al., 2013); and identify which public plazas are most preferred, used, and liveable (Martí et al., 2017). Beyond social media and digital mediums, specific concepts including how perceptions of greenspace quality, usability, and safety affect youth mental health require more investigation (Madzia et al., 2019). Future public health research should incorporate more longitudinal designs (Gascon et al., 2015; Lovasi et al., 2016; Markevych et al., 2017) and reproducible yet theoretically-motivated measures rather than self-reports (Alderton et al., 2019).

2.3.2 Planning

Modern city planning also emerged in the late 19th century with the aim to address the unsanitary conditions of growing industrial cities (Barton, 2009b). As a field distinct from public health, contemporary planning, as noted in Table 2.3.1, is primarily concerned with guiding urban development; informing decisions of transportation, urban design, and land use; and service provision (McGill University, 2020). Planning functions (i.e., duties, roles) can complement public health goals when they recognize the influence of additional influences like socio-cultural forces (Healey, 2007), economic development (Corburn et al., 2014; Corburn, 2015), and housing (Pillas et al., 2014) in several domains of urban health. Evolving understandings of health in planning have elevated notions of place identity, social 'constructions' of place (Natarajan, 2017), the spatial nature of place, and how spatial variations contribute to health inequalities (Barton, 2009a; Stevenson et al., 2016), with implications for the planning field in addressing youth mental health.

Planning processes can impact mental health (Rydin et al., 2012) since several social determinants of health are intertwined with planning governance and its processes (Burris et al., 2007). Land use decisions are particularly important as they affect health via design, density, diversity, and destination accessibility (Sallis et al., 2016). For instance, providing green space access can facilitate the development of social ties (Kaźmierczak, 2013), greater street-network accessibility can lower psychological distress (Sarkar et al., 2013), and higher levels of greenery (e.g., trees) can mitigate noise annoyance (Li et al., 2016). Mixed land use can make access to services and facilities easier (Feng et al., 2010), and also encourage exercise (Sarkar et al., 2013). Neighborhood design also affects mental health: areas that include 'soft edge' (e.g., front garden) spaces (Gehl, 1986) enable both movement and lingering which promote social interaction (B. Brown et al., 1998), enhance sense of community (Inclusive Design for Getting Outdoors, 2012), and improve quality of life (Gehl,

2011). Building designs featuring façades with windows and doors facing pathways provide surveillance through 'eyes on the street' and can contribute to a sense of safety (S. C. Brown et al., 2009).

Planning processes impacts on youth mental health are not equally distributed. For example, green infrastructure (GI) can improve mental health through reducing heat stress and air pollution, and providing opportunities for exercise (Amano et al., 2018; Irvine et al., 2013; van den Berg et al., 2015); however, youth experience their local infrastructure differently than adults due to limited independent mobility and parental controls (Alparone & Pacilli, 2012; Foster et al., 2014). Planning processes seeking to increase young people's use of GI and improve their mental health can address inequities by ensuring youth have equal opportunities to access these health promoting resources (Kyttä & Broberg, 2014). Planning for youth mental health therefore requires addressing environmental justice and equity (i.e., accessibility/usability) in local political processes (Braveman & Gruskin, 2003). Health equity or environmentally just planning processes have the potential to impact youth mental health and prevent problems during adulthood (Kieling et al., 2011) by proactively addressing potential aetiologies, mitigating identified risks, and enabling behavior changes via policy implementation and resulting opportunity structures.

Better orienting planning to effectively address youth mental health promotion requires an appropriate foundation. Much existing research promotes physically deterministic approaches that are rooted in the notion that changes to physical landscapes will result in desired social and behavioural changes (Ewing et al., 2003; L. D. Frank et al., 2006). These approaches, however, fail to consider the diverse social and environmental exposures that exist in urban areas and can contribute to (unequal) health impacts (Corburn, 2013). Consequently, interdisciplinary and socially conscious viewpoints have been advocated by researchers (Barton et al., 2015). Corburn (2009), for instance, articulates a relational view of urban places and health equity which suggests places are doubly constructed–physically (i.e., urban environment) and socially (i.e., assigned meanings, and construction of networks, institutions, and processes that shape such meaning)–and composed of complex relations among the physical features, social forces, and processes of meaning-making. Thus, no one fixed set of characteristics and meanings define a healthy/unhealthy place (Corburn, 2017). Recently, Verbeek and Boelens (2016) have furthered this work by suggesting co-evolving approaches that center on developing solutions to issues via local population participation and expertise. Physically deterministic approaches also fail to recognize the growing influence and roles of social and digital

media. In recent years, public sectors have turned to social media and web platforms to expand health information and support (Moorhead et al., 2013), as well as improve participation, co-production, and evaluations (Tursunbayeva et al., 2017). Adopting these approaches and data sources hold great potential to track urban space use, mobility flows, and reorient city services for local needs (Ilieva & McPhearson, 2018).

2.3.3 Neurourbanism, Cognitive Planning

The emergence of new fields offers novel methodological approaches for investigation. One relevant approach is neurourbanism (Adli et al., 2017), referred to by others as cognitive planning (Mondschein & Moga, 2018), which is a transdisciplinary field focused on precisely understanding effects of urban living and environments on neurological processes, and enhancing the collaboration between neuroscience public health, and planning, among other fields, to create more healthful environments (Adli et al., 2017). Broadly, the field, which currently exists mostly as a research-oriented endeavor absent an official affiliated practice component, promotes large-scale collaborations as a means to design more just and humane cities which improve health outcomes and equity for increasingly diverse populations (Lydon & Garcia, 2015; Mondschein & Moga, 2018). Growing evidence highlights the potential of this field and its strategies and methods for professional practice and health research (Fett et al., 2019; Ladouce et al., 2017; Smilek et al., 2006; Williams & Long, 2015). The increasing affordability of wearable sensing technologies that measure physiological parameters such as heart rate, electrodermal activity, and skin temperature has helped to propel the field forward (Piwek et al., 2016). These portable technologies have been employed to investigate well-being, emotions, and stress levels across places (Aspinall et al., 2015; Birenboim et al., 2019; Edelstein & Macagno, 2012; Elsadek et al., 2019; M. Kim et al., 2019; Kyriakou et al., 2019; Lakshmi et al., 2014; Werner et al., 2019), while lab-based technologies such as functional magnetic resonance imaging have been used to assess brain responses to different landscape visuals (T.-H. Kim et al., 2010; Tang et al., 2017).

Cognitive planning and neurourbanistic approaches have much to offer public health and planning. Wearable psychophysiological technologies allow for more detailed captures of cognitive and emotional outcomes through measuring specific physiological parameters (Zeile et al., 2016) like skin temperature and conductance, or heart rate variability (Kanjo et al., 2015). These measures may improve prevention efforts and policy by facilitating more robust investigations into mechanisms by

which different urban environment characteristics affect frustration (Aspinall et al., 2015), and more precisely examine the positive psychological effects of natural environment spaces (J. J. Roe et al., 2013). Methodologically, the incorporation of biosensors can complement qualitative research by transforming qualitative reports of perceptions into quantitative measures of emotions (Dörrzapf et al., 2019). This could allow researchers to more precisely understand and identify which features of urban environments have the greatest cognitive and emotional impacts on individuals (Banaei et al., 2015). Such insights may also help researchers draw closer to revealing the aetiology and mechanisms of psychopathology across the lifespan (Lau-Zhu et al., 2019), and inform medical and health practitioners on what types of locations might maximize the mental health benefits of exercise (J. Roe & Aspinall, 2011). Regarding urban design, these approaches could be used to more precisely measure and perhaps better measure how youth experience urban environments, both positively and negatively (Mavros et al., 2016).

2.4 Proposed Frameworks

This paper synthesized public health and planning literature regarding the urban environments-youth mental health relationship, and highlighted the methodological potential of neurourbanism/cognitive planning approaches. Using Schulz and Northridge's (2004) multidisciplinary conceptual framework, we have identified central concepts, designs, practices, processes, strategies, tools, and values relevant to this relationship from planning, public health, and neurourbanism. With this background, we designed two "integrated" frameworks that amalgamate multiple fields. We elected to follow this integrative approach to framework development as individual paradigms can be particularly adept at identifying particular concepts but are generally more limited with respect to articulating comprehensive multi-factorial phenomena (Manning, 2019; Pykett et al., 2020).

Given the calls for a holistic and transdisciplinary approach (Botchwey et al., 2015; Haskins, 2018), we offer two novel frameworks, one for practitioners (Figure 2.4.1) and one for researchers (Figure 2.4.2), to guide future practice and study regarding the urban environment-youth mental health relationship. The frameworks expand upon Bronfenbrenner's (1977) socio-ecological model (SEM) that highlights interactions between various systems shape and affect health outcomes, from the microsystem of the individual through multiple mesosystems (interpersonal, environments) to the macrosystem of society. In particular, the frameworks add new interactive/collaborative areas of

inquiry/importance, and adapts the SEM to four central tenets of the paper's syntheses: 1) a more holistic account of individual and interpersonal characteristics to incorporate a wider array of cognitive capacities and social factors; 2) relational (Corburn, 2009) and co-evolutionary (Verbeek & Boelens, 2016) approaches to advise researchers and practitioners to investigate assigned meanings of, and relevant social forces influencing, person-place interactions; 3) the inclusion of participatory methods as they can lead to healthier, just, and egalitarian communities (Suleiman et al., 2006); and 4) the integration of youth perspectives as they can make essential contributions to the design and implementation of programs and policies (Patton et al., 2016) and elucidate missing perspectives in existing models (Arunkumar et al., 2019).

The new *interactive* level/zone, digital and social media contexts, was added to the SEM to recognize the pervasiveness of these new settings, namely the influence of related technologies (e.g., smartphones, social media) in transforming and facilitating human behavior, communication, and interaction. Mounting evidence suggests such technologies can both positively and detrimentally affect mental health, extend the capabilities, quality, and reach of health services (Naslund et al., 2019), and produce a surfeit amount of social media, big, and other digitally-derived data that are of great interest to human behavior researchers (Ilieva & McPhearson, 2018). Recognizing a new distinct digital context can add to the breadth and depth of understanding regarding this relationship by further illuminating mobility flows and the uses and perceptions of urban spaces (Ilieva & McPhearson, 2018), providing revealed rather than stated preference data (Lopez et al., 2019), and allowing comparisons of emotional and attitudinal responses to social phenomena via sentiment analyses (Roberts et al., 2019; Schweitzer, 2014). Regarding the location of the digital context as the most distal component of the developed frameworks, while others (e.g., Shankardass et al., 2019) have suggested a more mirrored real-world and digital world conceptualization of how such contexts may influence human well-being, here we take an approach foremost rooted in recognizing the growing ubiquity (to be sure, digital contexts are not yet ubiquitous) of these influences as a force that cuts across and consequentially interacts with factors at the other levels of the framework.

Figure 2.4.1 Practitioner Framework for Youth Mental Health and the Urban Environment

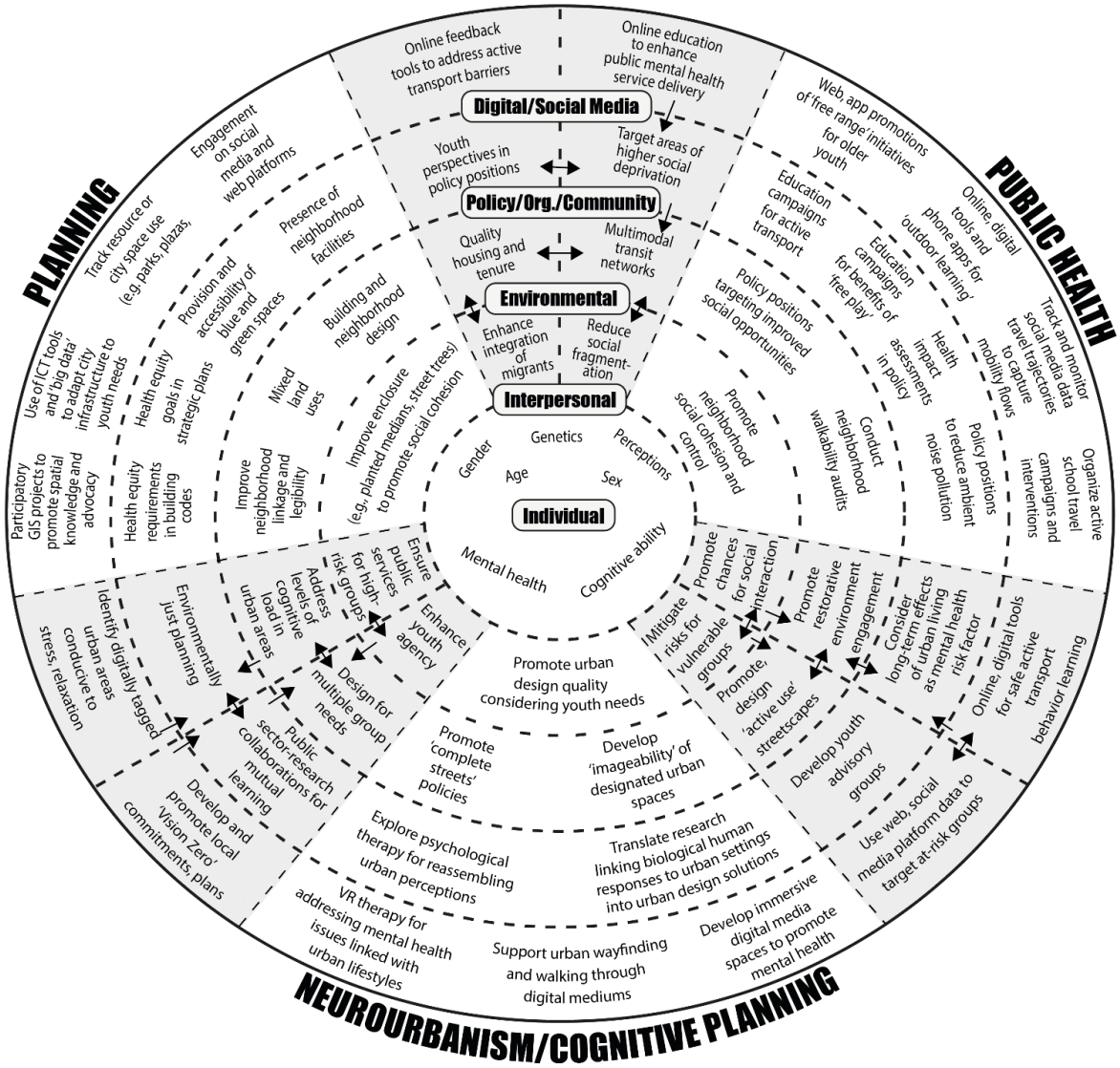
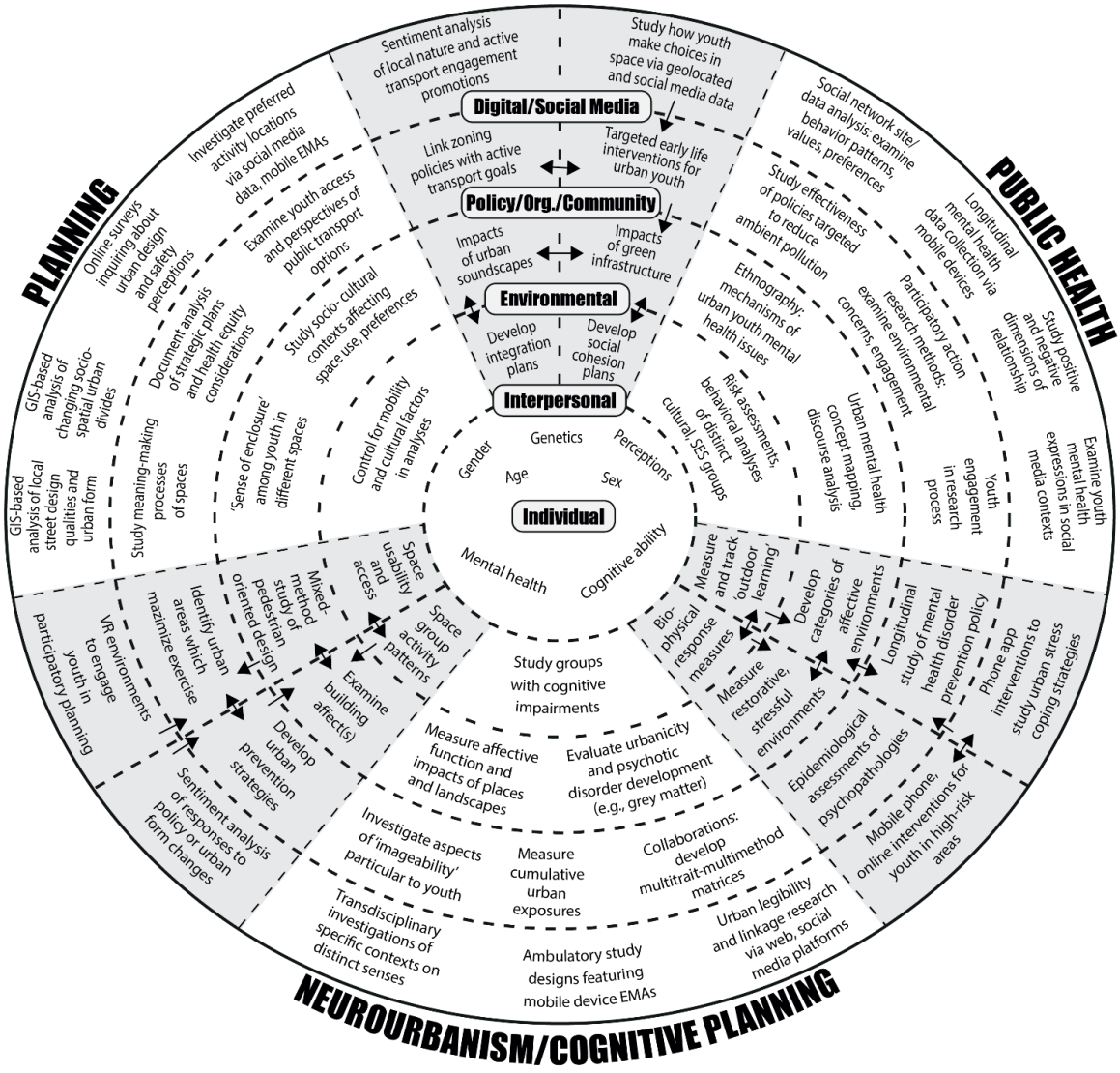


Figure 2.4.2 Research Framework for Youth Mental Health and the Urban Environment



2.5 Frameworks: Theory to Application

Each field's unique roles and opportunities (unshaded area) and potential collaboration areas with other fields (grey-shaded areas) are highlighted in the frameworks. Arrows between concepts illustrate specific potential interactions that the respective collaborations could explore. The frameworks also recognize the overlapping nature of roles and opportunities within each field with dashed lines to indicate the fluidity and multilevel nature of concepts, ideas, and points, and that policy positions (practice) and study topics (research) can be complementary endeavors. When interpreting the frameworks we acknowledge that neurourbanism is not an extant professional practice, rather an interdisciplinary research area. As such, we use this space in the frameworks to suggest ideas and concepts where other relevant fields (e.g., neuroscience, psychology) can collaborate and advance knowledge or improve practice. Last, while the discussion focuses on collaboration opportunities between the different fields, we note that total neurourbanism-planning-public health collaborations featuring concepts from the two frameworks are also encouraged.

Planning practitioners may use this framework to support youth mental health in urban areas via strategies such as digital technologies to track space use, mobility flows, and reorient city services (Ilieva & McPhearson, 2018) for youth needs; addressing housing tenure issues (Pillas et al., 2014) via amendments to municipal codes; and designing areas with greater enclosure to foster social cohesion and/or mitigate social fragmentation (Zammit et al., 2010). Public health practice may develop and disseminate outdoor learning materials to improve psychological resilience (Gray, 2019), or promote 'free range' initiatives to develop more environmentally connected adults (Goltsman et al., 2009). Campaigns to educate families about the mental health benefits of 'free play' in communal spaces (e.g., develop competence, emotion regulation, enhance confidence, resiliency (P. Gray, 2011)), and the promotion of policy positions to reduce noise pollution (Babisch et al., 2012; Tiesler et al., 2013) would also be advised to ameliorate youth mental health. Related fields (as illustrated in Neurourbanism portion) could advocate for 'complete streets' policies that support designing roadways and transit networks to safely accommodate all users and their needs (Chriqui et al., 2018), or explore the use of virtual reality technologies to address urban mental health phenomena such as acrophobia (Hong et al., 2017).

With respect to collaborative practices, planning-public health partnerships may seek to develop and promote policy that address neighborhoods with high levels of social deprivation (Prelow

et al., 2004), aim to improve neighborhood social cohesion (McPherson et al., 2014), or support multimodal transit networks to increase activity opportunities. Planning-neurourbanist collaborations could promote environmentally just planning for youth by proposing and developing space-specific legislation to lessen cognitive loads (e.g., bio-housing (T.-H. Kim et al., 2010)), building partnerships dedicated to mutual learning regarding planning and neuroscience topics (e.g., building, place affects), or using social media and other geolocated data to localize urban areas with high incidence of depression (Yang & Mu, 2015) and provide support via vision zero commitments (i.e., multipronged campaigns promoting safe transport, physical activity) (Chriqui et al., 2018).

Regarding research, planning researchers could explore the perceived exposure impacts of routinely travelled routes (e.g., trips to/from school) or frequented spaces (e.g., parks) via 'go-along' interviews (Carpiano, 2009) and place accessibility and meanings through PhotoVoice methods (Belon et al., 2014). Public health study may pursue research featuring the use of detailed ethnographic study of urban-derived youth mental illness as it has been previously suggested to investigate the mechanisms underlying urban living and mental disorders, and to better understand the lived experiences of affected individuals and groups (Manning, 2019). Ambulatory assessments (i.e., study of individuals in their natural environments) featuring ecological momentary assessments that strategically and repeatedly capture subjects' states on mobile devices (Shiffman et al., 2008) could be employed to examine preferred activity locations or engagement patterns. Neurourbanistic study, using neuroscientific methods and physiological sensors which objectively quantify impacts can potentially expand knowledge on place and building affect (Aspinall et al., 2015), and could investigate different relationships: the nature of different exposures across settings (e.g., alleys, intersections), or psychotic disorder development (Frissen et al., 2018).

Planning-neurourbanist research collaborations could examine the enhanced cognitive load of urban environments on the brain (Grassini et al., 2019); if/how distinct urban environments' designs such as linkage, legibility, enclosure, and imageability (Boeing, 2018) are perceived by and affect mental health outcomes; conduct sentiment analyses of youth populations regarding changes to urban form; or engage youth in virtual reality environments to gather feedback (Schrom-Feiertag et al., 2020). Neurourbanist-public health research collaborations could further investigate strategies to mitigate risks for vulnerable groups by researching biophysical and neurological responses to urban features including temperature ranges, noise levels, and odors (Choi et al., 2015), and settings (e.g., transportation corridors (Neale et al., 2019), foliage (Park et al., 2016)). Preventive-based research

could seek to implement web programs to support mental health (Anttila et al., 2019) or digital health promotion initiatives for youth in high-risk areas (e.g., adolescent girls in urban slums (Chandra et al., 2014)). Finally, public health-planning collaborations could use geolocated and social media data to study how youths make decisions in space that may impact relevant behavior (e.g., physical activity) (Ilieva & McPhearson, 2018), examine the impacts of distinct soundscapes (e.g., plazas, outdoor malls) and infrastructures (e.g., green infrastructure), or conduct document analyses linking local zoning policies with active transport goals.

2.6 Conclusion

Synthesizing literature from public health, planning, and neurourbanism/cognitive planning, this paper proposes two novel frameworks to inform practitioners and researchers on the urban environment-youth mental health relationship. The frameworks may be used to enhance practices at multiple social and ecological levels. Cross-field collaborations are encouraged to improve behavioral change research and interventions, and develop nuanced policy recommendations.

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Chapter 3

Urban Design and Adolescent Mental Health: A Qualitative Examination of Adolescent Emotional Responses to Pedestrian- and Transit-Oriented Design and Cognitive Architecture Concepts

With Dr. Jennifer Dean and Dr. Leia Minaker

3.1 Abstract

With the continued migration of people into cities, urban environments are becoming increasingly important determinants of health. However, the study of how precise environmental designs are linked to mental health are generally lacking, especially among adolescent populations. Using a qualitative approach featuring 23 go-along interviews with adolescents, we investigated the relationships between specific urban designs as outlined in pedestrian- and transit-oriented design (imageability, enclosure, scale, transparency, complexity) and cognitive architecture (biophilic architecture, symmetries, fractals) concepts and adolescent mental health indicators (i.e., emotional responses). Central findings from the subsequently undertaken framework analysis include considerably different perceptions regarding natural versus built enclosure and landmarks, significantly more expressed emotional engagement with visually rich and transparent urban designs relative to grey/concrete and windowless designs, and strong positive reactions to the three cognitive architecture concepts. Additional exploratory gender-based analyses were conducted and found potential differences in perceptions of design concepts between boys and girls. We note the broader relevance of these findings by discussing their implications for practitioners and suggesting how they can advance certain UN Sustainable Development Goals.

Role in the Dissertation

Having identified a paucity of research that includes and delves into adolescents' first-person perspectives and experiences of urban designs in the previous chapter's literature review and synthesis, Chapter 3 necessarily intends to provide an in-depth qualitative exploration of adolescents' emotional and relational understandings regarding a variety of real-world PTOD and CA concept examples. The first-hand accounts provided by the participants in this study importantly detail the perspectives of adolescents through noting the perceived benefits, drawbacks, symbolic meanings, and other socio-relational affordances related to their emotional responses that adolescents themselves attach to the different design concepts. Ultimately, these findings and their subsequent expanded conversations provide valuable descriptive context to the final synthesis and discussion of Chapter 7.

Keywords

adolescent; built environment; mental health; planning; qualitative research; urban design

3.2 Introduction

Adolescence, or the years between 10 and 19, is a critical period of time in the development of an individual (World Health Organization, 2018). Research into the mental health of this population, however, suggests concerning trends. For instance, in the US it is estimated that 36.7% of adolescents (12–17 years) have persistent feelings of sadness or hopelessness (Centers for Disease Control and Prevention, 2022), in Turkey over 35% of both girls and boys (11 years) report feeling low (e. g., unhappy) at least once a week, while more broad global estimates suggest that 10–20% of adolescents suffer from a mental health problem (Choi, 2018). Such mental health maladies incurred during this developmental period can eventually contribute to long-term disability (Kapungu et al., 2018) and increased risk of chronic illnesses (Scott et al., 2016) later in life. These risks are exacerbated by geography. For example, extant evidence suggests individuals residing in urban areas report higher rates of schizophrenia (Frick et al., 2013; Jacobi et al., 2014), post-traumatic stress disorder, and paranoia (Prina et al., 2011; Silove et al., 2014). However, additional research is needed to better understand the complex relationship between urban living and mental health (Okkels et al., 2018), especially given growing migration trends from rural to urban areas (United Nations, 2018). Examining links between urban environments and mental health is particularly important for vulnerable groups such as adolescents as such research is often under-supported relative to the cohort's growing mental health issues (Dubicka and Bullock, 2017; Signorini et al., 2018). Further, given the international community's stated commitment to the SDGs, there is a growing focus on desining urban areas that consider the needs and perspectives of younger populations in service of supporting their health. Accordingly, the present study investigates urban environments and adolescent mental health through a qualitative exploration of adolescents' perceptions of the links between urban and architectural designs and their emotional responses.

3.2.1 Adolescent Mental Health in Urban Environments

Study of adolescent mental health and urban environments can be further broken down into the study of built or natural urban settings. Built environments and their attendant characteristics have been connected with both beneficial and deleterious mental health impacts. Salubrious impacts such as improved social competence may be influenced by the presence of local facilities (e.g., library, recreational center), while physical and mental health may be enhanced via designs such as pedestrian crossovers (Rothman et al., 2014) and streetscapes featuring sidewalks (Rothman et al., 2018).

Conversely, auto-oriented environments can produce high levels of traffic noise leading to greater reported annoyance (Babisch et al., 2012) and sleeping problems (Tiesler et al., 2013). Natural urban spaces, meanwhile, are frequently associated with protective and developmental benefits. For example, bluespaces (e.g., rivers, ponds) and greenspaces (e.g., parks, recreation areas) can aid in emotional regulation (Djohari et al., 2018) and reduce stress (Feda et al., 2015) among adolescents, respectively. Despite these ostensible benefits, recent scholarship has recommended more methodological precision to identify further pathways of environmental determinants of adolescent mental health (Madzia et al., 2019), and specifically the mental health implications of distinct urban designs (Buttazzoni et al., 2022).

3.2.2 Pedestrian- and Transit-Oriented Design, Cognitive Architecture

A number of urban design concepts and paradigms have been developed with the intention of addressing the negative social, environmental, and health impacts of automobility and auto-oriented planning in modern cities (Gehl, 2011). Concerning urban health, the transit-oriented development (TOD) approach is one such framework that focuses on ameliorating health and well-being through facilitating social interactions by improving local facilities, developing better transit network connections (e.g., quiet and intimate thoroughfares), and prioritizing non-motorized mobility (e.g., calming automobile traffic, adding bike infrastructure and transit stops) (Jacobson and Forsyth, 2008). Other noteworthy TOD design strategies include a return to human scale public open spaces (Lamour et al., 2019) and streetscapes characterized by mixed-use transit and other public uses (Kong and Pojani, 2017)—both of which can foster positive pedestrian perceptions of and interactions with local environments. Additional theoretical concepts such as appropriation (i.e., the re-production of space to suit the needs of people) and publicness (i.e., the public's use, engagement with a space) have also been suggested to support the public's appropriation of urban spaces for improved well-being through promoting active use of and engagement with different settings (Leclercq and Pojani, 2021). More pointedly, as it relates to urban mental health, a variety of different specific design concepts aimed at enhancing well-being have been promoted such as, for example, green façades, streetscape naturalness, water displays, and place biodiversity or natural diversity (Buttazzoni et al., 2021).

While both larger, overarching urban design paradigms as well as specific concepts have been linked with urban health topics, larger paradigm notions such as appropriation and publicness are highly dependent on local political context and social norms in their issue framing processes,

while specific concepts such as green façades and water displays generally aren't ubiquitous in their presence. Consequently, to evaluate urban design concepts are that are both less bound to socio-political framing processes and relatively ubiquitous in their environmental presence across contexts, our study evaluates pedestrian and transit-oriented design (PTOD) and cognitive architecture (CA) concepts. PTODs are meant to promote more sustainable and active urban lifestyles through emphasizing enhanced population density, residential intensification, public transit use, walkability, and place accessibility (Calthorpe, 1993; Dittmar and Ohland, 2012; Renne, 2016). Five PTOD qualities have been noted as being important to the quality of living among urbanites: imageability, enclosure, human scale, transparency, and complexity (see Table 3.2.1) (Ewing, 2013; Ewing and Handy, 2009). *Imageability* often invokes one's 'sense of place' (Lynch, 1964) and comprises the spatial features (e.g., space climate, architectural quality) that add to leaving an enduring impression (Gehl, 1987). Second, *enclosure,* may be described as the extent to which vertical elements (e.g., buildings, walls, trees) visually define a public space and contribute to building a 'room-like quality', and is consequently linked to a sense of 'hereness' (i.e., identity with surroundings) (Cullen, 1995). Third is *human scale*, or the notion of how the physical qualities of a space (e.g., size, texture) either accommodate or occlude human activity (Kay, 1998). Specifically, spaces structurally designed for accelerated speeds (i.e., automobiles) can potentially overwhelm pedestrians, whereas settings that prominently feature signs and other wayfinding elements with smaller proportions may support pedestrian comfort (Kay, 1998). Fourth, *transparency*, is the concept of how much one can see or perceive (e.g., human activity) beyond the street (Jacobs, 1993), and is linked to one's awareness of space (Arnold, 1993). Last, *complexity* refers to the visual richness of a space as it relates to the diversity of architectural styles, buildings, ornamentation, landscape features, signage, and human activity (Rapoport, 1990). Complexity is often connected with one's engagement in an environment (Nelessen, 1994).

Table 3.2.1 PTOD Designs and CA Principles

	Concept(s) (e.g., features)
PTOD Feature	
Imageability	Distinctiveness (e.g., courtyards, plazas, historic building frontage, outdoor dining) (Clemente et al., 2005)
Enclosure	Room-like quality (e.g., proportion of street walls, viewable proportion of sky) (Clemente et al., 2005)
Human Scale	Detail, texture, physical elements (e.g., sight lines, average building height, # of small planters) (Clemente et al., 2005)
Transparency	Perceived/viewable human activity (e.g., proportion of street walls, proportion of active uses) (Clemente et al., 2005)
Complexity	Visual richness (e.g., # of buildings, # of basic colours, # of pieces of public art) (Clemente et al., 2005)
CA Principle	
Biophilia	Privileging of natural environment features in designs (Ryan et al., 2014)
Fractal Patterns	Division patterns of borders, frames, moldings, and ornament (i.e., compositional form of repeating patters) (Joye, 2007)
Symmetries	Bilateral symmetry of façades (Goldhagen, 2017)

While PTOD has largely focused on active living issues, other notions such as CA have sought to explore the implications of particular architectural designs with respect to mental health and cognition (Goldhagen, 2017). Relevant CA principles include biophilic architecture, fractal patterns, and symmetries. *Biophilic architecture* is the privileging of natural environment features and characteristics in urban design, and stems from humans' evolutionary and innate connection with nature (S¨oderlund and Newman, 2015). Examples include green rooftops and green façades, which have been linked with mood improvements (Tyrvainen et al., 2014) and relaxation (Matsunaga et al., 2011) in adult samples. *Symmetries* in architecture are repeated portions that are either translationally (i.e., repeated units along a line), rotationally (i.e., units repeated after rotation by an angle), or reflectionally (i.e., mirror images) symmetric (Salingaros, 2014). Humans have evolved to recognize symmetries automatically, and often perceive designs lacking these organizing mechanisms as random, disordered, and potentially as causing alarm (Salingaros, 2014). *Fractal patterns*, meanwhile, derive from the mathematical concept of fractal geometries, which are objects that repeat similar patterns on increasing and decreasing scales (Salingaros, 2014). Due to their immense detail, importance to building character (e.g., often found in cathedrals, city halls), and connections to internal brain functioning (e.g., preference for fractal structures), fractals may increase relaxation and

place attraction (Joye, 2007) and possess restorative qualities (Hagerhall et al., 2008). Together the selection of PTOD and CA concepts offer a diversity of theoretically relevant urban design and ornamentation concepts that may impact adolescent mental health and are likely to be relevant and applicable to other urban contexts beyond the frame of our study.

3.2.3 Research Justification, Questions, Context

Extant research examining urban environments and adolescent mental health has often focused on broadly defined natural or built urban spaces. Precise relationships between urban spaces and adolescent mental health indicators subsequently remain underexplored. Thus, recent scholarship has recommended that future research examine more granular pathways between urban environments and mental health (Buttazzoni et al., 2022; Madzia et al., 2019). Therefore, in this paper we sought to qualitatively explore, via go-along interviews, the *in-situ* emotions of adolescents in response to specific urban design qualities and architectural concepts. Within this outline we asked:

> What emotional responses do adolescents articulate in reference to the different PTOD and CA examples?
>
> Why do adolescents articulate these emotional responses in reference to the different PTOD and CA examples?

Along with these primary research aims, recognizing that there are gender-specific trends in adolescent mental health (Connolly et al., 2016; Patel et al., 2007), a secondary aim of this study was to explore potential gender differences in these responses.

To further contextualize the nature of these relationships and organize our findings, we framed our study within the Theory of Affordances which explains that *affordances* are what an environment offers an individual, and that one's intentions, capabilities, and value-mediated relational processes will determine how they interact with a setting (Chemero, 2003; Gibson, 1979). Application of this theory allows us to examine the significance of affordances defined as specific urban and architectural designs or concepts, like those in the PTOD and CA frameworks, and emotional responses such as those experienced by adolescents as they move through different urban environments. This theory has previously been effective with respect to understanding similar topics such as the youth-friendliness and activity affordances of urban design (Lopes et al., 2018), emotional affordances of natural landscapes (Roe and Aspinall, 2011), and play quality and opportunity affordances in nature-based play spaces (Herrington and Brussoni, 2015).

3.3 Methods

3.3.1 Study Context

All data collection took place in Kitchener, Ontario, Canada, a medium-sized urban area located 1 h outside of Toronto, and home to 261,610 people (Region of Waterloo, 2020). Walks for the go-along interviews were conducted on a pre-determined ~1.65 km route (see Figure 3.3.1) near and in downtown Kitchener. Our team scored each discrete setting on the route across the five PTOD constructs previously discussed (see Table 3.3.1) using a validated tool (Clemente et al., 2005). The scoring tool has been previously used as a design quality measure in studies assessing street enclosure (Yin and Wang, 2016), elderly people's navigation in built environments (Walford et al., 2011), and neighborhood walkability (Hooi and Pojani, 2020), with the latter study reporting urban design quality scores similar to ours. Design features were scored from roughly 1–7 such that the higher the score for a feature, the more prominent it was in the setting (Clemente et al., 2005). Our interview route featured stops on a 1) multimodal transit path, 2) residential street, 3) urban bluespace (i.e., lake), 4) urban greenspace (i.e., park/open area), 5) public transit hub, 6) built-up downtown street, and at City Hall. The last stop, the area around City Hall, contained three real-world examples of the principles of CA under study: biophilia (urban garden), symmetries (historical building), and fractal patterns (church) (see Appendix 7.10.1).

Table 3.3.1 Route Settings' Design Feature Scores

Design Feature	Imageability	Enclosure	Scale	Transparency	Complexity
Urban Setting					
1. *Urban Trail*	2.42	3.32	3.88	2.29	4.71
2. *Residential Street*	3.93	2.50	3.27	2.45	5.87
3. *Urban Bluespace*	5.54	1.66	3.70	2.24	5.93
4. *Urban Greenspace*	4.44	1.87	3.90	2.45	5.63
5. *Public Transit Hub*	3.82	1.98	3.13	2.31	5.95
6. *Downtown Street*	6.27	2.46	4.33	3.32	5.36

*Notes: The higher the score, the more prominent the particular design feature |
Tool available at:
https://activelivingresearch.org/sites/activelivingresearch.org/files/FieldManual_071605.pdf

Figure 3.3.1 Route Map

(Numbers correspond with the list in section 3.3.1)

3.3.2 Recruitment and Sample

Using purposive and snowball sampling techniques (Patton, 1990) to access an information-rich group and generate variation in terms of socioeconomic status (SES), gender, and age, we recruited 23 adolescent (ages 9–17) participants through our research team's social networks and local youth groups (e.g., digital social media posters/ads). Eligibility criteria stipulated that

participants be: 1) a resident of Kitchener-Waterloo for at least six months (i.e., familiar with the area); 2) between the ages of nine–16 years old (or 17 without a driver's license), therefore old enough to have some level of independent mobility but also too young to have obtained a driver's license and thus have an enhanced activity space; 3) physically able to complete a 1.65 km walk; 4) able to converse in English; 5) granted participation via written parental/guardian consent; and 6) free of any significant pre-existing diagnosed mental health condition(s) that would prevent them from travelling through public spaces. Recruitment ceased when saturation was met with respect to the stated scope (i.e., research area and depth of topic) and replication (i.e., common essential characteristics of data between participants) parameters of the study (Morse, 2015). No prospective participant was deemed ineligible, nor did any individual refuse participation after initially joining the study. Sample demographics can be found in Table 3.3.2. We collected SES information through obtaining participant reports of their parents'/guardians' jobs. Collectively, the participants reflected a group that was middle (e.g., schoolboard employees, trades workers) to upper-middle class (e.g., professors, engineers).

Table 3.3.2 Sample Demographics

Age	
9	1
10	4
11	3
12	1
13	5
14	5
15	1
16	2
17	1
Average	*12.7*
Ethnicity (n=23)	
Black/African/Caribbean	1
East/Southeast Asian	2
South Asian	1
White/European	19
Gender (n=23)	
Boy	12
Girl	10
Non-Binary	1

3.3.3 Data Collection

Go-along interviews, a combination of mobile in-depth interview and participant observation (Carpiano, 2009; Dean, 2016), were conducted with all participants along the previously described predetermined route. Prior to each interview the experienced qualitative interviewer (first author) described the study protocol to participants including the study aims, the interviewer's role, and the participant's rights. Parents were permitted to accompany their child, if they desired, but were asked not to speak during the interview (only five parents opted to follow along). The go-along format was deemed appropriate given that it: allowed participants to take an active role in shaping the interview (Garcia et al., 2012); balanced the power dynamic between researcher and participant, and promoted a collaborative approach (Anderson, 2004); and added a layer of depth to the study by including ambient noises, unscripted interactions, and context-driven interpretations of environmental experiences (Trell and Hoven, 2010).

The interview script was geographically linked to the go-along route with different spaces corresponding with context-specific questions and prompts (Dean, 2016). Importantly, this design provided us with a degree of comparability for the purposes of our analysis, as well as offered flexibility for participants to express their emotions and feelings and to comment on the features that they deemed most important to them during the interview (Axinn and Pearce, 2006). We followed a strategy of first using broad framing questions, followed by specific probing questions and intentional prompts (see interview guide in Appendix 7.10.3). Open-ended framing questions were posed to explore participants' current emotions as they related to the present setting. To assist participants in explaining their perceptions and experiences, each was given a 'feelings wheel' which provided a series of emotions along with a set of adjectives (see photo in Appendix 7.10.2). Probing questions gathered more specific information about design qualities (e.g., façades), building features (e.g., window patterns), and CA characteristics (e.g., fractal patterns on buildings). Probing questions were used to draw out participants' reasoning for *why* these relationships existed from their perspective, which during analysis helped to identify the important specific affordances that participants discussed.

All interviews lasted between 65 min and 105 min (average ~83 min). Interviews were audio recorded using a lapel microphone attached to a recorder and were transcribed verbatim by the primary author. Data were collected during the summer months between June and August of 2021.

All interviews were conducted in warm, sunny or partly sunny weather, with the exception of one interview that was completed during cloudy and partly rainy conditions. We asked each participant to provide their own pseudonym (i.e., self-select their own aliases) as this decision grants participants more control and "… space to negotiate how they are named and represented in the research" (Allen and Wiles, 2016, p. 163). We also altered any revealing information in the quotations to ensure anonymity. At the end of each interview, participants were compensated with a $40 pre-paid Mastercard. This study was approved by the University of Waterloo Office of Research Ethics (study #42580).

3.4 Data Analysis

3.4.1 Analysis Methods

We used a framework analysis strategy adapted from Gale et al.'s (2013) widely used process. The framework method is intended to develop descriptive and/or explanatory conclusions clustered around themes through the creation of a cross case (i.e., participant or interview) matrix output (Gale et al., 2013). The first steps of the transcription of, and familiarization with, the interview processes were completed as a part of our iterative process entailing interview guide development, audit log keeping, and data collection and preliminary analysis. The next steps—coding, developing, and applying the analytical framework—were completed once all of the transcripts had been completed. Coding was undertaken by initially deductively coding each of the 23 transcripts according to articulated affordances related to the six PTOD designs and three CA principles. First-level codes which reflected repeating ideas, concepts, and sentiments were then allocated and charted into the matrix according to the relevant design concept and whether or not the identified affordance was a fundamentally positive or negative mental health outcome. Second-level codes for each concept's positive or negative affordance categories were then developed to streamline the diverse first-level codes.

Once the matrix was fully charted, the next step of interpreting the data began with each of the six scored PTOD settings being used to frame the affordances and their included real-world examples (e.g., houses, trees) across sites. During this process, the route scores outlined in Table 3.3.1 were applied to aid in the development of larger cross-case themes by further contextualizing our findings (i.e., examine how the developed themes correspond with the prominent/lacking scores of an affordance in different settings). This analytical approach allowed us to examine each affordance

across a variety of urban contexts rather than simply in reference to one particular setting. After developing the final themes, to explore potential gender differences in emotional responses, we ran a second analysis where the second-level codes were instead sorted from their respective transcripts based on the gender of the participants and then linked to the larger themes. Last, expecting that our participants would present a variety of emotions in their discussions, and to improve the consistency of our interpretations, we applied Russell (1980) Circumplex Model of Affect. This 360◦ spatial model outlines several distinct affective concepts along the principle axes of arousal (inactive-active; e.g., bored/calm, tense/alert) and valence (displeasure-pleasure; e.g., upset/miserable, happy/pleased) in order to present a comprehensive conceptualization of psychological affect (Russell, 1980). In particular, and in the subsequent sections, this model was applied to help map and present in a coherent manner the developed themes in the ensuing results section based on their affective qualities according to the Model's outline (see Table 3.6.1).

3.4.2 Rigour and Quality Checks

To ensure the quality and rigour of our work we employed several techniques. Foremost, throughout the course of our coding process team members (A.B. and J.D.) engaged in peer debriefing (Baxter and Eyles, 1997) by discussing differing interpretative possibilities of the findings at key points in the analytical processes. Second, we undertook the processes of persistent observation (Baxter and Eyles, 1997) to ensure the capture of the most relevant experiences of our participants by developing our interview guide (e.g., pilot testing, script revisions) to closely reflect the 'things that count' regarding our research questions. Pilot tests were completed with three females between the ages of 10–14 to ensure the suitability of the predetermined route, the quality and flow of the interview questions, and the appropriateness of the length of the interview. An audit log was kept to document important decisions and developments throughout the data collection and analysis processes (Creswell and Miller, 2000). We also engaged in practices of triangulation (Tracy, 2010) through seeking to incorporate and validate findings across multiple sources (i.e., participants) and presenting quotes to illustrate the central findings from across our sample. Last, we sought to maintain inferential consistency, and therefore maximize the usefulness and potential of our investigation, by conducting our research within what we deemed to be an appropriate theoretical frame (Dellinger and Leech, 2007).

3.5 Results

Results are organized according to the themes derived from the framework analysis in relation to each PTOD and CA concept, and are presented in order of their nature (i.e., positive or negative) and importance (i.e., highest frequency) among the responses from participants. Quotations are included to illustrate the key concepts being discussed. Bolded words emphasize the participant's emotion while italicized words indicate the design concept/feature tied to the emotion being mentioned. Findings pertaining to gender differences, when notable, are discussed within the larger themes outlined below.

3.5.1 Imageability

3.5.1.1 Natural Reference Points, Aural Elements

Nature-based reference points and sounds, notably in the bluespace (i.e., lake) and greenspace (i.e., open field), were foremost connected by participants to creative, relaxing, and inviting feelings. This affordance was explained to derive from these features representing clear and attractive sites to which adolescents could emotionally connect. Regarding the open field, participants routinely expressed inviting sentiments and inspired feelings of creativity because it "can be used for a lot of stuff […] there are so many *different possibilities*, and there so many *different types of people* that come" (Jasper/10/girl).[7] Similar thoughts were voiced regarding the lake area where relaxing feelings were attached to several points of engagement:

> It's **calming**. I can hear the *water going around*, I can see the *ducks swimming* around. I think that's a **nice thing** to look at or experience. I can almost **stay here for a day** and just watch whatever is *happening out on the lake*. (Gabe/15/boy)

Likewise, natural aural elements elicited relaxed responses. This was particularly the case in the trail and bluespace environs where participants highlighted the sound of flowing water in the latter to be a key calming mechanism, with one explaining that while in the setting "you can just *focus on one thing*" (Karl/14/boy). In other areas, sounds of birds chirping and a calm breeze were also routinely cited as keys for restoring attention by lowering mental demand.

[7] Participant information organization: pseudonym/age/gender.

3.5.1.2 Non-rectangular Buildings, Historic Character, Outdoor Dining

Non-rectangular buildings, historic character, and outdoor dining were other imageability characteristics that elicited positive responses. Principally, a round clock tower in the greenspace and buildings with historical character (i.e., pre-World War II architecture) on the commercial and residential streets were praised for their distinctive designs that evoked feelings of comfort and interest. To this end, the clock tower was regarded as a positive reference point for navigation, while century homes on the residential street directed attention toward their pleasing designs:

> I would say **relaxed** […] because of the *clock tower* because that's like a great checkpoint for stuff […] If you're getting **lost** you feel like you can look at that clock tower and *know what direction you need to go in*. (Jay/13/boy)

> I like the way that all the houses look, it kind of *shows how old the city is* […] I like how all the houses are **unique** in their own way. The neighbourhood that I live in all the houses are kind of similar […] if you look down [this] street all the houses are different, and you can see that **uniqueness** *throughout the street*. (Emily/16/girl)

Outdoor dining areas were similarly recognized by participants to be attractive features of a space, especially in the commercial street area of our study. A local outdoor patio restaurant regularly garnered comments conveying that its presence added a welcoming feeling to the commercial street area, as well as an opportunity for fun social or leisure activities.

3.5.1.3 Artificial (Mechanical) Noise

Conversely, negative affordances were expressed in every location with respect to artificial (i.e., mechanical) noise from cars, busses, and construction which produced feelings of annoyance—a reaction which tended to be more pronounced among boys. Such noise pollution was panned for being emotionally draining with many participants explaining these sources of noise made areas "more **uncomfortable**" (Tee/14/boy) and "more **overwhelming**" (Dizzy/13/transgender). When probed about how this unwanted noise contributed to the experience of the various places, one participant elaborated that this unwelcoming impact facilitated a series of negative cascading effects:

> […] if I were sitting on them [the outdoor patio chairs next to the sidewalk] there would just be *a really busy road*, and it **wouldn't be fun** to just be eating and having a bunch of cars pass you […] because cars come by here all of the time and it's **not nice**. (Jasper/ 10/girl)

Other participants similarly elaborated that the unwanted noise functioned to increase negative arousal, remarking that it made spaces ultimately feel "a little **bit too much**" (Mo/17/boy). Most specifically, while in the commercial street and transit station areas (i.e., preeminent locations of this

response) participants related that the high levels of artificial noise tended to coincide with more anxious feelings and a more mentally fatiguing experience.

3.5.2 Enclosure

3.5.2.1 Natural Enclosure, Spatial Arrangement

Natural enclosure in the trail, greenspace, and bluespace areas, and mostly in the form of tall trees, was widely stated to be a calming and restorative influence. Central to this affordance was the spatial arrangement of tall trees around the different locations which was said to enhance intimacy through keeping attention away from external distractions. This allowed participants to concentrate on the focal point (s) of an area and, in some instances, seemingly experience present-moment awareness (i.e., stillness in thought, fully observing the here and now/present landscape):

> I like how it's just a lake, there's **nothing else distracting** from it, when you come here *you can just focus on the lake* […] you can just sit and look at the lake and there's nothing distracting […] *nothing around that you would rather go towards*. (Emily/15/girl)
>
> It prevents you from being able to see all of the buildings […] *The giant trees* just make you feel like you are **submerged into the nature** […] By having me move toward the water, it prevents me from looking at all the housing over there. (Jack/13/boy)

Participants further related that, to a lesser extent, a side hill in the greenspace area and fences with natural accents (e.g., ivy/vines) in the trail also helped to clearly demarcate those spaces from adjacent areas and subsequently contributed to calm and safe feelings.

3.5.2.2 Built Enclosure

By contrast, built enclosure, mostly in the form of tall buildings in the commercial street area, was more inconsistently perceived by participants with some associating it with excited responses and others more uneasy responses. Among those who noted positive feelings, it was reasoned that such verticality caught their attention, and specifically the different heights of the buildings as one boy argued "I kind of like it. I **like** being in the canyon of the buildings […] it's cool" (Bob/11/boy). Contrarily, for those relating negative responses, the verticality created anxious feelings with another boy explaining "I feel, I guess, **trapped** […] maybe kind of locked in here" (Tee/14/boy). Unlike natural forms of enclosure which were near unanimously desired, built forms represented one of the more significant divides regarding adolescent emotional responses to a particular design.

3.5.3 Scale

3.5.3.1 Safety, Natural, Social, and Accessibility of Area Furniture

Area features that functioned to ensure safety, offer social opportunities, incorporate nature, and improve accessibility were consistently and strongly emphasized as invoking inviting and comfortable responses. The presence of scale features appeared to be an especially high priority for girls with respect to these design concepts' presence facilitating positive emotional responses. Benches, sidewalk barriers (e.g., metal posts), planters/flower boxes, and street trees were principle features participants argued as providing refuge via mental or leisure 'breaks' (e.g., appreciate flowers, linger in a nature) from the more demanding experiences of built spaces. This was especially the case in the commercial street area:

> It [*street trees*] almost makes me feel **safe** and it's really an **attraction** for your eyes like […] 'Oh but there's those really *cool plants*! Or like *gorgeous flowers*. Or *trees*' […] It's like when we're walking it's much more **fun** […] If you took out every single plant here […] it would be so horrible. It would just be like 'oh whatever I'm walking', but instead *there's plants* and stuff that draw your eyes to them. (Liliahna/girl/12)

Other noteworthy relationships mentioned in this regard included residential front yard gardens, which many detailed as evoking welcoming and social feelings, and benches in the greenspace and bluespace areas which were asserted to facilitate lingering and social opportunities.

3.5.3.2 Mess/Debris, Lack of Safety Features

Responses of discomfort were elaborated in connection with mess/ debris (e.g., broken sticks, overgrown weeds, litter) along pedestrian paths or in concentrations within spaces, as well as with a perceived lack of area safety features. Debris/mess was perceived as most problematic in the trail and residential street areas where instances were suggested to reduce engagement with the settings' nature elements by directing participants' attention to these unpleasant sights. Capturing this point, one participant explained that on the urban trail she felt "a little bit **guilty**" because she was "trying to focus on the beauty of nature and then there's the *garbage*" (Ivy/14/girl). With respect to a perceived lack of area safety features, participants remarked that this caused them to have to be more aware and drained their attention. Of note here, a narrow sidewalk or combination of sidewalk and boulevard in the residential street setting was routinely noted for making participants feel "unsettled" and "stressed" due to being in rather close proximity to passing cars and passersby. The transit station area, meanwhile, was also specifically lamented for its lack of vertical barriers (e.g., posts, planters)

to separate the sidewalk and street. These issues pertaining to a lack of human scale design and feelings of being less safe in an area, tended to be of greater concern to girls.

3.5.4 Transparency

3.5.4.1 Façades With Windows, High Density Active Uses

In the more built-up locations (i.e., commercial street, transit station) participants noted that storefronts and buildings that featured windows created a safer and more inviting area. Façade transparency, importantly, afforded participants opportunities to more comprehensively evaluate areas for potential points of interest or stress. On this point, one participant simply explained windows "make [buildings] pop […] more **interesting** […] more **inviting** and makes people actually want to go in because they *can see what's going on inside*" (Julia/14/girl). Likewise, happy responses were also generated in these same areas as they featured a variety of active uses (e.g., street accessible shops, restaurants), a dynamic that piqued adolescents' interest. High density active use areas, as one girl explained, makes one "think about what people are doing in the shops […] it's pretty **cool** to think about all of the *different stuff around*" (Lauren/10/girl). This sentiment was echoed by many others when explaining how a higher number of perceived local active uses seemed to stimulate them and inspire feelings of engagement with an area. However, the importance of different transparency features seemed to vary between boy and girls. Girls were more inclined to share positive associations with streets and building fronts that featured higher proportions of windows, whereas boys more consistently noted a preference for streets with a variety of active uses (i.e., diversity of shops).

3.5.4.2 Façades Without Windows, Concrete Dominance

Façades lacking a significant window presence were said to elicit unwelcome and uneasy responses. Also concentrated in the more built spaces, this lack of windows in façades was said to limit participants' abilities to find points of interest and subsequently create a sort of chilling dynamic. In the commercial street, participants explained the dynamic noting that "walking *in a street that's pretty narrow and just concrete walls*, I think you feel a little **anxious**, **nervous**, not the happiest" (Ivy/14/girl), and in the transit station area that "it's *kind of closed off* because there's really not that many windows […] It feels like it's **not very welcoming**" (Bobby/13/girl). Unwelcoming feelings were also commonly attributed to landscapes dominated by concrete as they were perceived to be uninteresting and diminish desires to linger in a space. This was especially noted with respect to the transit station area with its concrete barriers, parking lot, and many brick façades. Along with the

sentiments of others, the crux of this emotional response was summed up by one participant who expounded "it's more *mashed together*, it's a very **unwelcoming** area […] it just seems like it's *not open enough*" (Harry/10/boy).

3.5.5 Complexity

3.5.5.1 Façades: Varied Colours and Features/Designs (Positive)

Building façades featuring a variety of colours, designs, or features (e.g., window patterns), as well as natural accents (i.e., ivy/vines) were perceived as particularly attractive and interesting. Observed most often in the transit station and the residential street areas, participants explained the perceived character or quality of a space was improved by seeing varied colours and designs or natural accents. For example, in the transit station area, a clear fondness for a downtown high-rise building featuring blue windows and triangular window patterns was often expressed; one boy explained "I like how there is *two triangles [pattern]* in the middle [of the windows …] that sticks out a lot. It **looks good**" (Luca/10/boy). Meanwhile, regarding the variety of house designs and colours on the residential street, and reiterating the link between variance in design and expressed attraction/interest, one participant articulated "I think it makes the street **unique**. If all the houses were the same colour or exactly the same, it would be kind of boring. I think that *each house is unique* […] they all **look nice** together" (Jack/13/boy).

3.5.5.2 Façades: Worn-Out, Grey Dominance (Negative)

Worn-out façades or storefronts were suggested by participants to be rather unwelcoming and unattractive. When probed further, the imagery of worn-out façades heightened negative arousal as such features were deemed to be potentially dangerous or higher risk. Describing this dynamic with regard to buildings in the commercial and residential street areas, respectively, participants reasoned: "[the restaurant's front is] *worn-out*, it almost looks like it's **suspicious** to me, like there's something going on behind it" (Tatem/16/girl), and "I feel **creeped out** by that [house and porch] because the *stairs don't look pleasant* because they're dirty" (Jasper/10/girl). In parallel to their reservations about concrete-dominant landscapes, participants explained that landscapes dominated by grey made them unhappy due to there being little to emotionally engage with. Most pronounced in the transit station area, participants lamented "it *looks really monotone*, it's just *grey all around* […] it's **very boring**" (Dizzy/13/transgender), and "[it's] just like a *parking lot with signs*. It's not as exciting [… it's] **boring** and **unwelcoming**. It's like there's not even a little boulevard or anything" (Julia/ 14/girl).

3.5.6 Biophilic Architecture

Considering the urban garden as an example of biophilic architecture, participants principally articulated feelings of being away, relaxed, and cheerful as its sight in the midst of a built-up urban area was said to draw focus away from the draining views of the adjacent built spaces. Another gender difference emerged here with some of these emotional responses (i.e., relaxed, calm) being especially pronounced among girls. Elaborating on this, the enclosure (i.e., surrounding trees) of the garden and its many colours (i.e., flower colours) were cited as key features as, in some cases, they helped facilitate present-moment awareness experiences:

> I really like how it's arranged because […] *the trees block out some of the other stuff*. It **brings your attention into some of the smaller details** inside the space. […] Having it blocked off draws your attention […] you don't really pay attention to any of the buildings or the cars going by outside. (Willa/13/girl)

Non-natural features in the garden area (e.g., public art sculptures, info plaques), however, were relatively controversial with some opining that they made the garden more welcoming by giving them "something to look at and **enjoy**" (Bobby/13/girl), and others finding them distracting and lacking fit which ultimately degraded the nature experience.

3.5.7 Symmetries

Symmetries observed in a historical building in downtown Kitchener were foremost suggested to engender calm and content responses. Probes regarding the symmetrical designs revealed that they were routinely perceived to be more 'complete' and predictable or easy to process which subsequently elicited calmer responses upon extended viewing:

> It's **pleasing** to look at. And, you know what, I think that *my mind was enjoying the symmetry without even acknowledging it* because that was not something that came to mind. Now it's like 'holy crap, everything about it is the exact same'. (Karl/14/boy)

While symmetries had subtler impacts on some, others outlined more drastic attentional and emotional changes as one girl remarked that "[the symmetrical design] just makes me feel like 'okay this is a place to **calm my mind**' instead of it going super crazy" (Liliahna/12/girl). Participants also often stated they preferred symmetrical architecture when they began to compare the example building with asymmetrical designs in other nearby buildings.

3.5.8 Fractal Patterns

Fractal patterns, as seen in a local church, were chiefly linked to feelings of authenticity and creativity/flow. Owing to their distinct nature, when probed further about the design, participants explained being 'drawn in' by their intricacy and often highlighted their considerable attentional impacts:

> It's kind of like something that **draws you in** and you want to sit and look at it, whereas everything else there's nothing special about it […] I think *the glass*, because *it's so intricate*, it makes you want to look at it. (Tatem/16/girl)

Others elaborated that feelings of creativity and interest stemmed from recognizing nature in the fractal patterns of the window, explaining that it "kind of *reminds me of a snowflake or a flower* […] I **like** that feeling" (Lauren/10/girl), and "almost *looks like stars* or something to me, it looks kind of **cool**" (Mo/17/boy). Like symmetry, when compared to nearby buildings lacking any fractal designs, the church design was preferred for its distinctive fractal window patterns capturing participants' attention and the ornamentation piquing their interest.

3.6 Discussion

Collectively, our findings outline a number of affordances regarding PTOD and CA concepts and adolescent mental health (see Table 3.6.1). Grounded in the Theory of Affordances, we identify four principle findings in our discussion. First, we found a marked contrast in the nature of affordances related to natural versus built enclosures and landmarks (imageability, enclosure). Second, participants expressed much greater emotional engagement with visually rich (complexity) and transparent (transparency) designs. Specifically, adolescents responded positively to more complex environments that tended to feature a variety of colours and designs, and more transparent environments that tended to feature façades with a higher proportion of windows. Third, participants noted many opportunities for mental well-being and attentional refuge provided by area safety and socialization features (scale). Finally, participants indicated a subtle attraction to, or restorative qaulity associated with, the three CA concepts. Each of these findings are described in more detail below, along with suggestions for future research and practice. Beyond these overarching findings, we also offer a brief discussion regarding some of the potential gender differences in perceptions of these relationships as found in our secondary analysis. Concluding the discussion, and to enhance the relevance of our findings, we also discuss the potential value of our findings with respect to different U.N. Sustainable Development Goals (SDGs).

Table 3.6.1 PTOD, CA and Adolescent Mental Health Affordance Structures

Design Concept	**Emotion** (Arousal (inactive-active), Valence (displeasure-pleasure))	**Place/Feature Connection(s)** ➢ **Gender Differences**	**Expression/Rationale**
Imageability	Creative, Inviting, Relaxing (moderate/high + arousal, moderate/high + valence)	Presence of natural reference points and aural elements.	Offered opportunities to positively emotionally engage with spaces.
	Comfortable (low/moderate + arousal, high + valence)	Designs featuring non-rectangular forms, historical character, or outdoor dining.	Uniqueness/distinctiveness generated comfortable feelings, helped with navigation.
	Annoyed (moderate/high – arousal, high – valence)	Presence of artificial noise (e.g., vehicle). ➢ **Boys** articulated more consistent struggles with noise pollution annoyance issues.	Noise was emotionally draining, distracted focus from natural/restorative features of spaces.
Enclosure	Calm (low/moderate + arousal, high + valence)	Natural forms of enclosure and concealing arrangement of tall trees.	Reduced external distraction, kept focus on space, potential for present-moment awareness.
	Interesting OR Uncomfortable (disputed)	Built forms of enclosure.	Caught attention, offered interesting views OR created trapped, closed dynamic.
Scale	Comfortable, Safe (low/moderate + arousal, high + valence)	Presence of area furniture that supports safety, nature exposure, social opportunity/lingering, and place accessibility. ➢ **Girls** emphasized the presence of scale features as being important to their positive perceptions.	Afforded independent mobility, social lingering, and leisure pursuit opportunities.
	Discomfort ranging from sad (mess) to distressed (lack of safety features) (moderate – arousal, moderate – valence)	Areas featuring mess/debris, lacking the inclusion of safety features. ➢ **Girls** articulated more uneasy feelings in response to a lack of scale features.	Reduced engagement with and desirability of spaces.

Transparency	Safe, At Ease, Happy (low/moderate + arousal, high + valence)	Façades featuring windows, areas with a high density of active uses. ➢ **Boys** tended to highlight and notice having a variety of active uses as a positive design. ➢ **Girls** seemed to favour street areas with higher proportions of windows as a positive design.	Afforded opportunities to more comprehensively evaluate landscape, more opportunities to engage with spaces.
	Anxious, Unwelcome (high – arousal, high – valence)	Façades lacking windows, landscapes dominated by concrete.	Reduced ability to evaluate safety of landscape, reduced opportunities for emotional engagement with spaces.
Complexity	Exciting, Interesting (high + arousal, moderate/high + valence)	Façades incorporating multiple colours/natural accents and/or different designs or features (e.g., window patterns).	Supported positive social attachments with an area (e.g., attractive area), attracted attention toward pleasant sights.
	Boring, Unhappy (low – arousal, high – valence)	Worn-out façades (i.e., in poor condition such as faded colours, cracked windows), landscapes where the overwhelming colour is grey.	Reduced desire to use/travel through spaces, negative social attachments (e.g., suspicious area), reduced opportunities for emotional engagement.
Biophilia (Biophilic Architecture)	Being Away, Cheerful, Relaxed (moderate/low + arousal, high + valence)	Urban garden enclosure provided by trees, varied colour from included flowers. ➢ **Girls** emphasized more feelings of calmness and peacefulness in the urban garden.	Garden offered restorative sight or opportunity, reduced external distraction focusing attention on natural space.
	Inviting OR Distracting (disputed)	Presence of built features (public art structures, info plaques) in urban garden.	Add context to garden OR lack fit and distract from nature experience.
Symmetries	Calm, Content (moderate + arousal, high + valence)	Inclusion of consistent patterns of windows, columns, and doorways on main façade.	Easy to process, comfortable sight, 'complete' design.
Fractal Patterns	Authenticity, Creativity, Flow (moderate/high + arousal, moderate/high + valence)	Trillium/flower pattern in church window.	Emotional engagement with window patterns, positive social attachment based on reminder of nature.

*__Notes__: valence and arousal dimensions added to the interpretation of findings in this table to help contextualize the affective qualities of the different design concepts. Based on Russell's (1981) Circumplex Model of Affect. | '+' = positive, '–' = negative |

In our study, highly imageable and enclosed designs marked by *natural* components (e.g., urban lakes, encircling trees, sounds of nature) were widely preferred to their *built* comparators, and typically evoked positive emotional responses (e.g., moderate positive arousal and high positive valence responses (e.g., relaxing)). Existing research typically categorizing places according to natural or built components has noted similar results; for example, natural bluespaces aiding in emotional regulation (Djohari et al., 2018) and residential greenspace lowering the risk of anxiety-related behaviors (Madzia et al., 2019). Our findings here expand on this research by examining PTOD features and the built/natural dichotomy simultaneously. In so doing, our results suggest one possible explanatory mechanism pertaining to the link between urban design and adolescent mental health. Specifically, *natural* imageability and enclosure designs seemed to offer adolescents more opportunities for comfort and positive emotional engagement within an area relative to their *built* equivalents. In fact, several points of our participants' rationales pertaining to these affordances (e.g., facilitating their ability to focus on restorative as opposed to demanding views, mitigating distractions) echo similar observations regarding more natural landscapes positively affecting mood and affective states (e.g., hedonic tone) among youth (Roe and Aspinall 2011). To further explore this potential of natural imageability and enclosure designs in relation to mental health, future quantitative study examining the strength and generalizability of these relationships is merited.

Second, visual richness in colour and design (i.e., complexity), high densities of active uses, and façades with windows (i.e., transparency) were likewise consistently connected to meaningful emotional engagement with a place, typically in terms of varied positive arousal and high positive valence responses (e.g., happy/exciting). Interestingly, our participants' reasoning behind these affordances, namely the potential for creating meaningful experiences and improved perceived safety, have been captured as tenets of larger concepts like place attachment (Scannell and Gifford, 2010) and sense of place (Gehl, 1987). Among adults, place attachment, a key concept in understanding person-place interaction, has been linked to improved psychological health, more satisfying social relationships (Tartaglia, 2013), and place satisfaction (Ramkissoon et al., 2013), while sense of place is often used as a proxy for the pleasantness of experiences (Gehl, 1987). In this way, our findings here could suggest that higher complexity and transparency in urban design may help to support adolescents in building stronger place attachment and satisfaction bonds to local spaces. However, as these concepts can vary due to differences in cultural perspectives (Scannell and Gifford, 2010), focused investigation into the role of culture in adolescent urban landscape perceptions is warranted to continue to develop our understanding of these emotional response and urban design affordances.

Third, participants' perceptions of human scale in design emphasized safety and social features (e.g., barriers, adequate sidewalks, planters, front yard gardens) characterized by low positive arousal and high positive valence emotional responses (e.g., calm/safe). Outlines of these relations could suggest a couple of important points. First, it may be that scale is central to facilitating environmental affordance actualization via promoting space safety and usage (e.g., mental breaks, leisure opportunities). More specifically, our findings may reflect cognitive recognition (i.e., awareness) on the part of adolescents regarding how environmental designs (e.g., scale features) can support their mental health. Second, opportunities to actualize environmental affordances may be *passive* (i.e., meaningful formed relationships with given characteristic) or *active* (i.e., use of space/features) (Kytt¨a, 2004), and can illuminate how social and cultural rules and practices regulate such individual-environment interactions (Broberg et al., 2013). Our findings (e.g., opportunities for lingering or social interaction) could suggest that higher levels of scale in design may act as both important *passive* (e.g., front yard gardens/shrubs) and *active* (e.g., adequate sidewalks) opportunities for adolescents to actualize their environments in service of improved mental health. Further exploration of these relationships in an expanded array of settings (e.g., high density metropolitan areas, rural areas) could help to outline how human scale designs support or diminish adolescent mental health across different levels of urbanicity.

Finally, the three CA concepts examined in our study were generally positively perceived, and largely described as having moderate positive arousal and high positive valence dynamics (e.g., calm). Previous research has highlighted links between CA concepts such as biophilic architecture and positive mood changes (Tyrv¨ainen et al., 2014), as well as fractals patterns providing refuge and attention restoration (S¨oderlund and Newman, 2015) and relaxation (Joye, 2007) among adult populations. Our findings suggest similar dynamics between the three real-world examples in our study and adolescents' emotional responses. Specifically, our participants' extended conversations about these affordances suggested that biophilic architecture may facilitate restorative opportunities, the predictability of symmetries may satisfy visual preferences, and the attractiveness fractal patterns may capture attention/focus. Taken with recent study which has likewise elaborated that, for instance, fractal patterns can play an important role with respect to promoting positive engagement and environmental affordances (Coburn et al., 2019), it may be the case that CA principles in design, broadly, help to foster more intimate person-place connections. While these findings appear to be promising, it should be noted we only discussed these affordances in this study with respect to three

discrete examples. Therefore, we recommend these relationships continue to be studied in reference to more concepts (e.g., curvilinear designs) and examples (e.g., fractals via floral ornamentation) of CA in future study, forms) to explore and identify adolescent emotional responses to a greater range of design concepts and exposures.

3.6.1 Potential Gender Differences in Emotional Responses to Design Concepts

In this study we also conducted a secondary exploratory analysis to investigate potential gender differences in the main urban design-mental health relationships explored. To this end, potential divergences were noted regarding emotional responses to noise pollution and active use designs (boys); and the presence or lack thereof of human-scale concepts in design, proportionality of street windows, and biophilic architecture (girls). While related existing study seems to have generally focused on adult populations, there are a few similar trends in our findings which focus specifically on adolescents. For example, regarding the importance of human-scale and transparency concepts in design supporting feelings of comfort and safety among girls in our study, a photo simulation study likewise found that removing solid walls led to significant improvements in safety perceptions among women (Navarrete-Hernandez et al., 2021). Similarly, regarding our finding of potentially more intense positive emotional responses to the urban garden (i.e., biophilic architecture) among girls, a recent review highlighted that greenspace-physical health associations were strongest for women relative to other groups (Sillman et al., 2022). However, our findings here are only exploratory, and consequently we encourage more study into the trends we've noted regarding the potential role that gender plays in the relationship between adolescent mental health and urban design.

3.6.2 Implications for Urban Design

The findings presented here have a few implications for planning practitioners and those in related fields. Human scale in design seems to support adolescent mental health by enhancing autonomy by allowing for 'multiple and variable interactions', a central tenet of larger capability approaches that have advocated for improved urban quality of life for disadvantaged groups including children (Cecchini et al., 2018). While multiple and varied interactions, or enhanced autonomy, can be supported by designs such as pedestrian crossovers (Rothman et al., 2014), our findings add that the presence of front yard gardens in residential spaces, sidewalk planters, and street trees, as well as narrower street designs that limit vehicular presence and/or speed, may also be potentially important design features that facilitate opportunities for socialization or lingering and enhancing perceived

safety. Similarly in line with capability approach concepts, our findings highlight the impact of environmental quality (Robeyns, 2009) to support positive emotion-environment interactions through emphasizing richness in design colour, form, and accents (e.g., natural accents); the presence of several active uses in an area (e.g., different shops, restaurants); and the inclusion of windows in façades. Finally, recognizing that urban design can promote prosocial feelings (Goldhagen, 2017), our findings suggest that practitioners interested in social cohesion and meaningful place-based experiences could consider natural forms of imageability and enclosure, or biophilic architecture/symmetries/fractals, in future project developments as key points of connection for younger populations.

3.6.3 Larger Context: Connections to SDGs

To enhance the relevance of this study to broader international aims, there are additional implications of our findings with respect to the UN SDGs. Similar research has connected young people's perceived affordances of greenspaces to SDGs in service of discussing how to support these global aims (Nissen et al., 2020); here, we connect our findings to the UN SDGs—specifically SDG 11 (Sustainable Cities and Communities)—to suggest how they may support the achievement of these international goals. Perhaps most notable is section 11.7 which calls for universal access to safe, inclusive and accessible, green and public spaces, in particular for children (United Nations, 2020), for which several of our results suggest potential urban design prescriptions. Specific concepts noted in the present paper which appear to support safe and inclusive spaces include designs incorporating street/area furniture (linked to comfort), featuring natural forms of enclosure (calm), and including façades with a diverse array of colours (exciting) and windows (safety). Additionally, our imageability findings,notably preserving historical character and maintaining/cultivating natural reference points, could help support section 11.4 which calls for the protecting and safeguarding of the world's cultural and natural heritage (United Nations, 2020) by highlighting how this particular objective may have specific mental health benefits younger groups. Finally, section 11.3 calls for sustainable urbanization (United Nations, 2020) which our results related to biophilic architecture, an example of green infrastructure, could be used to support these sustainable urbanization aims by highlighting how distinct forms of infrastructure can support mental health among adolescents.

3.6.4 Limitations

Qualitative study designs are typically used to explore in-depth "how" and "why" questions, rather than provide generalizable estimates of specific phenomena. While our methods were appropriate for our research questions, we note that the findings from the sample examined in this study were limited by relevant cultural conditions, and thus may not be generalizable to non-White/European perspectives or perspectives familiar with low-density urban designs and auto-oriented infrastructure, and a limited heterogeneity with respect to different social identities (e.g., non-binary, class, racial identities). The sample was also largely concentrated between the ages of 10–14 which prohibited us from conducting any age-specific analyses (e.g., pre-teens vs. teens), and subsequently restricted any insights that specifically pertain to such a subgroup. Additionally, by design we only evaluated the relationship between urban designs and mental health with respect to a relatively healthy group of adolescents. Consequently, our findings do not provide insights into how adolescents with internalizing or externalizing disorders, phobias, or other conditions may understand and experience the urban designs evaluated here. Seasonality also likely affected the findings of our study. As the interviews conducted in this study were completed in warmer summer weather, this set of conditions likely framed, and to some extent limited, the emotions of our participants relative to a multi-season or different season study. Last, we acknowledge the scale of this study as a potential limitation. While we attempted to engage participants in a variety of distinct settings along our planned interview route, our findings are unlikely to apply as well to rural and remote, peri-urban, or metropolitan/central business district environments. While we acknowledge these limitations, our study represents a first attempt to qualitatively explore specific urban and architectural design concept exposures and link them to adolescent emotional responses. Building on the work of this study, future research could investigate similar adolescent mental health and urban design relationships in different cultural and geographical contexts, in reference to different urban design paradigms (e.g., TOD) and concepts (e.g., publicness), or in relation to different samples (e.g., specific adolescent subgroups or groups comprised of more heterogenous social identities).

3.7 Conclusion

To the authors' knowledge this is the first in-depth and theoretically informed qualitative examination of the relational dynamics (i.e., affordances) between adolescent mental health and specific urban and architectural design concepts. Central results from our go-along interviews with 23

adolescents include notably different relational dynamics regarding natural versus built forms of imageability and enclosure, considerably different responses regarding landscapes featuring a variety of colours and higher levels of transparency relative to those dominated by concrete/grey and poor transparency, and positive sentiments attached to CA concepts in design. Specific design features such as natural reference points, area and street furniture, urban gardens, and fractal patterns in built design were generally positively responded to by adolescents. Preliminary gender differences were also observed regarding certain imageability, transparency, and scale features.

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Chapter 4

Exploring the Relationships Between Specific Urban Design Features and Adolescent Mental Health: The Case of Imageability, Enclosure, Human Scale, Transparency, and Complexity

With Dr. Leia Minaker

4.1 Abstract

Different types of environment stimuli (e.g., noise, aesthetics, vegetation density) in urban environments are becoming better understood as important determinants of the mental health of urban dwellers. Research on the impacts of urban exposures, especially those related to specific urban design concepts, and their potential impacts on the mental health and well-being of adolescents specifically, however, is currently lacking. In this study, we examine the relationship between five pedestrian- and transit-oriented design (PTOD) concepts—imageability, enclosure, human scale, transparency, complexity—and adolescent emotional responses to six settings of varied PTOD quality. Using an online survey method with recorded videos of each setting, a nationally representative sample of Canadian adolescents viewed the videos and indicated responses to six outcomes related to mental health: positive affect, negative affect, calmness, anxiousness, perceived restorativeness, and mental demand. Unadjusted and adjusted linear mixed models were constructed to examine the association between different urban settings and each outcome. Results of the adjusted mixed models indicated that, generally, as the quality of five PTOD concepts increased, as reflected in the scores of the different settings, positive emotional responses tended to increase while negative responses decreased—with the exception of mental demand. Specific urban design insights included that the level of imageability may be a key design in natural settings, while the quality of complexity may be noteworthy in both built and natural settings. Future studies should seek to further explore these relationships with other means (e.g., objective methods), as well as further explore different types of enclosure.

Role in the Dissertation

Similarly owing to the suggestions of Chapter 2, the aim of this first online survey study of the dissertation is to present a large-scale assessment of the relationships between adolescent emotional responses and aggregate space pedestrian infrastructure quality (as scored according to PTOD quality). This evaluation subsequently aims to outline and identify population-level trends among adolescents regarding their emotional responses to overall space quality in reference to multiple evaluated sites. In Chapter 7's synthesis, findings from this study are used to triangulate the emergent trends in the results of the other primary research chapters of this dissertation.

Keywords

built environment; mental health; planning; theory of affordances; urban design

4.2 Introduction

Mental health disorders account for 13% of disability-adjusted life-years (DALYs) (Vigo et al., 2016), and 50% of mental health disorders begin by the age of 14 (Kessler et al., 2005), adolescent (10-19 years). The onset of mental health disorders during adolescence can contribute to several negative long-term health outcomes including an increased risk of heart disease and stroke (Scott et al., 2016), long-term disability (Kapungu et al., 2018), and eventually a heightened risk of all causes of early age mortality (Kessler et al., 1995). Moreover, while ensuring one's mental health across the lifespan is important, it is especially so during early life as rapid brain development renders adolescents particularly vulnerable to the development of chronic emotional, neurological, and social issues (Dahl, 2004). Both natural and built urban designs are increasingly being highlighted as important factors regarding the mental well-being of young people (Buttazzoni et al., 2022; Christian et al., 2015; Sun et al., 2018). However, as such study continues to progress, gaps in the literature have been noted the precision of study into these relationships (Fleckney & Bentley, 2021). To address this, we examine the relationships between specific pedestrian- and transit-oriented design (PTOD) concepts, as reflected in videos of six distinct urban settings, and a range of subjective mental health responses among adolescents in Canada.

4.2.1 Impacts of Urban Environments on Adolescent Mental Health

Previous research has outlined several ways in which urban environments impact adolescent mental health. Broadly, urban living among adolescent populations is associated with multiple concerning, cross-country trends: in India, adolescents in urban areas report higher rates of mental disorders relative to their rural counterparts (Pillai et al., 2008); Bangladeshi youth in urban slums are significantly more likely than other urban and rural dwelling groups to have serious behavioural problems (Mullick & Goodman, 2005); and a multi-city study across three continents, found that certain groups of adolescents living in economically distressed areas of their respective city and who reported poor perceived social support had significantly higher odds of depression and posttraumatic stress compared to those with greater perceived social support (Cheng et al., 2014). More precisely, environments structured to prioritize the automobile produce high levels of noise that induce sleeping issues (Tiesler et al., 2013), while poor pedestrian route directness may increase the risk of depressive symptoms (Duncan et al., 2013). Conversely, salubrious effects of urban designs may be accrued through exposure to more natural areas such as greenspaces (e.g., parks) which can positively impact

cognitive development (Dadvand et al., 2015) and reduce reductions in ADHD symptoms (Amoly Elmira et al., 2014). Moreover, built designs that feature higher-quality environmental aesthetics (e.g., more tree shading) (Sun et al., 2018) and sidewalks (Rothman et al., 2018) can promote physical activity, which has been linked to improved mental health. Although these relationships have received more study recently, the impacts of specific exposure concepts (e.g., the quality of spaces) (Vanaken & Danckaerts, 2018) remain unclear. This gap is important for both research and practice – specifically – better understanding which urban design features are associated with mental health outcomes will help cities plan for mental health-promoting built and natural urban places.

4.2.2 Pedestrian- and -Transit-Oriented Design

Pedestrian- and transit-oriented design (PTOD) is a relevant planning paradigm that outlines multiple specific built design concepts that may be used to examine more precise linkages between urban environments and adolescent mental health. The PTOD paradigm centrally aims to support accessibility, active travel infrastructure, and ultimately improves pedestrian usage of spaces (Dittmar & Ohland, 2012; Renne, 2016). To achieve these objectives, important PTOD concepts include: imageability, enclosure, human scale, transparency, and complexity (see Table 4.2.1). *Imageability*, a design concept thought to contribute to 'sense of place'(Ewing, 2013), refers to the distinguishing features of a setting (e.g., landmarks, architectural structures) which can make it particularly memorable (Gehl, 1987). *Enclosure*, or a space's potential to cultivate a sense of 'hereness' or presence (i.e., identity with surroundings) (Cullen, 1995), describes the vertical nature of a setting and to what extent it's relevant features (e.g., buildings, trees) create a 'room-like quality' (Ewing, 2013). *Human scale* centrally outlines the orientation of a setting's physical qualities (e.g., infrastructure) (Ewing, 2013) toward either pedestrians—'lower-speed' designs (e.g., lower speed limits, street furniture) which may improve comfort—or vehicles— 'higher-speed' designs (e.g., wider roads, higher speed limits) which may be more overwhelming (Kay, 1998). *Transparency* has been associated with spatial awareness (Arnold, 1993) and denotes the level to which human activity is observable beyond a street or public space as a result of windows, doors, landscaping, and other openings (Jacobs, 1993). Finally, *complexity* encourages engagement with one's environment (Nelessen, 1994) and captures the visual richness of a setting via the range (i.e., number, styles) of present architecture, buildings, ornamentation, and landscape features (Ewing, 2013).

Table 4.2.1 Pedestrian- and Transit-Oriented Design Principles

	Concept(s) (e.g., features)	**Mental Health Phenomena**
PTOD Feature		
Imageability	Distinctiveness (e.g., courtyards, plazas, historic building frontage, outdoor dining) (Clemente et al., 2005)	'sense of place' (Cullen, 1995; Gehl, 1987)
Enclosure	Room-like quality (e.g., proportion of street walls, viewable proportion of sky) (Clemente et al., 2005)	'hereness' (Cullen, 1995)
Human Scale	Detail, texture, physical elements (e.g., sight lines, average building height, # of small planters) (Clemente et al., 2005)	'disorientation', 'comfort' (Kay, 1998)
Transparency	Perceived/viewable human activity (e.g., proportion of street walls, proportion of active uses) (Clemente et al., 2005)	'awareness of surroundings' (Arnold, 1993)
Complexity	Visual richness (e.g., # of buildings, # of basic colours, # of pieces of public art) (Clemente et al., 2005)	'boring', 'engaging' (Nelessen, 1994)

4.2.3 Theoretical Frame: Theory of Affordances

The Theory of Affordances further contextualizes the research described here. A transactional environmental psychology framework, this theory posits that *affordances* are value-mediated relational process which drive human-environment interactions, and the result of both what a person's intentions and capabilities are as well as what an environment presents the person (e.g., layout of an environment, other people, objects) (Gibson, 1979). Recent evolutions of the theory suggest affordances are a form of realism about meaning, and that affordances—meaning—is the result of the real (objective) *and* perceivable (subjective) rather than a property of either the environment or the individual (Chemero, 2003). Consequently, this contemporary perspective allows for the examination of an environment's 'functional significance', or the ways in which affordances are or aren't supported in a particular setting. This approach has been employed to explore similar topics like adolescents' use of space (Clark & Uzzell, 2002) and the needs of young people regarding local parks (Townshend & Roberts, 2013). In this way, functional significance constitutes the social and physical aspects of an environment necessitating that an individual and their context jointly contribute to the meaning and nature of a phenomenon (Heft, 2010). Having established this theoretical frame,

we use the theory to investigate the functional significance of affordances outlined as the relationship between the physical PTOD quality of urban areas and subjectively reported adolescent mental health outcomes. Therefore, we seek to explore the nature of PTOD affordances regarding their impact on six self-reported mental well-being of adolescents.

4.2.4 Research Justification and Questions

Young peoples' and adolescents' socio-spatial experiences of urban areas have been relatively understudied when compared to other groups (Skelton & Gough, 2013). Suggestions to improve the study of adolescent mental health and urban environments have noted the potential of exploring the impacts of specific design concepts (Buttazzoni et al., 2022). This paper addresses these points by examining different affordances in the form of the quality of distinct design exposures (i.e., PTODs) in different urban settings, and how they are associated with a series of adolescent mental health indicators. To this end, the following research question was posed:

> What are the relationships between PTOD exposures, as reflected in the six different settings, and adolescent mental health indicators (i.e., positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand)?

4.3 Methods

4.3.1 Sample

A nationally representative sample (in terms of region, age, and sex) of 1,500 Canadian adolescents were recruited through the Canadian market research firm Léger (Montreal, PQ, Canada), who reached out to families via their internal research panels. All participants were screened to ensure representativeness, with specific requirements denoting that each individual needed to: 1) be 9-17 years old, thus old enough to have some level of independent mobility but not old enough to have a full driver's license (which would alter environmental interactions); 2) be able to complete a survey in either English or French; 3) have obtained parental/guardian consent; and 4) have internet access via a mobile device or computer. Complete sample characteristics are presented in Table 4.3.1.

Table 4.3.1 Sample Demographics (n=1,500)

Characteristic	Sample Size	Weighted %
Age		
9	101	6.7
10	176	11.8
11	170	11.3
12	174	11.6
13	207	13.8
14	170	11.3
15	187	12.5
16	161	10.7
17	154	10.3
Ethnicity		
Indigenous	47	3.1
Black	46	3.1
East/SE Asian	131	8.7
Latin American/Hispanic	24	1.6
South Asian	99	6.6
West Asian/Arab	21	1.4
White	1021	68.1
Mixed	107	7.1
No Answer	4	0.3
Gender		
Boy	771	51.4
Girl	716	47.7
Transgender/Non-Binary	13	0.9
Geographic Location		
Atlantic (NB, NL, NS, PEI)	93	6.2
Quebec	326	21.7
Ontario	592	39.5
Western (AB, BC, MB, SK)	489	32.6
Birth Order		
Oldest/Only Child	862	57.5
Younger/Youngest Child	638	42.5
Urbanicity		
Rural Area	200	13.3
Small City or Town	357	23.8
Suburb of Large City	484	32.3
Large City	459	30.6
Parental Supervision		
One Parent/Guardian or Less	306	20.4
Two or More Parents/Guardians	1184	79.6
	Mean	**Std. Dev.**
Subjective Mental Health (range 1-5)	3.72	0.969
Subjective Social Status (range 1-10)	6.34	1.669

Notes: participants selected one ethnicity or, if they wanted, listed multiple and selected 'mixed'.
Abbreviations: AB = Alberta, BC = British Columbia, MB = Manitoba, NB = New Brunswick, NL = Newfoundland and Labrador, NS = Nova Scotia, PEI = Prince Edward Island, SK = Saskatchewan

4.3.2 Survey Protocol

An online survey with a single-blind (i.e., participants unaware of research question) format was developed by the authors using Qualtrics, transferred to the Survey Research Centre at the University of Waterloo to undergo quality control (e.g., testing, Qualtrics programming), and then sent to Léger for distribution to participants for completion via either a mobile device (e.g., phone, tablet) or computer. Parents or guardians were first asked to provide consent for their child who, after providing their assent to participate, then began the survey. The survey featured 10-15 second panoramic videos (with sound, re-watch available) of six different urban areas, with each video being followed by a series of questions about emotional responses to the area in the video. Overall, the survey took participants an average of 20 minutes to complete, and was structured to mitigate different forms of bias. In particular, the survey randomized the presentation order of the videos for each participant to guard against order bias, and ensured anonymity and participant blindness to the research question of the study and true locations of the recorded settings to minimize potential sources of response bias.

Decisions for the six urban areas used in this study were based on the research team's intention to develop a cross-section of settings varied in PTOD score quality, urbanicity, and setting type (i.e., natural vs. built). Consequently, the six selected locations featured: two natural urban areas, two built urban areas higher in PTOD quality, and two built suburban areas lower in PTOD quality (see Table 4.3.2). Scoring of the locations filmed and presented in the survey was based on Ewing and Handy's (2009) guide, and conducted using a validated tool (Clemente et al., 2005). Recorded PTOD scores in this study ranged from approximately 1-7 with higher scores a greater prominence of a design concept in a given setting, and were similar to other studies investigating neighbourhood walkability (Hooi & Pojani, 2020) suggesting good tool reliability and true variability in urban design concepts. Locations featured existed in either in Kitchener or Toronto, Ontario and comprised a multi-modal urban trail, urban bluespace (i.e., lake area), suburban residential street, suburban mall, urban pedestrian plaza, and urban market area (see photos in Appendix 7.10.4). This study was approved by the University of Waterloo Office of Research Ethics (study #43603).

Table 4.3.2 Video Settings' Design Feature Scores

Design Feature	Imageability	Enclosure	Scale	Transparency	Complexity
Urban Setting					
Multi-modal trail	2.42	3.32	3.88	2.29	4.71
Community bluespace	5.54	1.66	3.70	2.24	5.93
Suburban residential area	3.07	1.41	3.14	2.19	4.91
Suburban mall	2.78	1.03	2.69	2.18	3.86
Urban market	5.18	1.44	4.48	2.55	6.70
Urban pedestrian plaza	6.88	3.30	4.68	3.03	6.61

*__Notes__: The higher the score, the more prominent the particular design feature |
Tool available at:
https://activelivingresearch.org/sites/activelivingresearch.org/files/FieldManual_071605.pdf

4.3.3 Independent Variable

The six different urban settings scored for PTOD quality in Table 4.3.2 were the independent variables in the analyses, and a dummy variable was created to indicate the presence of each setting in the mixed models.

4.3.4 Dependent Variable

Six mental health outcomes reflecting different emotional responses were the dependent variables: positive affect, negative affect, calmness, anxiousness, perceived restorativeness, and mental demand. In order to ensure the completion of the survey and to not exhaust participants, the number of items for each outcome variable scale were reduced from their original scales based on results from cognitive interviews and pilot testing of the survey instrument with three adolescents between the ages of 11 and 15. *Positive* and *negative affect* were measured using the five-point (1-very slightly or not at all … 5-extremely) Positive and Negative Affect Schedule for Children (PANAS-C) (Ebesutani et al., 2012) which was adapted to present two positive affect items (e.g., 'joyful') and three negative affect items (e.g., 'sad'). *Calmness* and *anxiousness* were measured using the five-point (1-not at all … 5-extremely) Profile of Mood States (POMS) (Grove & Prapavessis, 1992) 'tension' (e.g., 'nervous') subscale and an adapted 'calmness' (e.g., 'peaceful') subscale which were adapted to two items each. *Perceived restorativeness* and *mental demand* were measured using the five-point (1-not at all … 5-extremely Perceived Restorativeness Scale (PRS)–Being Away subscale and the PRS-Coherence subscale (Hartig et al., 1997), respectively. Both measures were adapted to contain three items each related to restorativeness (e.g., 'it is a place to get away from it

all') and mental demand/fatigue (e.g., 'there is too much going on'). Total outcome scores for measure were then aggregated to develop final score ranges between 2-10 for positive affect, calmness, and anxiousness, and 3-15 for negative affect, perceived restorativeness, and mental demand.

4.3.5 Covariates

Individual-level covariates included demographic data such as age (9-17 years old) and gender (boy, girl, non-binary) to account for the documented differences across these factors (Connolly et al., 2016; Patel et al., 2007), as well as self-identified ethnic identity (Aboriginal/Indigenous, Black, East/Southeast Asian, Latin America/Hispanic, South Asian, West Asian/Arab, White, Mixed, Other) (Fox et al., 2020). Overall subjective mental health well-being assessments were gathered using the five-point (i.e., 1-Poor … 5-Excellent) single-item measure of self-rated mental health from the Canadian Community Health Survey (Government of Canada, 2015). Family and household factors were also compiled. Socioeconomic status (SES) information was collected using a subjective social status (SSS) measure (Amir et al., 2019) based on the MacArthur Scale of SSS, a validated cross-culture measure of social status (Goodman et al., 2001). As a part of the question, the measure presented an illustration of a ladder and asked participants to compare their family's money, education, and jobs to Canadian society by ranking their standing on the ladder between 1-10 for each category; these scores were later summed to create an aggregate SSS score. Parental supervision (one parent/guardian, two or more parents/guardians) was collected to account for parental controls which can impact an adolescent's interactions with their local environments (Alparone & Pacilli, 2012; Foster et al., 2014). There is some evidence of associations between birth order and individual social attitudes (Salmon, 2003), and social behaviors (Courtiol et al., 2009), thus to control for parental resource devotion across these groups (Booth & Kee, 2009; Price, 2008) we included a birth order (oldest/only child, younger sibling) variable. Broader environment-level covariates included region (Maritimes (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick), Quebec, Ontario, and Western Canada (Manitoba, Saskatchewan, Alberta, British Columbia)). Finally, urbanicity was gathered using an adapted and abbreviated version of a PEW Research Center measure (Miller et al., 2012) which asked "What type of community do you live in" (rural area, small city or town, suburb near a large city, large city).

4.3.6 Analysis

Analyses of the impacts of the six urban settings on the six emotional response outcomes of adolescents were conducted via a series of linear mixed models (LMMs). LMMs were selected due to their appropriateness for analyzing data that are nested, thus not assumed to be independent, as is the case for the outcome variables of this study (since each participant reported their mental health responses for each setting). Clustered responses like this potentially introduce additional correlation and consequently cause the standard errors to be underestimated if not accounted for in the analysis (increases probability of Type 1 error). Mixed models correct for clustered data by accounting for both fixed and random effects. Fixed effects are assumed to remain constant across clusters and have a fixed effect on the outcome of interest, while random effects vary in effect on the outcome across clusters and are not assumed to be constant. In the present study, LMMs allowed the analysis to account for repeated measures on the same individual, which are not independent, by specifying the random effect (unique participant ID) and fixed effects (covariates) at the individual level. Overall, 36 LMMs were run: one for each combination of setting and emotional response outcomes. Both unadjusted models and adjusted models controlling for the theoretically relevant covariates noted above were run for each set of analyses. All analyses were run using the Mixed Models procedure in SPSS Statistics version 25 (IBM Canada Ltd., Markham, Ontario, Canada).

4.4 Results

Full results of the unadjusted and adjusted LMMs for the six different urban settings and the six mental health outcomes are shown in Table 4.4.1. Findings from the unadjusted models outline significant positive associations between the natural settings (i.e., trail, bluespace) and all three salubrious mental health outcomes, the most exceptional being perceived restorativeness (trail: β=3.106, 95% CI: 2.934, 3.278; bluespace: β=3.498, 95% CI: 3.330, 3.666). The suburban mall setting (the lowest scored PTOD area) was consistently associated with the most significant deleterious mental health responses across all six outcomes. Notably, the setting was associated with significant decreases in calmness (β=-1.954, 95% CI: -2.066, -1.842), almost a full point lower than the setting with the next lowest score (urban market), and perceived restorativeness (β=-2.848, 95% CI: -3.022, -2.674), also roughly a full point lower than the setting with the next lowest score (suburban street). Contrarily, the highest scored built setting (i.e., setting that isn't the trail or bluespace), the urban plaza, was the only built setting to: be significantly associated with an increase

in positive affect (β=0.116, 95% CI: 0.010, 0.222), and featured a relatively minimal (but significant) decrease in perceived restorativeness (β=-0.358, 95% CI: -0.544, -0.173), and feature a nonsignificant decrease in negative affect (β=-0.040, 95% CI: -0.113, 0.032).

Trends observed in the unadjusted models were essentially the same even after including the covariates in the adjusted models. Noteworthy results include all four built settings remaining significantly linked to reductions in calmness, including the comparatively highly PTOD-scored urban plaza (β=-0.517, 95% CI: -0.637, -0.397)—and the suburban mall area staying as the only setting linked to a significant increase in reported negative affect (β=0.616, 95% CI: 0.545, 0.687). Even after being adjusted for several covariates, the relatively low scored suburban residential street area was significantly associated, albeit modestly, with reductions in anxiousness (β=-0.154, 95% CI: -0.221, -0.093), as well as mental demand (β=-1.351, 95% CI: -1.213, -1.488), representing the only built setting to feature these directional relationships. Between the two natural urban areas, noticeable differences in reported increases of calmness (trail: β=1.703, 95% CI: 1.598, 1.817; bluespace: β=2.144, 95% CI: 2.033, 2.254), and decreases in negative affect (trail: β=-0.246, 95% CI: -0.318, -0.173; bluespace: β=-0.428, 95% CI: -0.500, -0.357) and anxiousness (trail: β=-0.312, 95% CI: -0.376, -0.248; bluespace: β=-0.524, 95% CI: -0.587, -0.461) also remained in the adjusted models.

Table 4.4.1 Unadjusted and Adjusted Linear Mixed Models of Urban Environments and Adolescent Mental Health Outcomes

	Positive Affect				Negative Affect				Calmness			
	β	**95% CI**		**P**	**β**	**95% CI**		**P**	**β**	**95% CI**		**P**
Trail												
Unadjusted	1.323	1.222	1.425	**<.000**	-.249	-0.321	-0.176	**<.000**	1.704	1.590	1.818	**<.000**
*Adjusted	1.325	1.224	1.427	**<.000**	-.246	-0.318	-0.173	**<.000**	1.703	1.589	1.817	**<.000**
Bluespace												
Unadjusted	1.364	1.263	1.466	**<.000**	-.431	-0.502	-0.359	**<.000**	2.142	2.032	2.252	**<.000**
*Adjusted	1.365	1.264	1.467	**<.000**	-.428	-0.500	-0.357	**<.000**	2.144	2.033	2.254	**<.000**
Sub. Mall												
Unadjusted	-1.762	-1.860	-1.664	**<.000**	.615	0.544	0.686	**<.000**	-1.954	-2.066	-1.842	**<.000**
*Adjusted	-1.763	-1.861	-1.665	**<.000**	.616	0.545	0.687	**<.000**	-1.953	-2.065	-1.841	**<.000**
Sub. Street												
Unadjusted	-.821	-0.926	-.717	**<.000**	.047	-0.025	0.120	.201	-.246	-0.367	-0.126	**<.000**
*Adjusted	-.823	-0.927	-.718	**<.000**	.049	-0.024	0.121	.190	-.248	-0.369	-0.127	**<.000**
Urb. Market												
Unadjusted	-.219	-0.325	-.113	**<.000**	.056	-0.017	0.128	.130	-1.127	-1.245	-1.009	**<.000**
*Adjusted	-.220	-0.326	-.114	**<.000**	.058	-0.014	0.123	.117	-1.130	-1.248	-1.012	**<.000**
Urb. Plaza												
Unadjusted	.116	0.010	.222	**.032**	-.040	-0.113	0.032	.275	-.519	-0.639	-0.399	**<.000**
*Adjusted	.116	0.010	.222	**.033**	-.049	-0.112	0.023	.184	-.517	-0.637	-0.397	**<.000**

Notes: *Adjusted for: urban setting, age, gender, ethnicity, urbanicity, birth order, parental supervision, subjective mental health, subjective social status, and location.
Abbreviations: "Sub." – Suburban. | "Urb." – Urban.

	Anxiousness				Perceived Restorativeness				Mental Demand			
	β	**95% CI**		**P**	**β**	**95% CI**		**P**	**β**	**95% CI**		**P**
Trail												
Unadjusted	-.315	-0.379	-0.251	**<.000**	3.106	2.934	3.278	**<.000**	-1.528	-1.665	-1.391	**<.000**
*Adjusted	-.312	-0.376	-0.248	**<.000**	3.103	2.931	3.275	**<.000**	-1.526	-1.663	-1.389	**<.000**
Bluespace												
Unadjusted	-.526	-0.589	-0.463	**<.000**	3.498	3.330	3.666	**<.000**	-1.637	-1.773	-1.501	**<.000**
*Adjusted	-.524	-0.587	-0.461	**<.000**	3.503	3.334	3.671	**<.000**	-1.634	-1.770	-1.498	**<.000**
Mall												
Unadjusted	.590	0.527	0.652	**<.000**	-2.848	-3.022	-2.674	**<.000**	1.349	1.211	1.486	**<.000**
*Adjusted	.588	0.525	0.651	**<.000**	-2.850	-3.025	-2.676	**<.000**	1.351	1.213	1.488	**<.000**
Street												
Unadjusted	-.157	-0.221	-0.093	**<.000**	-1.886	-2.067	-1.705	**<.000**	-1.221	-1.360	-1.083	**<.000**
*Adjusted	-.154	-0.218	-0.090	**<.000**	-1.891	-2.072	-1.710	**<.000**	-1.224	-1.363	-1.086	**<.000**
Market												
Unadjusted	.311	0.247	0.375	**<.000**	-1.514	-1.696	-1.331	**<.000**	1.627	1.490	1.763	**<.000**
*Adjusted	.312	0.248	0.376	**<.000**	-1.515	-1.697	-1.332	**<.000**	1.633	1.497	1.769	**<.000**
Plaza												
Unadjusted	.097	0.033	0.162	**.003**	-.358	-0.544	-0.173	**<.000**	1.406	1.269	1.544	**<.000**
*Adjusted	.089	0.025	0.153	**.006**	-.352	-0.538	-0.166	**<.000**	1.396	1.259	1.534	**<.000**

Notes: *Adjusted for: urban setting, age, gender, ethnicity, urbanicity, birth order, parental supervision, subjective mental health, subjective social status, and location.

Abbreviations: "Sub." – Suburban. | "Urb." – Urban.

4.5 Discussion

Using an online survey with a nationally representative sample of Canadian adolescents, this study investigated the relationships between PTODs and adolescent mental health by examining how distinctly scored urban settings affected self-reports of positive affect, negative affect, calmness, anxiousness, perceived restorativeness, and mental demand. Overall, the findings delineate clear trends across the differently scored PTOD settings with respect to their impacts on the self-reported emotional responses of adolescents. Taken together, these results suggest that the PTOD quality of urban areas may have significant impacts on the mental health of this demographic. To further contextualize these results, we turn to the Theory of Affordances and the PTOD scores outlined in Table 4.3.2 to interpret the findings.

Trends across the four built urban environments generally suggest that as the aggregate PTOD quality worsens, reports of positive emotional responses become lower while reports of negative responses become more common. Such results support broader notions that pedestrian features in urban areas are beneficial for adolescents. For example, several studies have observed increased levels of physical activity (active travel) is associated with sidewalk presence (Rothman et al., 2018), narrower street width (Nasar et al., 2015), pedestrian crossovers (Rothman et al., 2014), and street connectivity (Giles-Corti et al., 2011). The trends observed in our results appear more marked, however, when comparing the two lowest scored PTOD areas (suburban mall, suburban street) to the two other built areas (urban market, urban plaza). In particular, the former are associated with considerably larger decreases in positive affect (as seen in the coefficients presented in Table 4.4.1: -1.7, -0.8 vs. -0.2, 0.1) and perceived restorativeness (Table 4.4.1 coefficients: -2.8, -1.9 vs. -1.5, -0.4), while the suburban mall is also the only area significantly associated with an increase in negative affect. Situating these results within our theoretical frame, it may be that higher PTOD presents adolescents with a greater number of environmental features (e.g., places to sit/socialize, active uses) that they can make use of, and/or which encourage more cheerful (positive affect) and less demanding (restorativeness) and upsetting (negative affect) experiences. Given the exploratory nature of these findings, however, future research should seek to replicate similar protocols in real-world settings to triangulate results or use objective methods (e.g., Buttazzoni et al., 2021) to further explore these relationships.

Natural urban environments in this study (trail, bluespace) scored lower in certain PTOD categories relative to some of the built settings, but were associated with the most substantial positive mental health outcomes and minimal negative mental health experiences. While natural environments

have previously been linked to a variety of mental and cognitive benefits (e.g., Amoly Elmira et al., 2014; Dadvand et al., 2015), a comparison of the two natural settings examined here illuminates some potentially noteworthy design-mental health affordances. Featuring comparatively higher imageability and complexity scores, the bluespace was associated with a roughly half-point (~0.40) increase in calmness and restorativeness. Considering the nature of these relationships with respect to affordances, it could be that clearer instances of natural imageability (e.g., presence of local lake, community gardens featured in the videos) and/or complexity (e.g., more colours or designs, public art) represent important specific design concepts for supporting adolescent mental health. Whether these relationships are principally due to perceptual (e.g., design or colour attraction) or physical (e.g., a greater number of environmental features to engage with) factors is beyond the scope of this analysis; however, such lines of inquiry are warranted in future study. Irrespective of the source, these theoretical relationships appear to be consistent with related research that has noted higher-quality environmental aesthetics can positively impact active travel (Sun et al., 2018), while vegetation richness can increase aesthetic preference (Zhuang et al., 2021), and imageability features (e.g., flowers, water sources) can enhance a setting's restorative potential (Wang et al., 2019).

Insights into the relative importance of specific PTOD concepts in built spaces may be further explored by examining differences across the six reported mental health outcomes associated with the two poorest scored built areas (suburban mall, suburban street) and the highest scored built environment (urban plaza). For example, the two suburban areas featured consistently low scores across all the design categories with the exception of complexity where the scores diverge more considerably (3.86 (mall) vs. 4.91 (street)); consequently, it may be that complexity is an especially important design concept built environments as well. Complexity, or visual richness, in the form of designs that incorporate contours or curvature (Vartanian et al., 2013), fractals (i.e., repeating patterns) (Taylor et al., 2005), and other naturalistic patterns (e.g., tree-like structures, floral ornamentation) (Coburn et al., 2019) have been documented to impact aesthetic evaluations and preferences. In the context of affordances in this study, it is possible that greater complexity within built designs reduce negative responses, specifically anxiousness and mental demand/fatigue, through enhancing engagement as previously theorized (Nelessen, 1994), or potentially through eliciting fascination or contemplation among adolescents.

Regarding the findings associated with the urban plaza setting, it could be that enclosure is particularly important to promoting positive affect and minimizing emotional distress (negative

affect). For context, the area of the urban plaza scored in this study featured an enclosure score that was the result of a mix of a consistent number of larger street trees with sizeable canopies in a relatively clearly defined pedestrian plaza area accompanied by tall residential and commercial buildings. Given that some of these features, namely street trees, have been associated with the potential to reduce annoyance (Sarajevs, 2011), our results suggest that the combination of natural (street trees) and built (tall area buildings) enclosure affordances may create a more comforting, intimate space as perceived by adolescents. When compared to the natural settings featured here (i.e., varied enclosure, largest positive and negative affect effect sizes), however, it seems that more natural forms of enclosure may be particularly noteworthy for adolescent emotional responses of comfort and/or distress. Additional research into the potential differing impacts of natural and built forms of enclosure is warranted.

4.5.1 Implications for Practitioners

Results of this study illustrate several connections between the level of PTOD quality in an urban setting and the emotional responses of adolescents, and consequently have implications for professional practice. Our results suggest that natural spaces that feature high levels of imageability (i.e., more distinctiveness) and complexity (i.e., more visual richness) in their design may be key design concepts for planners and urban designers to consider. Examples of such designs include, but are not limited to, gardens/flower arrangements or building facades with more diverse colour palettes, distinctive public art displays, notable built landmarks or buildings with rounded edges (i.e., non-rectangular buildings), and detailed building/structure ornamentation. More broadly, results of this study would advise planning practitioners and other urban designers to consider scale in their community's relevant design guidelines. For instance, practitioners could evaluate relevant policies to assess their potential to implement street trees, sidewalk barriers, or street/plaza planters next to thoroughfares or arterial roads; to evaluate the extent to which local policies allow for the pairing of active travel infrastructure (e.g., bicycle racks, benches, wayfinding signs) with other public transit networks and infrastructure (e.g., bus/LRT stops); or, more broadly, to examine how their residential development codes specifically protect individuals from traffic and its attendant impacts.

4.5.2 Limitations

When interpreting the results of this study, there are some limitations to be aware of. Most notably, the development of the survey required reducing the number of items from the validated

scales we used to develop outcome variables for feasibility. Consequently, this may have resulted in smaller variation in outcome variables, which would logically lead to smaller coefficients in our results and an increased chance of a type II error (failure to reject a null hypothesis that is actually false). The delivery method of the survey—an online format—may have also contributed to an underestimating of the true effects of the urban settings on adolescent mental health. While the videos participants watched were 360° and included audio of the settings, participants were not physically exposed to environmental conditions such wind, nor were they able to accurately consider vestibular (i.e., balance and movement in reference to space) or kinesthetic (i.e., bodily sense) inputs with respect to the different settings. This survey also exclusively used video examples of urban settings from the Canadian context, and any generalizations of these results to other contexts with distinctly different urban environments should be done cautiously. Finally, the research conducted here is cross-sectional in nature, thus it is not possible to speculate about causality. That said, the study design (observations nested within individuals), the large sample size (n=1500) and the representativeness of the sample in terms of region, sex and age were all strengths of the research, and appropriate considering the lack of extant research on this topic.

4.6 Conclusion

To examine the impact of specific urban designs on adolescent mental health, we scored and videotaped six different settings and conducted an online survey with 1,500 Canadian adolescents. Findings suggest that the PTOD quality of urban areas are significantly associated with emotional responses of adolescents, positively in the case of higher quality areas and negatively in poorer quality areas. Future study should look to conduct similar studies in real-world settings with objective measures to compare results, as well as further examine the role and impacts of imageability and complexity in natural urban areas.

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Chapter 5

Associations Between Adolescent Mental Health and Pedestrian- and Transit-Oriented Design Quality: Evidence From a National-Level Online Canadian Survey

With Dr. Leia Minaker

5.1 Abstract

Adolescence is a critical phase in an individual's development. Adolescents are especially susceptible to the impacts of external environment stimuli, yet relatively little research has sought to quantify how urban design exposures might affect their mental health. To explore the links between specific urban design features and adolescent mental health, we quantified the pedestrian- and transit-oriented design (PTOD) quality of six different urban areas using a validated tool, and presented videos of these areas to 1,500 Canadian adolescents via an online survey. Outcomes of interests were participants' emotional responses to each video (i.e., positive affect, negative affect, calmness, anxiousness, perceived restorativeness, and mental demand). Linear mixed models were run and then adjusted for a variety of sociodemographic and environmental controls. Even after adjusting for several theoretically relevant covariates, findings from the adjusted models show several significant associations between increases in the scores of the different PTOD concepts and the reported emotional responses of adolescents. Most significantly, the design concept *transparency* was associated with the greatest increases in positive affect, calmness, and perceived restorativeness. *Scale* was associated with significant increases in positive affect (β=0.656, 95% CI: 0.608, 0.704) and decreases in negative affect (β=-0.202, 95% CI: -0.239, -0.164), as was *complexity* with both positive affect (β=0.429, 95% CI: 0.396, 0.461), and negative affect (β=-0.148, 95% CI: -0.174, -0.123). To support adolescent mental well-being through design, urban designers should consider scale and complexity concepts in their design guidelines and building codes. Future research opportunities are also discussed.

Role in the Dissertation

Intended to complement the previous chapter's similar large-scale evaluation, the main objective of Chapter 5 is to provide a population-level assessment of the links between specific PTOD concepts (as they change in prominence between different sites) and adolescent emotional responses. As such, this chapter also intends to identify broad trends among adolescents pertaining to which specific PTOD designs may be the most effectual with respect to eliciting positive/negative adolescent emotional responses. Findings from this article are used in Chapter 7's triangulation to compare and contrast the more design-specific results from the other component manuscripts.

Keywords

adolescent health; mental health; pedestrian infrastructure; theory of affordances; urban design

5.2 Introduction

Rates of mental health disorders and psychological distress among adolescents (10-19 years) (World Health Organization, 2021) continue to rise worldwide (Bor et al., 2014; Collishaw, 2015). Currently, one in seven adolescents, globally, experience a mental disorder (World Health Organization, 2021). As global settlement patterns continue to shift from rural-to-urban living in the coming decades (United Nations, 2018), one factor of growing importance to adolescent mental health is their local environments, and especially urban environments. Urban environments impact adolescent mental health through phenomena such as place attachment and belonging, which support their mental wellbeing (Prince, 2014). Conversely, auto-centric designs increase noise pollution, resulting in inattention and sleeping problems in this age group (Tiesler, et al. 2013). Although research into urban environments and adolescent mental health has seen a recent uptick, it has been noted that there is a need for more precision in studying these relationships (Fleckney and Bentley, 2021). This study therefore examines a range of adolescent emotional responses in relation to five specific pedestrian-oriented planning design concepts.

5.2.1 Adolescent Mental Health and Urban Environments

Urban environments can have consequential effects on the mental well-being of adolescents. For instance, urban designs that facilitate opportunities for social interaction are particularly significant as social interaction and connectedness during adolescence can affect brain development (Lamblin et al., 2017). Designs such as accessible greenspaces (e.g., parks) that facilitate opportunities for social interactions (Kaźmierczak, 2013) and areas featuring destinations like recreation centres and libraries, which may aid in social competence progress (Christian et al., 2015) can therefore support positive development. Physical activity is a similarly important aspect of adolescent mental health (Hallal et al., 2006). Environmental designs such as narrow street width (Nasar, Holloman, and Abdulkarim, 2015), pedestrian crossovers (Rothman et al., 2014), higher-quality environmental aesthetics (e.g., more tree shading, air quality) (Sun et al., 2018), street connectivity (Giles-Corti et al., 2011), and sidewalk presence (Rothman et al., 2018) can promote opportunities for physical activity and improved mental well-being in this population.

Natural urban environments and features (e.g., green spaces and blue spaces) have likewise been examined in the context of this topic. Notably, engagement with urban greenspaces has been associated with reduced ADHD symptoms (Markevych et al., 2014) and can support cognitive

development (Dadvand et al., 2015). Higher levels of greenness in urban spaces have similarly been linked to reductions in internal and external behavioral issues (Madzia et al., 2019) and depressive symptoms (Mavoa et al., 2019), while bluespacess (e.g., ponds, rivers) may aid in emotional regulation (Djohari, Brown, and Stolk, 2018). While exploration into adolescent mental health and urban environments continues to delineate new pathways between the environment and mental health, recent review of the topic has revealed that uncertainties persist regarding space exposure concepts (e.g., the quality of spaces) (Vanaken and Danckaerts, 2018), as well as the precision of the relationships that have been examined to date (Buttazzoni, Doherty, and Minaker, 2022).

5.2.2 Pedestrian- and -Transit-Oriented Design

The application of the pedestrian- and transit-oriented design (PTOD) planning paradigm offers a worthwhile frame for classifying urban design features. PTOD reflects a planning paradigm that emphasizes the development of urban places that primarily support pedestrian activity and active lifestyles (Dittmar and Ohland, 2012; Renne, 2016). A list of notable PTOD concepts and their theorized benefits are outlined in Table 5.2.1 and include: imageability, enclosure, human scale, transparency, and complexity.

Table 5.2.1 Pedestrian- and Transit-Oriented Design Principles

	Concept(s) (e.g., features)	**Mental Health Phenomena**
PTOD Feature		
Imageability	Distinctiveness (e.g., courtyards, plazas, historic building frontage, outdoor dining) (Clemente et al. 2005)	‘sense of place’ (Cullen 1995; Gehl 1987)
Enclosure	Room-like quality (e.g., proportion of street walls, viewable proportion of sky) (Clemente et al. 2005)	‘hereness’ (Cullen 1995)
Human Scale	Detail, texture, physical elements (e.g., sight lines, average building height, # of small planters) (Clemente et al. 2005)	‘disorientation’, ‘comfort’ (Kay 1998)
Transparency	Perceived/viewable human activity (e.g., proportion of street walls, proportion of active uses) (Clemente et al. 2005)	‘awareness of surroundings’ (Arnold 1993)
Complexity	Visual richness (e.g., # of buildings, # of basic colours, # of pieces of public art) (Clemente et al. 2005)	‘boring’, ‘engaging’ (Nelessen 1994)

First, distinguishing features of a setting such as prominent architectural structures which can result in making a place particularly memorable are the essence of imageability (Gehl, 1987), a design concept thought to contribute to 'sense of place'(Ewing, 2013). Second, fostering a sense of 'hereness' or presence (i.e., identity with surroundings) (Cullen, 1995), enclosure is a design concept that reflects the vertical nature of a space and how certain elements (e.g., buildings, trees) define spaces with respect to how much they create a 'room-like quality' (Ewing, 2013). Third, the concept of human scale refers to another type of defining element, specifically to what degree the physical qualities of a space (e.g., size, texture) are oriented to pedestrians and walking speeds (Ewing, 2013). 'Higher-speed' designs which are scaled to accommodate vehicles (e.g., wider roads, higher speed limits), by contrast, can overwhelm and disorient people, whereas 'lower-speed' designs that are structured to support pedestrians (e.g., lower speed limits, wayfinding signs) may aid in comfort (Kay, 1998). Fourth, an area's transparency refers to the level of human activity that is observable beyond a street or other public space (Jacobs, 1993). Transparency has been previously linked to individuals' awareness of space (Arnold, 1993). Last, the visual richness of spaces as captured in the diversity (i.e., number, styles) of architecture, buildings, ornamentation, and landscape features, among other characteristics, reflects the design concept of complexity (Ewing, 2013), which may play an important role with respect to environmental engagement (Nelessen, 1994).

5.2.3 Research Justification and Questions

Research into the relationships between urban environments and adolescent mental health lacks precision regarding the nature of environmental exposure as seen, for example, in the lack of consistency regarding "greenspace" (Nordbø et al., 2018). Improved methodological precision has subsequently been suggested to better understand these relationships, as well as more clearly identify specific exposures (Buttazzoni et al., 2022; Madzia et al., 2019). Therefore, the overarching aim of this paper is to examine affordances comprised of five distinct design concepts (i.e., imageability, enclosure, scale, transparency, complexity) and theoretically relevant emotional responses among adolescents. The following research question guided this inquiry:

> What are the relationships between each of the five specific PTOD concepts (i.e., imageability, enclosure, scale, transparency, complexity) and adolescent mental health indicators (i.e., positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand)?

5.3 Methods

5.3.1 Sample

With the assistance of Léger (Montreal, PQ, Canada), a Canadian polling and market research firm, a representative sample (age, location, gender) of 1,500 Canadian adolescents was recruited to complete an online survey. Eligibility requirements stipulated participants needed to: 1) be between the ages of 9-17, and thus old enough to have some level of independent mobility but too young to have a full driver's license; 2) be able to read and answer a survey in either English or French; 3) be granted participation via parental/guardian consent; and 4) have internet access via a mobile device or computer. Full sample characteristics are presented in Table 5.3.1.

5.3.2 Survey Protocol

A single-blind (i.e., participants unaware of research question) online survey design was used for this study. The online survey was originally developed by the authors using Qualtrics, and then sent to the University of Waterloo Survey Research Centre for quality control checks and ongoing administration (e.g., consultations, daily monitoring of quotas and completion rates). After the development phases were complete, the survey was transferred to Léger for translation, distribution, and data collection. Participants were able to complete the survey on either a mobile device (e.g., phone, tablet) or computer. Development of the survey began with the research team selecting a cross-section of locations based on allowing for the survey to compare a variety of PTOD scores across different types (e.g., natural, urban, suburban) and quality (i.e., poor vs. high scores) of settings. Ultimately the six selected locations included: two natural urban areas, two built suburban areas scoring lower in PTOD quality, and two built urban examples scoring higher in PTOD quality (see Table 5.3.2). Panoramic videos of and on-site scoring for each location was then carried out. Location scores were derived from a validated tool (Clemente et al., 2005), and featured a range from roughly 1-7 wherein higher scores reflected greater prominence of a PTOD concept. Our scoring of locations were similar to other studies examining neighbourhood walkability (Hooi & Pojani, 2020) suggesting good tool reliability and true variability in urban design concepts. Locations filmed and evaluated in this study were a mix of places in Kitchener and Toronto, Ontario and included a multi-modal urban trail, urban bluespace (i.e., local lake area), suburban mall, suburban residential street, urban pedestrian plaza, and urban market area (see photos in Appendix 7.10.4).

Table 5.3.1 Sample Demographics (n=1,500)

Characteristic	Sample Size	Weighted %
Age		
9	101	6.7
10	176	11.8
11	170	11.3
12	174	11.6
13	207	13.8
14	170	11.3
15	187	12.5
16	161	10.7
17	154	10.3
Ethnicity		
Indigenous	47	3.1
Black	46	3.1
East/SE Asian	131	8.7
Latin American/Hispanic	24	1.6
South Asian	99	6.6
West Asian/Arab	21	1.4
White	1021	68.1
Mixed	107	7.1
No Answer	4	0.3
Gender		
Boy	771	51.4
Girl	716	47.7
Transgender/Non-Binary	13	0.9
Geographic Location		
Atlantic (NB, NL, NS, PEI)	93	6.2
Quebec	326	21.7
Ontario	592	39.5
Western (AB, BC, MB, SK)	489	32.6
Birth Order		
Oldest/Only Child	862	57.5
Younger/Youngest Child	638	42.5
Urbanicity		
Rural Area	200	13.3
Small City or Town	357	23.8
Suburb of Large City	484	32.3
Large City	459	30.6
Parental Supervision		
One Parent/Guardian or Less	306	20.4
Two or More Parents/Guardians	1184	79.6
	Mean	**Std. Dev.**
Subjective Mental Health (range 1-5)	3.72	0.969
Subjective Social Status (range 1-10)	6.34	1.669

Abbreviations: AB = Alberta, BC = British Columbia, MB = Manitoba, NB = New Brunswick, NL = Newfoundland and Labrador, NS = Nova Scotia, PEI = Prince Edward Island, SK = Saskatchewan

Parents of prospective participants on Léger's research panels were contacted by the firm and first asked to provide consent for their child to participate in the study. Adolescents were subsequently prompted to provide their assent before starting the survey. Participants proceeded through the repeated measures survey (20 minutes on average to complete) by watching short 10-15 second panoramic videos (with sound, re-watch available) of the six different settings and then answering questions regarding their emotional responses in each of the six domains. The survey featured designs to address different forms of bias. Notably, the survey randomized the presentation order of the settings and videos across participants to guard against order bias, as well as guaranteeing anonymity and not informing participants of the research question of study nor the locations of the videos to minimize potential sources of response bias. This study was approved by the University of Waterloo Office of Research Ethics (study #43603).

Table 5.3.2 PTOD Concept Feature Scores in the Six Urban Settings Videos

Design Feature	Imageability	Enclosure	Scale	Transparency	Complexity
Urban Setting					
Multi-modal trail	2.42	3.32	3.88	2.29	4.71
Community bluespace	5.54	1.66	3.70	2.24	5.93
Suburban residential area	3.07	1.41	3.14	2.19	4.91
Suburban mall	2.78	1.03	2.69	2.18	3.86
Urban market	5.18	1.44	4.48	2.55	6.70
Urban pedestrian plaza	6.88	3.30	4.68	3.03	6.61

*__Notes__: The higher the score, the more prominent the particular design feature | Tool available at: https://activelivingresearch.org/sites/activelivingresearch.org/files/FieldManual_071605.pdf

5.3.3 Independent Variable

Scale variables of the five specific PTOD concepts (imageability, enclosure, scale, transparency, complexity) were created using the scores recorded in Table 5.3.2 and represented the predictor variables in our analyses.

5.3.4 Dependent Variable

Adolescents self-reported six emotional response outcomes of interest: positive affect, negative affect, calmness, anxiousness, perceived restorativeness, and mental demand/fatigue. Importantly, to not exhaust participants or negatively impact their completion of the survey, the survey instruments underwent cognitive interviews and pilot testing with three adolescents between

the ages of 11 and 15 resulting in the number of items for each outcome variable scale were reduced from their original scales. To assess positive and negative affect we used the Positive and Negative Affect Schedule for Children (PANAS-C) (Ebesutani et al., 2012). The five-point PANAS-C scales (1-very slightly or not at all … 5-extremely) were adapted to present two positive affect items (e.g., 'joyful') and three negative affect items (e.g., 'sad'). Calmness and anxiousness were measured using the five-point Profile of Mood States (POMS) (1-not at all … 5-extremely) (Grove & Prapavessis, 1992) 'tension' subscale (e.g., 'nervous') as well as an adapted 'calmness' (e.g., 'peaceful') subscale that both featured two items each. Perceived restorativeness and mental demand were measured using the Perceived Restorativeness Scale (PRS) 'being away' subscale and the 'coherence' subscale (Hartig et al., 1997), respectively. Both measures were five-point scales (1-not at all … 5-extremely) and contained three items each related to restorativeness (e.g., 'it is a place to get away from it all') and mental demand/fatigue (e.g., 'there is too much going on'). Outcome measure scores were aggregated to develop final score ranges between 2-10 for positive affect, calmness, and anxiousness, or 3-15 for negative affect, restorativeness, and mental demand for the final analysis.

5.3.5 Covariates

Documented mental health outcome differences across sociodemographic factors required the collection of age (9-17 years old) and gender (boy, girl, non-binary) (Connolly et al., 2016; Patel et al., 2007), as well as ethnic identity (Aboriginal/Indigenous, Black, East/Southeast Asian, Latin America/Hispanic, South Asian, West Asian/Arab, White, Mixed, Other) (Fox et al., 2020) data. Subjective mental health assessments (i.e., 1-Poor … 5-Excellent) were gathered via a single-item measure from the Canadian Community Health Survey (Government of Canada, 2015). Subjective social status (SSS) (Amir et al., 2019) information was collected to control for socioeconomic status. The SSS variable is based on the MacArthur Scale of SSS, a validated cross-culture measure (Goodman et al., 2001), presents an illustration of a metaphorical ladder, and asks participants to compare their family's money, education, and jobs to, in this case, Canadian society through ranking their standing on the ladder between 1-10 (1-least/worst … 10-most/best) for each of the three categories. Scores for the three SSS categories were subsequently aggregated in the analysis. To account for parental controls which can impact an adolescent's environmental interactions (Alparone & Pacilli, 2012; Foster et al., 2014), participants were also asked to provide information about their parental supervision (one parent/guardian, two or more parents/guardians) situation. Noting associations between birth order and individual social attitudes (Salmon, 2003) and social behaviors

(Courtiol et al., 2009) we also controlled for birth order (oldest/only child, younger sibling) in the analysis. Environmental-level covariates included location data that were collected as a part of the sample weights (Maritimes (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick), Quebec, Ontario, and Western Canada (Manitoba, Saskatchewan, Alberta, British Columbia)), and urbanicity information which was gathered using an adapted version of a PEW Research Center measure (Miller et al., 2012) and asked "What type of community do you live in" (rural area, small city or town, suburb near a large city, large city). We also controlled for setting type (built, natural) to account for the potential differences between the four included built settings and two natural settings.

5.3.6 Analysis

To examine the association between the five specific PTOD concepts and the six mental health indicators of interest, a series of linear mixed models (LMMs) were run using the Mixed Models function in SPSS Statistics Version 25 (IBM Canada Ltd., Markham, Ontario, Canada). LMMs are an extension of linear regression and are appropriate when analyzing data that are clustered or nested and can therefore not be assumed to be independent. Each level of clustering can introduce additional variation and correlation and may thus cause the standard errors to be underestimated if not accounted for in the analysis, increasing the probability of Type 1 error (false-positive). LMMs address this by allowing both fixed and random effects to be included in the model, consequently affording the ability to account for repeated measures on the same individual which are not independent. In our analyses, fixed effects, which are assumed to remain constant across clusters, were specified as the covariates in the LMMs, while the random effects, assumed to vary in effect on the outcome across clusters, were specified as unique participant IDs. A total 30 LMMs were run: one for each combination of the five PTOD concept scales and six mental health outcomes. Unadjusted models and models adjusted for the listed covariates above were run.

5.4 Results

Table 5.4.1 presents the results of both the unadjusted and adjusted LMMs for each of the five PTOD concepts across the six emotional response outcomes. After adjusting for individual, family, and environmental covariates, the LMM analyses outline several significant associations between the specific PTOD concepts and adolescent responses. Considering the relationships between each of the PTOD concepts and the positive mental health outcomes, across settings, increases in

transparency were significantly associated with the greatest improvements in reported positive affect (β=1.442, 95% CI: 1.332, 1.562), calmness (β=0.540, 95% CI: 0.410, 0.669), and perceived restorativeness (β=1.976, 95% CI: 1.792, 2.159). Scale had the second highest magnitude of effect among the PTOD concepts as increases in the prominence of the design in the different settings was significantly associated with increased positive affect (β=0.656, 95% CI: 0.608, 0.704), calmness (β=0.277, 95% CI: 0.224, 0.329), and perceived restorativeness (β=0.790, 95% CI: 0.715, .864). Complexity was also positively and significantly associated with positive affect (β=0.429, 95% CI: 0.396, 0.461), calmness (β=0.229, 95% CI: 0.193, 0.263), and perceived restorativeness (β=0.511, 95% CI: 0.461, 0.561). Coefficients of the adjusted imageability and enclosure models were comparatively smaller with respect to the positive emotional responses.

When examining the relationships between the PTOD concepts and the negative mental health indicators, transparency had the largest effect size, and was significantly negatively associated with negative affect (β=-0.384, 95% CI: -0.477, -0.290) and anxiousness (β=-0.107, 95% CI: -0.189, -0.025). Conversely, transparency was also significantly positively associated with mental demand (β=1.400, 95% CI: 1.233, 1.566). Scale and complexity also had relatively large effect sizes, and were both significantly negatively associated with anxiousness (β=-0.071 for both), and negative affect (scale: β=-0.202, 95% CI: -0.239, -0.164; complexity: β=-0.148, 95% CI: -0.174, -0.123). Increases in all five of the PTOD design features were significantly and positively associated with mental demand. Imageability and enclosure were associated with similar significant coefficients across the three negative emotional response outcomes, although they were smaller coefficients relative to the other design concepts.

Table 5.4.1 Unadjusted and Adjusted Linear Mixed Models of Specific PTOD Concepts and Adolescent Mental Health Outcomes

	Positive Affect				Negative Affect				Calmness			
	β	**95% CI**		**P**	**β**	**95% CI**		**P**	**β**	**95% CI**		**P**
Imageability												
Unadjusted	.153	0.129	0.177	**<.000**	-.058	-0.075	-0.042	**<.000**	.021	-0.007	0.048	.137
*Adjusted	.226	0.205	0.247	**<.000**	-.077	-0.093	-0.061	**<.000**	.120	0.098	0.143	**<.000**
Enclosure												
Unadjusted	.608	0.568	0.648	**<.000**	-.146	-0.175	-0.117	**<.000**	.570	0.523	0.617	**<.000**
*Adjusted	.349	0.309	0.389	**<.000**	-.080	-0.111	-0.049	**<.000**	.156	0.114	0.199	**<.000**
Scale												
Unadjusted	.488	0.434	0.543	**<.000**	-.159	-0.197	-0.121	**<.000**	.050	-0.014	0.113	.125
*Adjusted	.656	0.608	0.704	**<.000**	-.202	-0.239	-0.164	**<.000**	.277	0.224	0.329	**<.000**
Transparency												
Unadjusted	.359	0.229	0.490	**<.000**	-.110	-0.199	-0.021	**.016**	-.826	-0.973	-0.678	**<.000**
*Adjusted	1.442	1.322	1.562	**<.000**	-.384	-0.477	-0.290	**<.000**	.540	0.410	0.669	**<.000**
Complexity												
Unadjusted	.356	0.319	0.393	**<.000**	-.130	-0.156	-0.104	**<.000**	.128	0.085	0.171	**<.000**
*Adjusted	.429	0.396	0.461	**<.000**	-.148	-0.174	-0.123	**<.000**	.228	0.193	0.263	**<.000**

Notes: *Adjusted for: age, gender, ethnicity, urbanicity, birth order, parental supervision, subjective mental health, subjective social status, location, and setting type (built (Suburban Mall, Suburban Street, Urban Market, Urban Plaza) vs. natural (Trail and Bluespace)).

	Anxiousness				Perceived Restorativeness				Mental Demand			
	β	**95% CI**		**P**	**β**	**95% CI**		**P**	**β**	**95% CI**		**P**
Imageability												
Unadjusted	-.013	-0.028	0.001	.069	.149	0.107	0.191	**<.000**	.272	0.241	0.303	**<.000**
*Adjusted	-.035	-0.050	-0.021	**<.000**	.324	0.292	0.356	**<.000**	.196	0.167	0.225	**<.000**
Enclosure												
Unadjusted	-.125	-0.151	-0.099	**<.000**	1.162	1.092	1.232	**<.000**	-.185	-0.242	-0.128	**<.000**
*Adjusted	-.035	-0.062	-0.009	**.010**	.479	0.418	0.539	**<.000**	.194	0.139	0.250	**<.000**
Scale												
Unadjusted	-.022	-0.056	0.012	.209	.393	0.296	0.491	**<.000**	.680	0.607	0.753	**<.000**
*Adjusted	-.071	-0.104	-0.038	**<.000**	.790	0.715	0.864	**<.000**	.508	0.440	0.576	**<.000**
Transparency												
Unadjusted	.188	0.109	0.267	**<.000**	-.497	-0.726	-0.268	**<.000**	2.300	2.133	2.465	**<.000**
*Adjusted	-.107	-0.189	-0.025	**.010**	1.976	1.792	2.159	**<.000**	1.400	1.233	1.566	**<.000**
Complexity												
Unadjusted	-.049	-0.072	-0.026	**<.000**	.338	0.271	0.404	**<.000**	.322	0.272	0.372	**<.000**
*Adjusted	-.071	-0.093	-0.048	**<.000**	.511	0.461	0.561	**<.000**	.244	0.198	0.290	**<.000**

Notes: *Adjusted for: age, gender, ethnicity, urbanicity, birth order, parental supervision, subjective mental health, subjective social status, location, and setting type (built (Suburban Mall, Suburban Street, Urban Market, Urban Plaza) vs. natural (Trail and Bluespace)).

5.5 Discussion

The quality of urban environments is increasingly being understood as an important determinant of adolescent mental health (Kaźmierczak, 2013; Lamblin et al., 2017). To further explore these relationships, we explored the impacts of five specific PTOD characteristics on the self-reported mental health indicators of adolescents based on their emotional responses to videos of six distinct urban settings scored for their presence of these PTOD concepts. Overall, this study suggests that each of the five specific PTOD concepts evaluated are associated with enhanced positive emotional responses and mitigated negative emotional responses (with the exception of mental demand) among adolescents. To further contextualize these findings, the following discussion is positioned within the frame of the Theory of Affordances as outlined earlier.

Taken together with related work showing pedestrian infrastructure features such as street connectivity (Giles-Corti et al., 2011) and sidewalk presence (Rothman et al., 2018) are linked to physical activity opportunities, our results suggest that the five PTOD features examined in this study may have potential to improve adolescent experiences or reports of positive affect and mitigate those of negative affect. Within our theoretical frame, these trends may indicate that PTOD concepts could support positive affect by minimizing potential environmental causes of emotional distress (e.g., poor aesthetics, poor navigability). Moreover, the combined influence of PTOD concepts may be particularly powerful in this way because adolescents are still growing and external environments are known to influence brain development (Dahl, 2004). Our findings could therefore possibly reflect that PTOD concepts capture a series of salutary external environment stimuli that reduce adolescents' susceptibility to known negative environmental elements present in many modern urban areas (e.g., ambient air or noise pollution).

It is also important to note that this relatively stronger association with positive and negative affect responses, compared to restorativeness or mental fatigue responses, could be partially the result of the PTOD paradigm being more active travel-oriented relative to other design paradigms. PTOD features, as a general planning approach, are aimed at urban design changes that influence active travel choices, and specifically ways to enhance the walkability of an area (Clemente et al., 2005). We selected PTOD concepts, in part, because of its focus on quantifying specific and fairly ubiquitous built environment exposures; however, other paradigms such as green infrastructure (GI) offer other important designs worth exploring on this topic. In fact, the ideas and designs that comprise GI, although variously defined, tend to outline a variety of concepts ranging from the implementation of green corridors to reservoir development for storm surge control to planning local

networks of environmental resources (e.g., woodlands) (Mell, 2008). The presence of these GI concepts in an urban area would appear to have much more likely theoretical links to supporting calmness and/or perceived restorativeness. In fact, some of these GI projects like stormwater and flood management initiatives have already been noted to reduce property damage and thereby potentially contribute to improved mental health (Nieuwenhuijsen, 2021), while other initiatives such as greening schoolyard interventions have shown the potential to create restorative public spaces for adolescents (Kelz et al., 2015). With a variety of distinct urban and architectural design paradigms which contain their own specific concepts, future research comparatively exploring the potential of pedestrian-oriented designs, GI, and/or different distinct architectural design styles across common outcomes could serve to illuminate their functionality of their respective concepts with respect to the mental well-being of adolescents.

Of the five specific designs examined in this study, it appears that the concepts most consistent and strongly associated with mental health indicators were scale, complexity, and transparency. Importantly, among adolescents, our results support the previously theorized links between scale, comfort (Kay, 1998), and transparency (Arnold 1993). Applying our theoretical frame, scale may be such a notable design for adolescents for several reasons. First, examples of the concept such as narrower streets, area/street furniture (e.g., pedestrian-scale streetlights), sidewalk barriers, pedestrian signage, and small plants/planters could be perceived by adolescents as helping to create safer environments, especially ones that mitigate feelings of being overwhelmed (e.g., from poor area navigability). Second, scale and transparency may be highly associated with the responses evaluated here because of each design's implications for social interaction opportunities or the promotion of social connectedness—both of which have been noted as important factors in adolescent development (Lamblin et al., 2017). From this second perspective, our findings might indicate that adolescents perceive spaces with higher levels of scale (in this study: bluespace, urban plaza, urban market areas) or transparency (market, pedestrian plaza, trail) in their design as providing more opportunities for social interaction or lingering due to their street/area furniture (e.g., chairs, benches), improving accessibility (e.g., lights, bike racks), opportunities to actively engage with a place (e.g., nearby shops), or improving their spatial awareness or situatedness (enhanced sightlines regarding accessory pedestrian infrastructure). Future qualitative study exploring the specifics of adolescents' perspectives regarding areas with varying levels of scale design quality, as well as their most important features, is needed to further clarify these relationships.

Complexity featured similar effect sizes as scale with respect to its general associations with the adolescent emotional responses recorded in this study. The general direction and strength of outcomes, with the exception of mental demand, associated with complexity lend support to the notion of complexity as an engaging design concept (Nelessen, 1994). Theoretically, these findings could indicate that visually rich environmental designs like those with a diversity of building and accent colours, building forms, and/or ornamentation (in this study: the two urban settings), may support fascination or emotional engagement with spaces among this cohort. Such an interpretation would accord with current notions of how patterned complexity (i.e., patterns coupled with creativity in design) can stimulate affective experiences (Goldhagen, 2017). A corollary of this would be that design complexity could therefore affect adolescents' embodied cognition as visually rich urban areas might facilitate more powerful instances of 'situated experiences'—i.e., responses to events or episodes, visually perceived situations (Varela et al., 1991)—due to their physical intricacies and variegation. We encourage further study into the exploration of specific forms of urban design complexity (e.g., architectural or ornamentation styles, contrast, synthetic vs. natural shapes) and their potential links to different emotional responses in younger populations.

One other note about the findings of this study also bears mentioning. First, no one specific PTOD concept was significantly associated with a reduction in mental demand; instead, increases in all designs were linked to reports of increased mental demand in the adjusted models. In the unadjusted models, however, enclosure was significantly associated with modest decreases in mental demand. Having discussed the differences between PTOD concepts and those of GI earlier, as well as having controlled for setting type in the adjusted models, we speculate that higher levels of natural forms of enclosure (e.g., tall trees in the trail setting) may have been more decisive in this context than forms of highly scored built enclosure (i.e., tall buildings in the urban plaza setting). Future research here should investigate the nature of the stimulation provided by natural and built forms of enclosure to assess their potentially different emotional qualia (e.g., calmness, perceived restorativeness) and determine if they comprise different affective (emotional) stimuli for adolescents.

5.5.1 Implications for Practitioners

Practical implications of this research are perhaps the clearest for planners and urban designers. Results of this study suggest that the design concepts of transparency, human scale and complexity may be particularly important for adolescent mental well-being, particularly experiences

of positive affect. Transparency features have been argued to allow for planning practitioners to 'design in' engaging spaces which can consequently have important mental health impacts. For example, active use spaces or features (e.g., streetscape with shops, cafes, windows at street level) may help to integrate different movement networks, afford individuals opportunities to linger or engage in informal activities in a space, or to relax with the provided amenities (Carmona, 2019). The implementation of many examples of human scale concepts, meanwhile, have already begun to be associated with larger and similar notions of pro-social place designs in community reports. For instance, our results would support the promotion of practices such as designing walkable environments (e.g., parks/greenspaces, streets, common spaces), which have been discussed for future interventions in jurisdictions such as New Zealand to improve mental health and social cohesion (e.g., Wild et al., 2021). Concerning complexity in urban design, our findings add to related work that has likewise noted similar considerations such as the number of visual layers and aesthetic quality of a scene being important to perceived view quality (Matusiak & Klöckner, 2016), and the concept of fascination as central to place attractiveness (Galindo & Hidalgo, 2005). Consequently, we recommend that urban designers interested in developing more aesthetically preferable or visually desirable public spaces for adolescents consider their projects with respect to the complexity of its designs.

Public health practitioners may also find value in this study by using these findings to develop new public mental health promotion and education strategies. Psychopathologies often reflect aberrant behaviours, cognitions, or emotions. While those with a healthy state of mind generally tend to respond well to positive aspects of an environment and remain resilient to negative experiences, the presence of a mental illness tends to reduce such capacities (Bridley & Daffin Jr., 2020). As one of the most common psychopathologies among adolescents is anxiety disorders (Costello et al., 2011), our results could be used to inform public mental health efforts that seek to highlight specific positive environmental exposures—in this study, designs that are more visually rich, pedestrian scale, enclosed—for those with a diagnosed condition. More broadly, when partnered with extant research illustrating the links between excess noise pollution and increased sleeping issues (Tiesler et al., 2013), and poor spatial distribution of infrastructure (e.g., poor pedestrian route directness) and possible heightened risks of depressive symptoms (Duncan et al., 2013), results of this study can bolster public mental health efforts that seek to highlight how adolescents may accrue mental health benefits from pedestrian-oriented rather than auto-oriented environments.

5.5.2 Limitations

There are a few limitations to this study. Foremost, having to reduce the number of items on each scale used in this study in order to make our survey more accessible to a younger sample resulted in outcome variables with considerably reduced ranges. This decision may have contributed to the relatively smaller than would otherwise be expected coefficients observed in the results of the study. Similarly, the method of delivering spatial exposures via an online video necessitated a situation where participants weren't subject to, or could not account for in their response, any kinesthetic (i.e., bodily senses: limb position, forces in reference to space) or vestibular (i.e., balance and movement in reference to space) inputs that they may experience in a real-world setting. This development may have also contributed to less variance in the observed results. Time constraints (i.e., only 20-minutes online) associated with the delivery of this online survey also precipitated some limitations, notably a lack of some desired control variables (e.g., general levels of active travel/physical activity) which could have affected the results of this analysis. Last, the use of an online survey may have also precluded adolescents who lack a stable internet connection from participating thereby excluding this group from the results. However, having noted these limitations, this study was exploratory. Moreover, the relatively large sample was representative of the population by region, age, and sex, which was a major strength of the current study.

5.6 Conclusion

Using an online survey with videos of six different urban settings quantitatively scored for their PTOD quality and subsequently controlling for a number of individual, family, and environmental covariates, the findings of study delineate significant relationships between increases in specific design concept scores and emotional responses among adolescents. Transparency, scale and complexity design concepts were most strongly associated with the six evaluated emotional responses, while positive and negative affect saw the most notable changes in response to the five evaluated PTOD concepts. Based on the findings of this study, it is recommended that future scholarship explore specific examples of transparency and complexity in design, as well as different levels of human scale in design and their attendant impacts on adolescent mental health, and the potentially different effects induced by built versus natural forms of enclosure.

5.7 References

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Chapter 6

Investigating the In-Situ Emotional Responses of Adolescents Toward Pedestrian- and Transit-Oriented Designs and Cognitive Architecture for Adolescents: An Ecological Momentary Assessment Study

With Dr. Leia Minaker

6.1 Abstract

Despite demographic and health trends observing a rise in both urban populations and adolescent mental illness, respectively, there is presently a dearth of research exploring the relationship between urban environments and adolescent mental health topics. Given that, more pointedly, the study of links between specific urban designs and adolescent mental is particularly absent, this study uses ecological momentary assessment survey methods to explore the in-situ associations between pedestrian- and transit-oriented designs ((PTOD) imageability, enclosure, scale, transparency, complexity), as well as cognitive architecture ((CA) biophilic architecture, symmetries, fractals) concepts, and adolescent mental health indicators (i.e., emotional responses) with a sample of 70 participants. Both unadjusted and adjusted linear mixed models (LMMs) were run for the analyses. After controlling multiple sociodemographic covariates, the adjusted LMMs showed several significant associations. Notably, high levels of natural forms of complexity, imageability, and enclosure appeared to support the healthiest emotional responses; mixed built and natural spaces (i.e., multimodal trail) high in scale and complexity seem to have the potential to support positive experiences among adolescents; and biophilic architecture appears to be the most effectual design ornamentation concept. One of the main implications of this research is that planners may want to consider implementing natural forms of enclosure (e.g., tall trees, ivy walls), imageability (e.g., nature-oriented landmarks), and/or complexity (e.g., variety of natural features such as gardens, shrubs) in or around spaces frequented by adolescents (e.g., schoolyards, recreations areas).

Role in the Dissertation

Chapter 6 complements the research of the three preceding chapters in different ways. With respect to the qualitative investigation of Chapter 3, as these two manuscripts explore the same real-world examples, Chapter 6 presents a direct comparison and quantification of the described PTOD- and CA-emotional response relationships investigated in the earlier qualitative chapter. Concerning the online survey manuscripts of Chapters 4 and 5 which present quantitative analyses of greater breadth (i.e., broad population trends), Chapter 6 offers a similar quantitative analysis but with more depth (i.e., in-situ ecological evaluation accounting for situated environmental factors). Findings from this chapter are also used in the cross-study triangulation and synthesis of Chapter 7.

Keywords

adolescent health; ecological momentary assessment; mental health; pedestrian infrastructure

6.2 Introduction

Urban environments can have both salutary (Gascon et al., 2015) and deleterious (Gruebner et al., 2017) impacts on the mental health of adolescents (ages 10-19). With global migration patterns suggesting urban-dwelling populations will continue to grow in the coming decades (United Nations, 2018), urban environments are likely be an increasingly important determinant of adolescent mental health. Working toward a better understanding of the role(s) of urban design in adolescent mental health is further bolstered by recent decrees from international institutions like the World Health Organization, which have called the prevention and treatment of adolescent mental health disorders one of the major current global public health priorities (World Health Organization, 2021). Despite these developments, the relationships between urban environments and adolescent mental health are not particularly well understood, and more work is needed to delineate more precise pathways by which such environments may affect the mental health of adolescents (Buttazzoni, Doherty, et al., 2022). Studying specific built design concepts such as imageability, human scale, and complexity as well as others outlined in pedestrian- and transit-oriented design (PTOD) (Ewing, 2013), in addition to biophilic designs (i.e., nature-like designs in built form) and other cognitive architecture (CA) concepts (Goldhagen, 2017), represents such an opportunity to investigate precise urban design elements and exposures, which may impact adolescent mental health. With the earlier survey manuscripts of this dissertation representing perhaps the first assessments of the links between specific designs and adolescent emotional responses there are several opportunities for work on this topic to contribute novel findings, including the undertaking of more ecologically valid research that accounts for situated environmental factors that may impact these associations (e.g., vestibular (spatial orientation) and kinesthetic (sensory body and movement) inputs). Consequently, the aim of the present paper is to explore the potential *in-situ* (i.e., real-world situated experience) associations between PTOD and CA concepts and adolescent mental health indicators (i.e., emotional responses).

6.2.1 Adolescent Mental Health and Urban Environments

The everyday environments that people inhabit and interact with influences how they feel and behave (Ellard, 2015). Urban environments comprised of a variety of built, natural, and mixed forms can have a myriad of implications for adolescent mental health. In this regard, designs which afford physical activity or restorative experiences are especially noteworthy. For example, regarding activity, the presence of playgrounds (Pagels et al., 2014) and public greenspaces (Zhang et al., 2011),

area walkability, mixed land use (Liu et al., 2007), and street connectivity (Rothman et al., 2014) can affect exercise and thus impact adolescent mental health. Restorative experiences, meanwhile, afforded by more natural urban settings, can also be quite effectual. Bluespaces (e.g., lakes, rivers) can enhance emotion and distress management (Djohari et al., 2018), provide opportunities for increased social interaction (Ashbullby et al., 2013), and support feelings of relaxation (Roe & Aspinall, 2012). Green spaces (e.g., parks, gardens) likewise may reduce stress (Feda et al., 2015), depressive symptoms (Mavoa et al., 2019), and internal and external behavioural issues (e.g., conduct problems, anxiety) (Madzia et al., 2019), as well as improve emotional well-being (van Lier et al., 2017). Conversely, though, auto-oriented urban designs have been linked to several deleterious mental health impacts among adolescents. Environments that prioritize vehicular transportation can produce high levels of traffic noise, resulting in increased annoyance (Babisch et al., 2012) and sleeping problems (Tiesler et al., 2013), not to mention contribute to increases in noxious air pollutants (e.g., nitrogen oxides) which have been linked to an increase in the risk of general psychopathology (Reuben et al., 2021). Left unencumbered, such environmental designs and the resulting excessive pollution can diminish social cohesion and the restorative quality of spaces, increase adolescent mental health issues (Dzhambov et al., 2018) and symptoms of depression and anxiety (Stansfeld et al., 2000), and potentially impair cognitive function (Haines et al., 2001). Although several links between various environments and adolescent mental health phenomena have been documented, there is still a lack of scholarship examining associations between precise urban design concepts and adolescent mental health outcomes (Buttazzoni, Doherty, et al., 2022).

6.2.2 Pedestrian- and Transit-Oriented Design, Cognitive Architecture

Two sets of relevant designs that may potentially illustrate different specific pathways through which built forms impact adolescent mental health are PTOD and CA concepts. PTODs comprise a set of built form concepts that center on reducing automobile use and promoting active lifestyles through supporting the development of engaging and accessible pedestrian infrastructure and spaces. Most commonly PTODs have been advocated to address a variety of modern urban development topics (Dittmar & Ohland, 2012; Renne, 2016), and have been argued to aid in improving pedestrian wayfinding, comfort, and safety (Ewing, 2013; Ewing & Handy, 2009). In this regard, to date, PTODs have been examined in relation to a number of urban physical health phenomena such as area walkability (Ewing & Handy, 2009), cycling opportunities (Forsyth & Krizek, 2011), and pedestrian place accessibility (Vale, 2015). While a number of social phenomena

have been studied in reference to the different designs promulgated within the PTOD realm, five particular PTODs will be examined in the present paper with respect to their potential links to adolescent mental health indicators (see Table 6.2.1).

First, *imageability*, or any features (e.g., life of the space, architectural quality) of a space that contribute to leaving an enduring impression on an individual (Gehl, 1987). Previously imageability has been thought to contribute to one's 'sense of place'(Ewing, 2013). Second, *enclosure*, is the degree to which the attendant vertical elements (e.g., buildings, trees) visually define a space and build a 'room-like quality' (Ewing, 2013). Enclosure has often been connected to creating a sense of hereness (i.e., identity with surroundings) (Cullen, 1995). Third, *human scale*, refers to the physical qualities that delineate a space (e.g., size, texture) and reflects its scale in reference to human walking speed (Ewing, 2013). For example, places which are auto-oriented in scale will include features such as higher speed limits for vehicles, wider roads, and less street furniture (e.g., benches, planters, street trees) for pedestrians. Subsequently this level of scale is thought to potentially overwhelm and disorient pedestrians. Places that reflect 'lower-speed' scales, however, will tend to contain safety signs, narrower streets, and more street furniture and are contended to support pedestrian usage and comfort (Kay, 1998). Fourth, *transparency* reflects how much human activity can be observed beyond the street of a given area via windows in buildings and the area's proportion of active uses (i.e., uses which generate significant pedestrian traffic; e.g., public parks, shops) (Jacobs, 1993). Transparency as a design has been suggested to enhance one's awareness within a space or of its surroundings (Arnold, 1993). Finally, *complexity* refers to the visual richness of space, specifically considering the diversity (i.e., number, styles) of architecture, buildings, ornamentation, landscape features, street furniture, signage, and human activity (Ewing, 2013). Places higher in complexity have been argued to be more environmentally engaging and aesthetically pleasing for people (Nelessen, 1994).

Table 6.2.1 Pedestrian- and Transit-Oriented Designs and Cognitive Architecture Principles

	Concept(s) (e.g., features)	Mental Health Phenomena
PTOD Features		
Imageability	Distinctiveness (e.g., courtyards, plazas, historic building frontage, outdoor dining) (Clemente et al., 2005)	'sense of place' (Cullen, 1995; Gehl, 1987)
Enclosure	Room-like quality (e.g., proportion of street walls, viewable proportion of sky) (Clemente et al., 2005)	'hereness' (Cullen, 1995)
Human Scale	Detail, texture, physical elements (e.g., sight lines, average building height, # of small planters) (Clemente et al., 2005)	'disorientation', 'comfort' (Kay, 1998)
Transparency	Perceived/viewable human activity (e.g., proportion of street walls, proportion of active uses) (Clemente et al., 2005)	'awareness of surroundings' (Arnold, 1993)
Complexity	Visual richness (e.g., # of buildings, # of basic colours, # of pieces of public art) (Clemente et al., 2005)	'boring', 'engaging' (Nelessen, 1994)
CA Principles		
Biophilia	Privileging of natural environment features in designs (Ryan et al., 2014)	'healing' (Salingaros, 2013) 'positive affect' (Söderlund & Newman, 2015)
Symmetries	Bilateral symmetry of façades (Goldhagen, 2017)	'disconnection', 'connection' (Salingaros, 2014)
Fractal Patterns	Division patterns of borders, frames, moldings, and ornament (i.e., compositional form of repeating patterns) (Joye, 2007)	'relaxed' (Joye, 2007) ' 'restorative' (Hagerhall et al., 2008), 'stress' (Taylor, 2006)

The second set of designs, CA concepts, have attracted significant attention due to the confluence of research pursuits from psychology, architecture, and neuroscience, among other areas, interested in examining the psychological dimensions of distinct built designs and ornamentations (e.g., Goldhagen, 2017; Weinberger et al., 2021). With respect to the present study, there are three particular examples of CA concepts that will be investigated: biophilic architecture, symmetries, and fractals patterns. Owing to the innate and evolutionary connection with nature that humans possess, *biophilic architecture* is the incorporation of nature in urban design (Söderlund & Newman, 2015). Biophilic architecture itself is an umbrella term that covers different concepts; however, it can take specific forms such as green façades which have been associated with mood improvements (Tyrväinen et al., 2014) or green roofs which have been suggested to support restoration (Matsunaga et al., 2011). *Symmetries* in architecture, meanwhile, are repeated designs that are either

translationally (i.e., repeated units along a line), rotationally (i.e., units repeated after rotation by an angle), or reflectionally (i.e., mirror images) symmetric (Salingaros, 2014). Like biophilic architecture, symmetries can also take several forms in external architecture, and have been proposed to have important implications for human emotions—objects lacking symmetricity are likely to be perceived as random, disordered, and potentially cause alarm (Salingaros, 2014). Third are *fractal patterns*, a concept that derives from the mathematical concept of fractal geometries and fractals found in nature (e.g., leaves, snowflakes), and are designs that repeat similar patterns on increasing and decreasing scales (Salingaros, 2014). Fractal patterns have been widely used in external architecture designs to highlight the aesthetic appeal of prominent buildings like cathedrals and city halls (Joye, 2007), and have subsequently been suggested to potentially reduce stress (Taylor, 2006).

6.2.3 Theoretical Framework: Theory of Affordances

Contextualizing the results of this study is the Theory of Affordances, a transactional framework that posits that *affordances* are what an environment offers an individual, and that an individual's intentions and capabilities, through a value-mediated relational process, will determine how the individual interacts with the setting (Chemero, 2003; Gibson, 1979). In its original form the Theory stipulated that affordances can take a range of potential forms being either physical (e.g., surfaces which afford posture, locomotion, manipulation) or social (i.e., provided by other people; e.g., social interactions) (Gibson, 1979). More recent interpretations of the framework have suggested, however, that affordances are both real (objective) and perceivable (subjective), but aren't properties of either the environment or the individual; rather, affordances are consequently *relations* between particular aspects of individuals and particular aspects of situations (Chemero, 2003). Simply put: "affordances … are relations between the abilities of organisms and features of the environment" (Chemero, 2003, p. 189).

Such an understanding of affordances importantly offers this study a critical realist ontological means to conceptualize relations between adolescents and urban designs as a process in which the examined emotional responses are a real aspect of the world and not simply in the heads of adolescents (i.e., entirely subjective), and exist in the context regardless of the presence of an individual. Application of the Theory of Affordances more precisely allows for the study of the 'functional significance,' or jointly derived nature of a phenomenon (Heft, 2010), of the different urban designs as they relate to adolescent mental health—that is to say which relations are or aren't

supported in a particular setting (Clark & Uzzell, 2002). Apropos of the framework's explanatory power, this approach has been used to explore similar topics to the present paper's such as adolescents' use of space (Clark & Uzzell, 2002), and young people's needs with respect to neighborhood parks (Townshend & Roberts, 2013). Noting these similar past uses of the Theory of Affordances, the present study operates within this transactional framework to examine the functional significance (i.e., jointly produced nature) of multiple urban/architectural design concepts and adolescent emotional response relations.

6.2.4 Research Justification and Questions

Research into the linkages between urban places and the mental health of younger populations is relatively understudied compared to other groups like adults (Gascon et al., 2015; Krabbendam et al., 2020). Moreover, extant study into these relationships has generally been broad, often employing relatively crude measures of space (e.g., examining 'spaces' as a general concept like greenspace) which lack precision regarding the incorporated designs and their quality and usability resulting in calls for methodological improvements in the resulting assessments (Madzia et al., 2019). The earlier online survey studies conducted in Chapters 4 and 5 took important first steps toward addressing some of these gaps by beginning to quantify precise associations between specific urban design concepts and adolescents' emotional responses; however, these exploratory investigations do not take into account the many situated real-world influences that may impact these relationships (e.g., proxemics (how one structures space around themselves)). This study aims to expand on the work of the two prior chapters and address these methodological shortcomings by examining precise affordances in the form of specific designs (i.e., PTODs and CA concepts) and their links to a range of positive and negative adolescent mental health indicators via *in-situ* methods that capture the previously omitted environmental factors. To guide this inquiry, the following research question was posed:

> What are the in-situ associations between specific PTOD and CA concepts and adolescent mental health indicators (i.e., emotional responses)?

6.3 Methods

6.3.1 Sample

A convenience sample of 70 participants were recruited through local youth groups and associations (e.g., Children's and Youth Planning Table of Waterloo Region and Kitchener Youth Action Council), as well as the research team's social networks. Eligible participants were required to meet the following criteria to be included in the study: 1) be a resident of Kitchener-Waterloo for over at least six months (i.e., familiar with the area); 2) be between the ages of 9-16 years old, or 17 without a driver's license, and thus be old enough to have some level of independent mobility but too young to have obtained a full driver's license; 3) be able to complete a 1.65 km walk; 4) be able to converse in English; and 5) be granted participation via written consent from a parent or guardian. Full demographic characteristics of the sample are presented in Table 6.4.1 (in results section).

6.3.2 Protocol/Procedure

An ecological momentary assessment (EMA) survey design was used for this study. The EMA approach was principally selected because of its advantages pertaining to the capture and analysis of subjects' in-situ emotional states (Shiffman et al., 2008) which take into account a space's impacts on participants' perceptions via sensory inputs from bodily movements, external forces, spatial orientation, and general proprioceptive processes. Moreover, although "EMA" can encompass a range methods and approaches, additional benefits from the approach used in the present study included conducting the study in real-time to minimize recall bias and collating multiple observations of the same outcomes within individuals across locations to allow for more reliable comparisons (Shiffman et al., 2008). Specific to this EMA study, survey data was collected regarding participants' emotional responses to the different PTOD and CA concepts through a web-based survey that was synched to progress with a predetermined walking route and accessed via participants' smartphones. To promote the social and economic diversity of our sample, and as a result of working with a younger population that may lack device ownership, we also made available tablets for use during the surveys. The survey was created by the authors and hosted on Qualtrics (Seattle, Washington, USA).

Prior to the data collection portion of this study, and in order to quantify the presence of the PTOD designs of interest, six distinct settings were scored along the walking route according to the five PTOD concepts noted in the introduction (see Table 6.3.1) using a validated tool (Clemente et al., 2005). This tool has been previously used as a design quality measure in studies assessing street

enclosure (Yin & Wang, 2016), navigation in built environments (Walford et al., 2011), and neighbourhood walkability (Hooi & Pojani, 2020), with the latter study reporting urban design quality scores very similar to ours (Hooi & Pojani, 2020). Based on this congruence, the six settings described and scored below appear to represent substantial variability in terms of urban design elements. Design features were scored from roughly 1-7 such that the higher the score for a feature, the more prominent it is in the setting (Clemente et al., 2005). As our team isn't aware of any such validated scoring tool regarding the three CA concepts under study here, these designs were simply evaluated in relation to participant evaluations of real-world examples for each concept.

Table 6.3.1 Route Settings' Design Feature Scores

Design Feature	Imageability	Enclosure	Scale	Transparency	Complexity
Urban Setting					
1. *Urban Trail*	2.42	3.32	3.88	2.29	4.71
2. *Residential Street*	3.93	2.50	3.27	2.45	5.87
3. *Urban Bluespace*	5.54	1.66	3.70	2.24	5.93
4. *Urban Greenspace*	4.44	1.87	3.90	2.45	5.63
5. *Public Transit Hub*	3.82	1.98	3.13	2.31	5.95
6. *Downtown Street*	6.27	2.46	4.33	3.32	5.36

*__Notes__: The higher the score, the more prominent the particular design feature | Tool available at: https://activelivingresearch.org/sites/activelivingresearch.org/files/FieldManual_071605.pdf

Figure 6.3.1 EMA Survey Route Map

(Numbers correspond with the numbering of locations in Table 6.3.1)

A repeated-measures survey was administered over the course of a predetermined walking route (see Figure 6.3.1) which traversed six distinct urban settings. The route was approximately 1.65 km long and located near and in downtown Kitchener, Ontario, Canada. The six urban settings on the route included a: multimodal transit path, residential street, urban bluespace (i.e., local lake), urban greenspace (i.e., local park), public transit hub, and built-up downtown street. The purposeful

selection of locations was designed to capture variance in terms of different types (i.e., built and natural settings) quality (i.e., range in scores), and purposes/uses (e.g., residential, commercial) associated with the settings (see Figure 6.3.1). A final seventh stop on the route near the Kitchener City Hall featured three different landmarks which each contained one CA concept (see photos in Appendix 7.10.1): an urban garden (biophilic architecture), a historical building (symmetries), and a church (fractal patterns). In each of the first six settings, participants were prompted to look around and observe their surroundings for a few moments before providing their responses, whereas when examining each of the CA concepts participants were prompted to observe and focus on only the specific designs on their respective landmarks and not the entire setting before answering their survey. This study was approved by the University of Waterloo Office of Research Ethics (study #42270).

6.3.3 Independent Variables

Each of the six distinct urban settings outlined in Table 6.3.1 which are comprised of the array of PTODs, as well as the three CA concepts, represented the independent (predictor) variables in our analyses. Dummy variables were created in each of the analyses to indicate the presence of the different settings and CA principles in their respective models.

6.3.4 Dependent Variables

Outcome variables in the analysis were comprised of the subjectively reported emotional responses thought to be associated with the PTOD and CA concepts. Each of the six settings' PTOD qualities were assessed for their association to the following sets of scales: positive affect and negative affect, calmness and anxiousness, and restorativeness and mental demand. Based on feasibility considerations (e.g., participants mental exhaustion), CA concepts were assessed in reference to only one set of complementary scales each: biophilic architecture (restorativeness and mental demand), symmetries (positive affect and negative affect), and fractal patterns (calmness and anxiousness). Regarding *positive and negative affect*, the Positive and Negative Affect Schedule for Children (PANAS-C) (Ebesutani et al., 2012) were used. The 5-point Likert (1-very slightly or not at all … 5-extremely) PANAS-C scale was adapted to ask participants to connect their present emotions with a series of two positive affect items (e.g., 'joyful') and three negative affect items (e.g., 'sad'). With respect to the *calmness and anxiousness*, the 5-point Likert (1-not at all … 5-extremely) Profile of Mood States (POMS) (Grove & Prapavessis, 1992) 'tension' subscale and an adapted 'calmness'

subscale were used. Both subscales were cut to two items related to both calmness (e.g., 'peaceful') and anxiousness (e.g., 'nervous'). Regarding *restorativeness and mental demand* the Perceived Restorativeness Scale (PRS)–Being Away subscale and the PRS-Coherence subscale (Hartig et al., 1997) were used to assess restorativeness and mental demand, respectively. Both PRS subscales were 5-point scales (1-not at all … extremely) and contained three items each related to restorativeness (e.g., 'it is a place to get away from it all') and mental demand/fatigue (e.g., 'there is too much going on'). Prior to the final analyses, all of the mental health outcome measures were aggregated, resulting in final score ranges from 2-10 for positive affect, calmness, and anxiousness, and 3-15 for negative affect, perceived restorativeness, and mental demand. Decisions to adapt and reduce the length of items included in the survey were based on feedback provided from cognitive pilot tests of the survey with three adolescents during the survey development phase of the study.

6.3.5 Covariates

A number of covariates of interest were controlled for in the analyses. Demographic data were collected for *age* (9-17 years old) and *gender* (boy, girl, non-binary) as mental health outcomes can significantly vary based on these traits (Connolly et al., 2016; Patel et al., 2007). Data were also collected for *ethnic background* (Black, East/Southeast Asian, Indigenous, Latin American/Hispanic, Mixed, Other, South Asian, West Asian/Arab, and White) as ethnic group disparities in mental health outcomes have been documented (Fox et al., 2020), and *subjective social status* (SSS). To obtain accurate socioeconomic status (SES) information from an adolescent population, we elected to use the SSS measure (Amir et al., 2019) which is a validated cross-culture measure based on the MacArthur ladder (Goodman et al., 2001). The SSS presents a visual image of a country's organization through the metaphor of a ladder (i.e., top of the ladder has the best, while bottom has the least) and then subsequently asks participants a series questions framed as "compared to most families, my family has" (house, food, money) with three response options (nicer/more, same, less). In this survey, this question was adapted to a 10-point scale for each response option such that "less" was placed at 1, "same" was placed at 5-6, and "nicer/more" was placed at 10. In the resultant analyses these three responses were aggregated into one summative SSS measure (range: 0-30). Participants were also asked of any *diagnosis of a mental health condition* by a health professional (no, anxiety or depression, eating disorder, other/please explain) in order to control for their potential impact on the relationships being evaluated. Fewer covariates were included in these analyses relative to Chapters 4 and 5 due to the smaller samples size.

6.3.6 Analysis

To analyze the associations between the adolescent emotional response outcomes and the six urban settings scored for their PTOD quality, as well as the three CA concepts, a series of unadjusted and adjusted linear mixed models (LMMs) were run. Dealing with nested response outcomes variables, as this study does, not only could the data not be assumed to be independent, but it also presents an increased probability of Type 1 error if such clustering is left unaccounted for. Recognizing these data limitations, LMMs were deemed appropriate for the analysis as they correct for clustered data through accounting for both fixed and random effects in the same model. In the present study, the fixed effects (i.e., the covariates in the models) were assumed to remain constant across clusters and have a fixed effect on the outcome of interest, while random effects (i.e., the individuals, represented by a unique participant IDs in the models) were assumed to vary in effect on the outcome across clusters and this not assumed to be constant at the individual level. Across both the unadjusted and unadjusted models, 42 sets of LMMs were run: one set of unadjusted and adjusted models for each combination of setting and emotional response outcomes (36), and one set for the two outcomes examined in reference to the three CA concepts (6). Adjusted models controlled for the sociodemographic factors outlined in this section. P-values <0.05 were considered statistically significant. All analyses for this study were run using the Mixed Models procedure in SPSS Statistics version 25 (IBM Canada Ltd., Markham, Ontario, Canada). While both unadjusted and adjusted results are presented, the ensuing results section will discuss those pertaining to the adjusted models.

6.4 Results

Complete results of the unadjusted and adjusted LMMs in relation to the different emotional response outcomes are presented in Table 6.4.2. After adjusting for a number of individual-level and family-level control variables, several significant relationships between adolescent emotional responses and the various settings and design concepts remained in the LMMs. Clear trends in adolescent emotional responses were associated with the two natural urban spaces (i.e., bluespace and greenspace): relatively similar increases in positive affect were reported in both the bluespace (β=1.480, 95% CI: 0.957, 2.005) and greenspace (β=1.081, 95% CI: 0.549, 1.613); however, the bluespace was linked with considerably larger increases in calmness (β=1.952, 95% CI: 1.403, 2.502) and restorativeness (β=2.835, 95% CI: 1.853, 3.818) relative to the greenspace. Similarly, while comparable significant decreases in anxiousness (bluespace: β= -0. 690, 95% CI: -1.064, -0.317;

greenspace: β= -0.424, 95% CI: -0.800, -0.047) were observed, the bluespace was associated with substantially larger decreases in mental demand (bluespace: β= -2.269, 95% CI: -3.208, -1.329; greenspace: β= -1.269, 95% CI: -2.223, -0.329).

Table 6.4.1 Sample Demographics (n=70)

Characteristic	Sample Size	Weighted %
Age		
9	9	12.9
10	10	14.3
11	13	18.6
12	11	15.7
13	7	10
14	10	14.3
15	4	5.7
16	3	4.3
17	3	4.3
	Mean	**Std. Dev.**
	12.1	2.21
Ethnicity		
White/European Descent	56	80
Ethnic Minority	13	18.6
Mixed	1	1.4
Gender		
Boy	33	47.1
Girl	36	51.4
Transgender/Non-Binary	1	1.4
Pre-Existing Mental Health Diagnosis		
Yes	12	17.1
No	58	82.9
	Mean	**Std. Dev.**
Subjective Social Status (range 0-30)	21.0	3.91

Notes: participants selected one ethnicity or, if they wanted, listed multiple and selected 'mixed'.

More divergent trends emerged regarding the two more mixed built-up and natural public spaces (i.e., trail area and residential street). Concerning negative affect, both the trail area (β= -0.462, 95% CI: -0.851, -0.074) and residential street (β= -0.477, 95% CI: -0.863, -0.091) were roughly equal in their mitigating impacts. Beyond this similarity, however, only the trail was significantly associated with an increase in calmness (β=1.085, 95% CI: 0.517, 1.654) and decrease in mental demand (β= -1.919, 95% CI: -2.864, -0.973). Conversely, trends in adolescent emotional responses were by far the poorest in the most physically built-up areas (i.e., transit area and commercial street). Both of these settings were associated with significantly lower calmness (transit area: β= -2.181, 95%

CI: -2.726, -1.672; commercial street: β= -2.214, 95% CI: -2.756, -1.672) and restorativeness (transit area: β= -4.047, 95% CI: -4.996, -3.099; commercial street: β= -2.797, 95% CI: -3.797, -1.798), as well as significantly higher anxiousness (transit area: β=0.9423, 95% CI: 0.574, 1.311; commercial street: β=1.026, 95% CI: 0.659, 1.393) and mental demand (transit area: β=4.081, 95% CI: 3.191, 4.970; commercial street: β=3.531, 95% CI: 2.622, 4.439).

Exploring the relationships between the CA concept examples and the different emotional response outcomes among adolescents, there were only a few significant findings. Biophilic architecture was associated with the strongest and most consistent outcomes as the adjusted models illustrated a considerable significant increase in associated positive responses and a concurrent significant decrease in negative responses. Precisely, the urban garden, which was located in an otherwise built-up space, was linked with a significant increase restorativness (β=2.752, 95% CI: 1.768, 3.737) and simultaneous decrease in mental demand (β= -1.486, 95% CI: -2.437, -0.534). While some of the relationships regarding symmetry and fractal ornamentation approached statistical significance, no such associations were found in this analysis.

Table 6.4.2 Unadjusted and Adjusted Linear Mixed Models of Specific PTOD Concepts and Adolescent Mental Health Outcomes

	Positive Affect				Negative Affect				Calmness			
	β	**95% CI**		**P**	**β**	**95% CI**		**P**	**β**	**95% CI**		**P**
Trail												
Unadjusted	.331	-0.215	0.877	.235	-.468	-0.865	-0.073	**.020**	1.085	0.515	1.656	**<.000**
*Adjusted	.331	-0.208	0.870	.229	-.462	-0.851	-0.074	**.020**	1.085	0.517	1.654	**<.000**
Res. Street												
Unadjusted	.031	-0.516	0.578	.912	-.476	-0.869	-0.082	**.018**	.152	-0.426	0.731	.605
*Adjusted	.031	-0.509	0.571	.911	-.477	-0.863	-0.091	**.015**	.153	-0.424	0.729	.604
Bluespace												
Unadjusted	1.481	0.950	2.012	**<.000**	-.376	-0.770	0.019	.062	1.952	1.400	2.504	**<.000**
*Adjusted	1.480	0.957	2.005	**<.000**	-.377	-0.763	0.009	.056	1.952	1.403	2.502	**<.000**
Greenspace												
Unadjusted	1.081	0.542	1.619	**<.000**	-.390	-0.800	0.020	.062	1.036	0.464	1.606	**<.000**
*Adjusted	1.081	0.549	1.613	**<.000**	-.376	-0.763	0.010	.056	1.036	0.466	1.604	**<.000**
Transit Area												
Unadjusted	-1.519	-2.049	-0.989	**<.000**	1.073	0.041	1.426	**<.000**	-2.180	-2.724	-1.638	**<.000**
*Adjusted	-1.519	-2.042	-0.996	**<.000**	1.040	0.663	1.417	**<.000**	-2.181	-2.726	-1.636	**<.000**
Com. Street												
Unadjusted	-.869	-1.411	-0.327	**.002**	0.975	0.589	1.360	**<.000**	-2.214	-2.758	-1.670	**<.000**
*Adjusted	-.869	-1.404	-0.334	**.001**	0.974	0.595	1.352	**<.000**	-2.214	-2.756	-1.672	**<.000**
Bio. Arch.												
Unadjusted	—	—	—	—	—	—	—	—	—	—	—	—
*Adjusted	—	—	—	—	—	—	—	—	—	—	—	—
Symmetries												
Unadjusted	-.536	-1.086	0.009	.054	-.325	-0.720	0.069	0.106	—	—	—	—
*Adjusted	-.536	-1.074	0.002	.051	-.326	-0.714	0.060	0.098	—	—	—	—
Fractals												
Unadjusted	—	—	—	—	—	—	—	—	.169	-0.409	0.747	.567
*Adjusted	—	—	—	—	—	—	—	—	.169	-0.407	0.745	.565

Notes: *Adjusted for: age, gender, ethnicity, pre-existing mental health diagnosis, subjective social status, and setting type.

	Anxiousness				Perceived Restorativeness				Mental Demand			
	β	**95% CI**		**P**	**β**	**95% CI**		**P**	**β**	**95% CI**		**P**
Trail												
Unadjusted	-.440	-0.826	-0.055	**.025**	.669	-0.358	1.697	.202	-1.919	-2.892	-0.964	**<.000**
*Adjusted	-.440	-0.817	-0.064	**.022**	.669	-0.343	1.681	.195	-1.919	-2.864	-0.973	**<.000**
Res. Street												
Unadjusted	-.190	-0.578	0.197	.335	-1.031	-2.056	-0.006	**.049**	-.669	-1.655	0.317	.184
*Adjusted	-.190	-0.568	0.187	.323	-1.031	-2.041	-0.021	**.045**	-.669	-1.628	0.290	.171
Bluespace												
Unadjusted	-.690	-1.073	-0.307	**<.000**	2.835	1.837	3.834	**<.000**	-2.269	-3.236	-1.302	**<.000**
*Adjusted	-.690	-1.064	-0.317	**<.000**	2.836	1.853	3.818	**<.000**	-2.269	-3.208	-1.329	**<.000**
Greenspace												
Unadjusted	-.424	-0.809	-0.038	**.031**	1.619	0.600	2.638	**.002**	-1.269	-2.250	-0.287	**.011**
*Adjusted	-.424	-0.800	-0.047	**.027**	1.619	0.615	2.623	**.002**	-1.269	-2.223	-0.315	**.009**
Transit Area												
Unadjusted	.942	0.566	1.321	**<.000**	-4.047	-5.012	-3.082	**<.000**	4.081	-3.162	-5.000	**<.000**
*Adjusted	.943	0.574	1.311	**<.000**	-4.047	-4.996	-3.099	**<.000**	4.081	-3.191	-4.970	**<.000**
Com. Street												
Unadjusted	1.026	0.650	1.402	**<.000**	-2.798	-3.781	-1.814	**<.000**	3.531	2.593	4.468	**<.000**
*Adjusted	1.026	0.659	1.393	**<.000**	-2.797	-3.797	-1.798	**<.000**	3.531	2.622	4.439	**<.000**
Bio. Arch.												
Unadjusted	—	—	—	—	2.752	1.752	3.753	**<.000**	-1.486	-2.464	-0.507	**.003**
*Adjusted	—	—	—	—	2.752	1.768	3.737	**<.000**	-1.486	-2.437	-0.534	**.002**
Symmetries												
Unadjusted	—	—	—	—	—	—	—	—	—	—	—	—
*Adjusted	—	—	—	—	—	—	—	—	—	—	—	—
Fractals												
Unadjusted	-.223	-0.611	0.163	.257	—	—	—	—	—	—	—	—
*Adjusted	-.223	-0.602	0.154	.245	—	—	—	—	—	—	—	—

Notes: *Adjusted for: age, gender, ethnicity, pre-existing mental health diagnosis, subjective social status, and setting type.

6.5 Discussion

In the present paper several relationships between various PTOD scored public spaces and real-world CA concepts and adolescent emotional responses were explored via in-situ EMA surveys conducted along a predetermined walking route. Adolescents' first-hand experiences of the PTOD-scored settings illustrated the most positive emotional responses in the two predominantly natural urban spaces, and to a lesser extent the trail area and residential street. On the other hand, adolescents reported much poorer emotional responses to the two predominantly built settings, irrespective of their differences in PTOD quality. Interpreted within the context of PTOD scores, these trends may potentially reflect a proclivity or preference for more natural forms of enclosure, imageability, and complexity in design. Emotional responses to the three CA concepts, meanwhile, indicated considerable positive emotional responses to biophilic architecture (i.e., urban garden example). Links between emotional responses to fractal patterns and symmetries were less clear. The following discussion situates these findings within the Theory of Affordances to further explore their potential implications. Limitations of the study, implications of these findings for practitioners, and areas for future study are subsequently discussed.

First, however, it should be noted the ways in which this EMA survey study complements the work of the preceding chapters in this dissertation. Foremost, through presenting the results of an in-situ evaluation that accounts for a variety of situated environmental factors, the present study offers a more comprehensive (in-depth) investigation of the same urban design-emotional response relationships that were previously evaluated with more breadth (i.e., larger representative sample) in Chapters 4 and 5. Second, building from the previous point, the present study's findings appear to generally support those of the two previous online survey studies in suggesting that certain PTOD concepts in more naturalistic forms (i.e., complexity, imageability, enclosure), as well as even more mixed built-naturalistic areas (e.g., multi-modal trails), appear to have the potentially to positively impact adolescent emotions. And third, this study complements the qualitative work of Chapter 3 through its quantitative assessment of the associations between three real-world examples of CA concepts and adolescent emotional responses. Although only the biophilic architecture and restorativeness/mental demand relationships were statistically significant—potential reasons for which the others were not significant are discussed in more detail below—this EMA still presents a first attempt to quantify the links between specific exterior architecture ornamentation and adolescent mental health indicators.

Adolescent emotional responses were most positive in the two natural urban spaces (i.e., bluespace, greenspace). With respect to their PTOD quality, these two spaces were both relatively high in imageability (i.e., scored 2nd and 3rd) and complexity (2nd and 4th)—scores which largely derived from their nature-related characteristics (e.g., imageability: landscape features, lower noise levels; complexity: array of area item colours, fountains and other sculpted landmarks). While these findings corroborate other research on the impacts of natural spaces on adolescents' mental health (e.g., Amoly Elmira et al., 2014; Dadvand et al., 2015; Markevych et al., 2014), this study more precisely suggests that instances of *natural imageability* and *complexity* may be a particularly important design concept with respect to adolescent's emotional engagement or evaluations of place. Previous study has outlined that adolescents value nature spaces differently than adults as they've reported a keen interest in natural sights like local lake areas (Buttazzoni, Dean, et al., 2022), public activity parks, and other landmarks (e.g., cliffs)—unlike parents, who may prefer a greater range of greenspaces (Mäkinen & Tyrväinen, 2008)—as well as varied visual landscape elements like flowers, gardens, and trees (Jansson et al., 2016). Recognizing that adolescents seemingly retain their own preferences for public nature spaces, our findings might suggest that natural imageability and complexity are two relatively important and specific designs in these areas that those in this group connect to or develop attachments with. Such links may consequently play a significant role in creating more aesthetically pleasing landscapes, and/or providing more opportunities for meaningful social activities, both values which teens have previously espoused as preferential in nature spaces (Mäkinen & Tyrväinen, 2008). Ultimately, the potential affordances presented by instances of high-quality natural imageability and complexity designs may serve to support multifunctional public space designs that can support adolescents' connectedness to and comfort within a place, as well as invite space usage.

Positive emotional responses among adolescents were also observed in the multimodal trail, or the environment with the highest enclosure score which, like the designs discussed in the preceding paragraph, was largely the result of scored natural features (e.g., tall overhanging trees, fences with ivy accents). Like related work on seniors which noted neighbourhood street-level visual enclosure to be associated with decreases in depression (Wang, Lu, et al., 2019), this finding suggests similar trends among adolescents in the form of reductions in mental demand along with concurrent increases in calmness when experiencing high levels of *natural enclosure*. These trends in emotional responses appear even more stark when compared to the commercial street area (i.e., location with the highest

enclosure score resulting from physical built features) and its predominantly built enclosure design. However, given that previous study has posited that adolescents tend to positively respond to environments that they understand or perceive to be 'serene' (Peschardt & Stigsdotter, 2013), this divergence in responses to different forms of enclosure might indicate that higher levels of natural enclosure in public spaces afford adolescents more desirable sights that minimize views of or direct attention away from more mentally demanding scenes, whereas higher levels of built enclosure does not function in this manner. Alternatively, spatial studies of perception have indicated that natural enclosure balanced by some level of openness may produce the highest restoration experience (Stigsdotter et al., 2017), thus it could also be that natural enclosure contributes to more clearly defining public pedestrian spaces (i.e., a multimodal trail as pedestrian infrastructure) than built enclosure. This could possibly afford adolescents more effectively restorative experiences by presenting them with a clearer outline of the pedestrian realm in a public space, and more precisely a visual cue that is less confounded by vehicular considerations (e.g., street edges, street wall features (e.g., parking lot entrances, shop façades)) and thus allows them to be more present in a given area.

Analyses of the relationships between the three CA concepts and adolescent emotional responses suggested most vividly that biophilic architecture may possess the potential to positively impact the emotions of adolescents. In this way, these findings support the previous arguments of Chapter 3 as well as others by suggesting that both nature in urban areas (biophilic designs) and nature-like patterns (biomorphic forms) in physical built architecture can induce positive psychological benefits similar to that of interacting with larger natural settings itself (Alexander, 1977; Coburn et al., 2019; Joye, 2007; Salingaros, 2013, 2014). As it concerns adolescents' larger experiences of public spaces, place bonding can be enhanced by a perception that a place provides the individual with basic conditions such as security or refuge (Ruiz et al. 2013), and it might be that biophilic architecture and fractal ornamentation aid in facilitating these processes for adolescents. More specifically, these designs may provide adolescents' with refuge through biophilic architecture, or at least urban gardens, supporting a sense of refuge from built scenes through offering restorative experiences—a finding also observed in electroencephalography studies of green façades (Elsadek, 2019).

Conversely, the two most built-up spaces (i.e., the transit area, commercial street), as well as symmetrical ornamentation, were associated with the poorest emotional responses among adolescents. With respect to the former, despite their differences in aggregate PTOD quality, a few

extraneous environmental factors may have mitigated the potential benefits of these pedestrian infrastructure designs. As previous research has outlined that built and mixed built and natural environments differ regarding their restorative potential (Ivarsson & Hagerhall, 2008), one potential explanation is to reiterate a central criticism of modernist urban forms:

> Modernist architecture mainly consists of simple volumetric forms and thus deprives the senses in their constant search for meaningful information … [the modern] building is often dictated by efficiency and economic motives, barely leaving room for symbolic and stylistic references to natural contents … much of the modern built environment fundamentally lacks (references to) the contents and structural organization that are characteristic of a good habitat" (Joye, 2007, p. 311).

These two spaces arguably capture this essence (see photos in Appendix 7.10.1). Moreover, while having similar aggregate human scale quality scores as the two natural settings, these two areas' general orientation toward automobiles might have produced additional negative impacts (e.g., heavy vehicles) that diminished the appeal of potential perceived affordances for adolescents to emotionally connect with in these spaces (e.g., complexity: diversity of designs in commercial street). This combination of dense volumetric built-up modern physical forms along with the negative impacts of auto-oriented infrastructure might have consequently mitigated some of the benefits that could be accrued from the positive designs in these areas.

Regarding the latter, the lack of significant results pertaining to symmetrical ornamentation could be the consequence of a couple of different factors. First, this may have been the result of asking about relevant emotional responses through the wrong outcome prism. While responses characterized by hominess have been linked to exterior architectural designs before (Weinberger et al., 2021), our emotional responses assessment of symmetrical ornamentation through positive affect (e.g., joyful, cheerful, lively) and negative affect (e.g., miserable, sad) may have been incongruous. And second, a couple of extraneous factors may have also affected these results. First, the base colour of the example building observed in this study was red (see SM), which is a colour that psychological research investigating the impact of colour on emotions has pointed out is typically linked to higher levels of arousal than other colours (Wilms & Oberfeld, 2018; Zieliński, 2016). On the other hand, while we explicitly instructed participants to examine the structure and design detail of the target building, we can't rule out that participants may have been considering certain social attachments given that the building is identifiable through a university crest on its main façade and several plaques around it. Noting this, it would be prudent for future study interested in examining the potential

emotional responses of adolescents to real-world examples of symmetrical ornamentation to find ways to minimize such potentially intervening factors or visual cues in their approaches.

6.5.1 Implication for Practitioners

A lack of knowledge pertaining to the specific urban design concept characteristics associated with adolescent mental well-being can make it challenging for city planners and architects to create public spaces that support positive emotional engagement for individuals in this cohort. To this end, the results from this study allow practitioners to interpret the potential of a variety of PTODs and CA concepts with respect to adolescent mental health, and thereby use them in their public space design and retrofitting processes. This study suggests that adolescents' emotional experiences of public spaces may be enhanced through the inclusion of natural forms of enclosure (e.g., tall trees, ivy walls), imageability (e.g., nature-oriented landmarks), and complexity (e.g., variety of natural features such as gardens, shrubs), as well as nature or naturalistic ornamentation in design. Considering these findings in the context of applied planning practice, the inclusion of these designs may be undertaken in any number of public spaces to add emotional value and subsequently promote free play among adolescents, which has been highlighted as a key to more bodily, emotional, and sensuous interaction with nature in younger adolescents (Skar et al., 2016). Moreover, as the places that adolescents occupy are often connected to the stories (about play, fun etc.) which give them meaning (Mäkinen & Tyrväinen, 2008), the emotional linkages noted in this study suggest that the inclusions of these three designs in areas that are frequented by adolescents (e.g., school areas, local sports and recreation areas, cycling paths) could help to foster more meaningful interactions for adolescents. It has also been observed in multiple studies from different geographic contexts that traffic safety is a key factor in adolescents' use and experiences of their local environment, and that designs like more pedestrian crossings and parks that are car-free are preferential design concepts (e.g., Carroll et al., 2015; Drianda & Kinoshita, 2015). The inclusion of natural enclosure designs could be another such design that helps to reduce the real and perceived negative impacts of local traffic through more clearly delimiting public spaces and directing attention to the pedestrian space (see also Buttazzoni, Dean, et al., 2022).

6.5.2 Limitations

Limitations of this study should be noted. Foremost, the nature of this research is cross-sectional and thus unable to provide any inferences regarding causality. Secondly, in a qualitative

assessment of these same designs and settings, adolescents indicated that the artificial (i.e., vehicular) noise present in and around various spaces was especially draining (Buttazzoni, Dean, et al., 2022); however, the PTOD design scoring system used in this study only accounts for noise pollution as one part of the imageability rating. This aural dynamic, which likely negatively affected the reported emotional responses of participants, especially in the transit station and commercial street areas, was thus potentially not proportionally accounted for in the applied design scoring system. Similarly, while we prompted participants to focus specifically on the urban designs and architectural concepts that were of interest, we can't be sure that larger contextual factors didn't impact our participants' responses. For example, as speculated in the discussion, with respect to the real-world example symmetries (historic city building) and fractals (church), participants may have also been factoring in other aesthetic (e.g., red colour of historic building) and social (e.g., religious feelings evoked by church) considerations into their emotional evaluations. Last, it should be stated that this EMA study evaluated five particular PTOD and three CA concepts which collectively only represent some of the urban forms that adolescents interact with in contemporary urban environments. Factors such as the nature of intersections, other forms of biophilic architecture (e.g., green roofs), and distinct architectural styles (e.g., modernist, postmodernist) were not directly considered in this study, nor were other contextual factors like the length of stay or seasonal effects (i.e., weather).

6.5.3 Areas for Future Study

As research in this area is relatively new, there are several opportunities for future study. With respect to the PTODs evaluated here, having examined these design qualities as characteristics indicative of the aggregate quality of the pedestrian infrastructure in larger public spaces, future study should examine these relationships more specifically as they relate to the individual designs themselves. For example, this may be undertaken using computer-based methods featuring series of graduated photos (e.g., Wang, Zhao, et al., 2019) that illustrate a particular concept (e.g., imageability, enclosure, complexity) at different stages of increasing prominence within a standardized area or landscape to more directly explore the associations between that singular design and different adolescent mental health outcomes. This study also only examined three particular instances of CA concepts, and only at one scale. Consequently, more studies evaluating similar real-world or virtual examples of green façades, green roofs, water displays/presence in built areas, and various biomorphic forms in design (e.g., symbolic reference to contours, textures found in nature), and at varying levels of prominence within a landscape, could also be explored in future study.

Irrespective of the particular designs being evaluated, the relations evaluated in this study need further investigation with larger samples to confirm their reliability and to determine whether they can be generalized to different contexts and groups. Finally, based on the present study's findings regarding the more built-up areas (i.e., transit area, commercial street), it would be worthwhile for future qualitative research to expand the scope of work beyond PTOD and CA concepts (i.e., Chapter 3's work) to additional concepts and architectural styles. For example, future work could explore the interactions regarding how adolescents understand different architectural styles (e.g., modern, neoclassical, rural forms) or design concepts (e.g., aesthetics (hominess, approachability, vitality), contrast, height (Lindal & Hartig, 2013)) and their symbolic or metaphorical attachment opportunities (or lack thereof) in public spaces.

6.6 Conclusion

Using EMA survey methods this study examined the in-situ experiences of 70 adolescent participants with respect to the design quality of various public urban spaces and architectural ornamentation of three different buildings/areas. Central findings indicated that natural forms of imageability, enclosure, and complexity, as well as biophilic architecture (i.e., urban garden), may be mental health supporting designs for this cohort. General trends regarding the most built-up spaces evaluated here might suggest that, despite the high PTOD quality of some such areas, the potential beneficial impacts of their pedestrian infrastructure features may be mitigated by larger built forms that are still 1) principally auto-oriented, and/or 2) comprised of physical buildings that are devoid of opportunities for adolescents to develop meaningful emotional attachments to. While these findings offer specific insights pertaining to how urban designs potentially impact adolescent mental health, the links between this cohort's emotional engagement with specific built forms are not necessarily straightforward as other relational (e.g., symbolic attachments) and environmental (e.g., ambient artificial noise) factors appear likely to be shaping these interactions, and thus require further investigation.

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Chapter 7

Synthesis of Articles and Final Discussion: Understanding How Urban Design Quality and Compositions Shape the Environmental Affordances that Impact the Emotional Reponses of Adolescents

7.1 Synthesis Introduction and Structure

Bringing together the five integrated articles of this manuscript, the aim of this dissertation, as articulated in Chapter 1, was to explore "What is the nature of the relationship between specific urban built and natural design concepts and different adolescent mental health indicators (i.e., emotional responses)?" Defining mental health according to Galderisi et al.'s (2015) outline which recognizes

> Basic cognitive and social skills; ability to recognize, express and modulate one's own emotions, as well as empathize with others; flexibility and ability to cope with adverse life events and function in social roles; and harmonious relationship between body and mind represent important components of mental health which contribute, to varying degrees, to the state of internal equilibrium (p. 231-232),

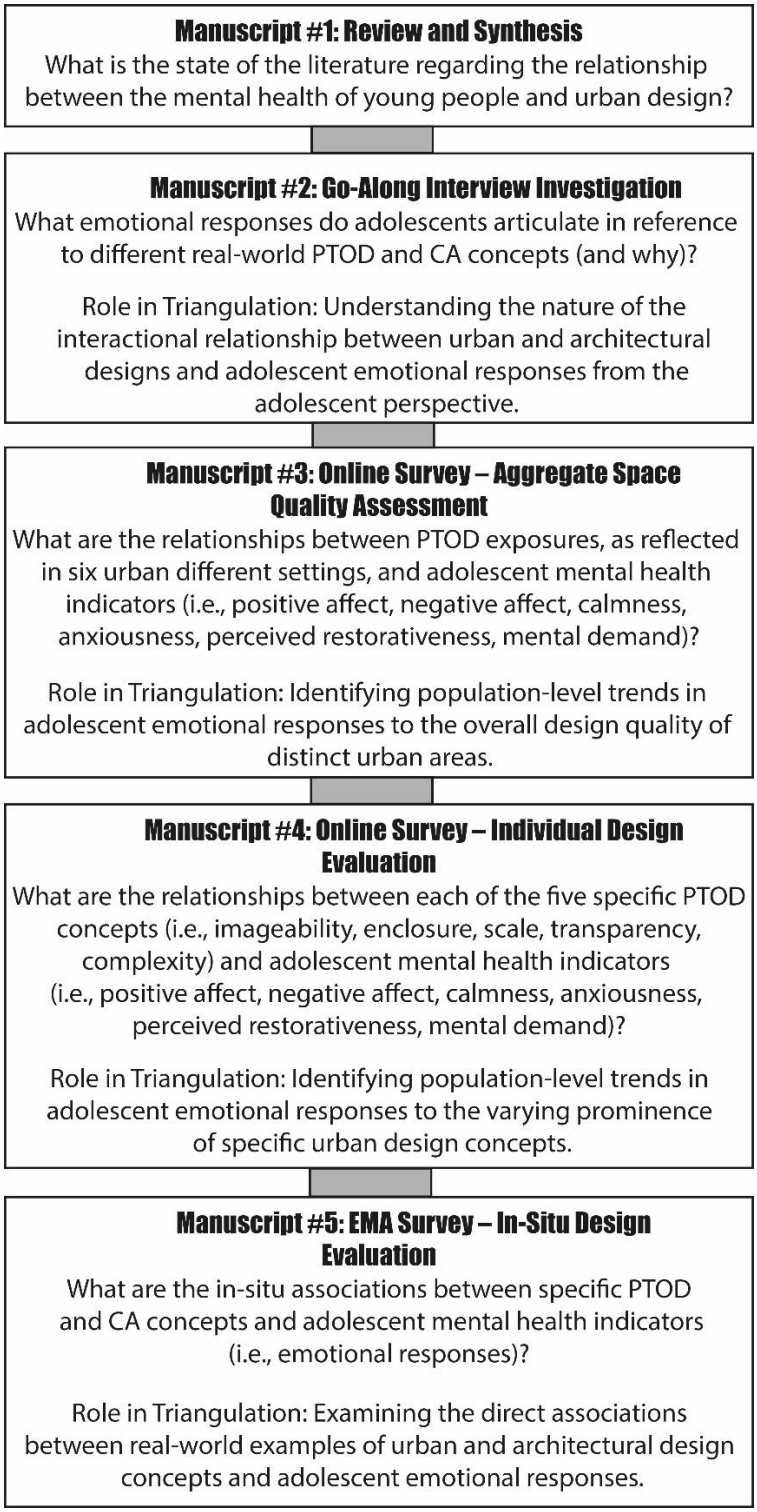
this dissertation used emotional responses as a specific proxy for those features related to self-regulation, coping, and the relationship between body and mind as they relate to urban designs. To ensure the breadth and depth of this inquiry, an interdisciplinary approach along with a mixed methods structure was applied in this dissertation. Methods used in this dissertation included qualitative go-along interviews, online surveys (i.e., larger sample, group-level emotional response trends evaluation), and ecological momentary assessment surveys (i.e., smaller sample, in-situ emotional response evaluation). Chapter 7 begins with summarizing each of the five integrated articles and outlining their role in the ensuing triangulation, which is then followed by the triangulation and synthesizing of the five manuscripts regarding their collective research and methodological contributions, as well as policy and practice implications. Concluding Chapter 7 are the limitations of the scholarship undertaken and the resulting opportunities for future research to pursue in this area of study.

7.2 Summary of Studies

Five integrated articles were presented in this dissertation with the collective aim to conduct a comprehensive investigation of the relationship between specific built designs and adolescent mental health. This overarching aim was pursued through the application of different methods with coordinated accompanying objectives to explore relational understandings (Chapter 3), large-scale group-level trends (Chapter 4, 5), and small-scale in-situ perceptual evaluations (Chapter 6) associated with this environment and mental health relationship (see Figure 7.2.1). First, though, a review (Chapter 2) of relevant literature from planning, public health, and neurourbanism was

conducted to highlight potential research pathways the ensuing primary research manuscripts could pursue. Drawing on some of Chapter 2's suggestions, the second article (Chapter 3), qualitatively investigated, through the use of go-along interviews, the in-situ perceptions and emotional responses of adolescents regarding six different urban settings scored for their PTOD quality and three real-world CA examples. Chapters 4 and 5 subsequently presented the results of an online survey study which sought to explore potential group-level adolescent emotional response trends associated with overall space PTOD quality (Chapter 4) and individual design prominence (Chapter 5). Concluding the primary research articles, the ecological momentary assessment (EMA) survey study in Chapter 6 quantitatively assessed the in-situ emotional responses of adolescents in relation to six urban settings scored for their PTOD quality and three real-world CA examples in service of conducting a more ecologically valid (e.g., account for kinesthetic and vestibular sensory inputs) evaluation.

Figure 7.2.1 Outline of Component Article Objectives and Role in Synthesis Triangulation



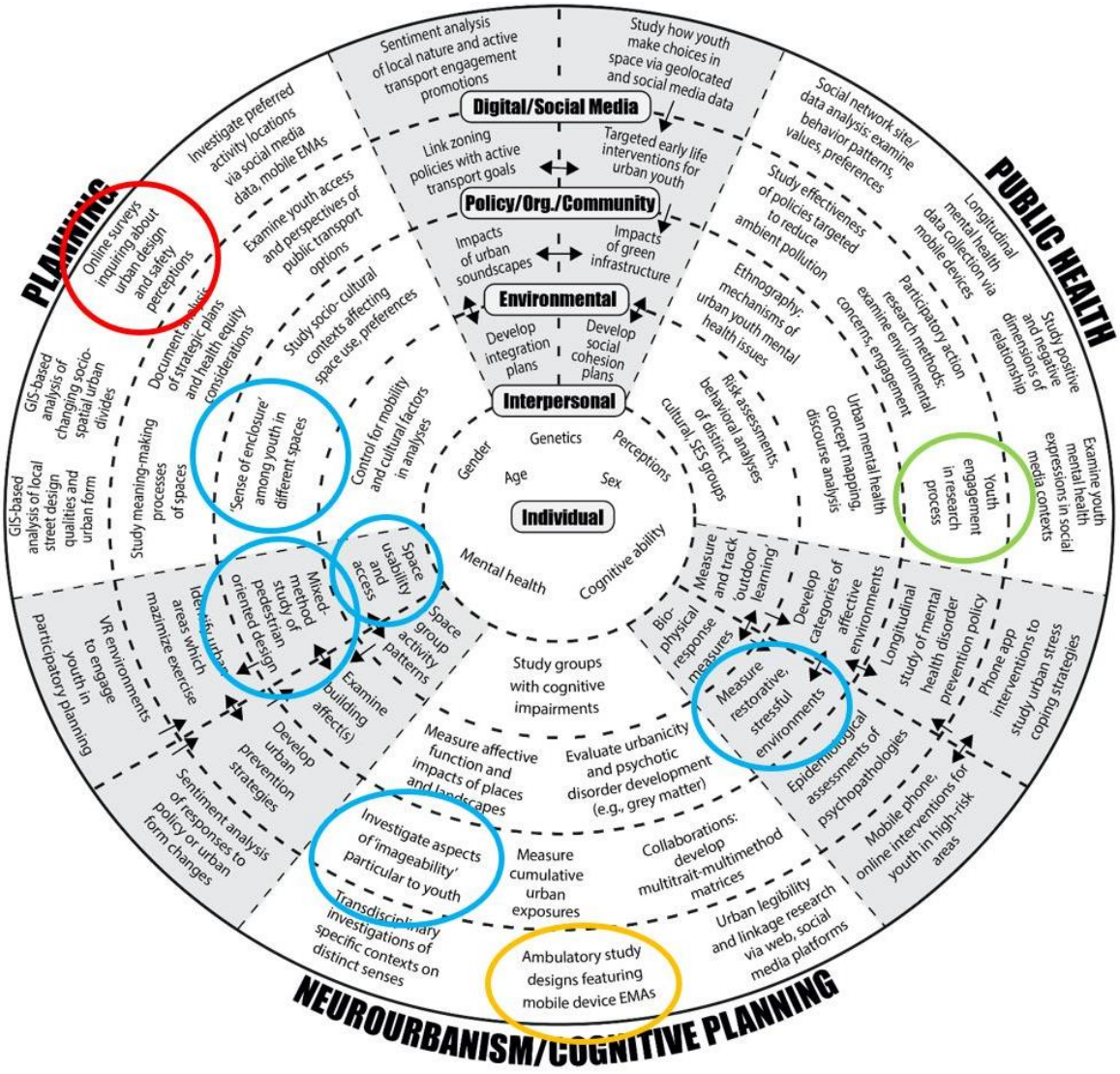
7.2.1 Manuscript #1: Literature Review and Frameworks

Research Question/Objective: *What is the state of the literature regarding the relationship between the mental health of young people and urban design?*

The first of the integrated articles in this dissertation was the review and framework manuscript (Chapter 2). Recognizing that the topic of young people's mental health and urban environments as an area of study lacks comprehensive organizing frameworks (Ruiz & Chaix, 2019; Suglia, 2019) resulting in methodological and conceptual gaps related to space affect and quality (Madzia et al., 2019), this manuscript's objective was to conduct a multifield assessment of the state of the literature regarding the relationship between the mental health of young people and urban environments. Consequently, the review documented literature from three fields regarding young people's mental health and urban environments—and specifically, their attendant features, exposures, social opportunities, land uses etc.—in service of developing transdisciplinary/multifield frameworks for both practitioners and researchers. Together the literature review and its resultant synthesis offered multiple discussions to inform practitioners and researchers on potential ways to better engage with the topic by bringing together the fields of planning and public health along with the emerging multifield/discipline area of neurourbanism. Drawing from Schulz and Northridge's (2004) original multifield and multiple disciplinary socio-ecological framework for environmental health promotion, this manuscript builds on the interdisciplinary perspective offered in Chapter 1 outlining the mental health-urban environment relationship as dynamic, socio-relational, and multi-level. Layering context onto this outline, the reviewed planning and public health literature detailed a variety of social and environmental determinants of health relevant to framing this topic, while the neurourbanism literature added novel cognitive/neuroscientific and methodological ideas to the discussion. The ensuing synthesis portion of the manuscript describes the addition of a new fifth level (i.e., the digital level) to the socio-ecological model (SEM). This fifth level incorporates the technological advances that have been made in recent years and which have implications for both research and practice. In addition to the five-tiered layout, both of the developed frameworks also illustrated multiple cross-field collaboration opportunities between the three areas. Among the recommendations made for future study in the research framework, several were used to guide the investigations of the following chapters with Chapter 3 more thoroughly incorporating adolescent perspectives into this area of study, Chapters 4 and 5 examining more precise relationships between urban designs and adolescent

mental health indicators via online survey methods, and Chapter 6 exploring a broad array of urban settings through ambulatory EMA methods (see Figure 7.2.2).

Figure 7.2.2 Chapter 2's Research Framework Links to Subsequent Integrated Articles



Legend: Chapter 3 – Green | Chapter 4 & 5 – Red | Chapter 6 – Yellow | All Chapters – Blue

7.2.2 Manuscript #2: Go-Along Interview Investigation

Research Question/Objective: *What emotional responses do adolescents articulate in reference to different real-world PTOD and CA concepts (and why)?*

Role in Triangulation (from Table 1.6.1): *Understanding the nature of the interactional relationship between urban and architectural designs and adolescent emotional responses from the adolescent perspective*.

Identifying the opportunity to further incorporate adolescents themselves through including their perspectives in this area of research, as well as investigate more precise design-mental health relationships, Chapter 3 of this dissertation qualitatively explored both the positive and negative in-situ emotional responses of adolescents with respect to public spaces of distinctly different environmental design quality. Go-along interviews near and in downtown Kitchener, Ontario with 23 participants ranging in age from 9-17 years old were completed in the summer months of 2021, investigated both PTOD concepts and real-world examples of CA principles, and were subsequently analyzed using an adapted framework analysis method. In addition to the ToA, results of the analysis were placed within Russell's (1981) 360º spatial Circumplex Model of Affect to enhance the consistency of interpretations regarding the findings, as well as present a more comprehensive conceptualization of the variety of psychological affective experiences participants articulated. Results captured both positive and negative in-situ emotional responses of adolescents to examples of the specific urban design concepts like imageability (e.g., natural reference point-creative, artificial noise-annoyed), complexity (e.g., multiple façade colour-exciting, worn-out façades-unhappy), and enclosure (e.g., built enclosure-interesting or uncomfortable, natural enclosure-calm), as well as to the real-world CA concepts that were observed like biophilic architecture (e.g., being away, relaxed). In addition to this main analysis, a secondary exploratory gender-based analysis following the same framework analysis methods was also completed. Notable results of this analysis included specific links between girls and scale (e.g., sidewalk barriers), transparency (e.g., windows on street level façades), and biophilic architecture (i.e., greater emphasis on calming responses) designs, and different transparency (i.e., active uses) designs and positive responses among boys. Attempting to better understand their perspectives, discussions of the results posited different theoretical reasons for the observed responses of adolescents, speculated on some of the potential reasons for the differences in gender responses, and also connected the findings to a few sections of the UN SDG goal 11 to augment the relevance of the manuscript to international audiences.

7.2.3 Manuscript #3: Online Survey – Aggregate Space Quality Assessment

Research Question/Objective: *What are the relationships between PTOD exposures, as reflected in six urban different settings, and adolescent mental health indicators (i.e., positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand)?*

Role in Triangulation (from Table 1.6.1): *Identifying population-level trends in adolescent emotional responses to the overall design quality of distinct urban areas*.

Seeking to explore group-level trends among adolescents regarding their emotional responses to public spaces of varying pedestrian design quality, Chapter 4, explored the impacts of a diverse set of urban settings through quantitatively evaluating the links between six distinct urban environments scored for their PTOD quality and adolescent mental health indicators. Crucially, in this chapter, the settings' designs were conceptualized, analyzed, and discussed as aggregate place predictors (i.e., indicative of a setting's overall PTOD quality) of adolescent mental health indicators. Using a nationally representative sample of 1,500 adolescents from across Canada, the online survey presented 360º videos (with sound) of the six different urban settings and had participants respond in reference to positive affect, negative affect, calmness, anxiety, perceived restorativeness, and mental demand outcomes for each setting. Both unadjusted and adjusted linear mixed models (LMMs) were run to evaluate the design-mental health relationships. Results of the adjusted analysis suggested that, generally, higher PTOD scores (e.g., urban plaza) positively associated with the more sanguine emotional responses (e.g., positive affect), while those areas which featured poorer PTOD scores (e.g., suburban mall) tended to be associated with the more inimical emotional responses (e.g., negative affect). Additionally, natural urban settings (i.e., urban trail, urban bluespace) in particular were associated with the greatest increases in positive emotional responses, while conversely the suburban areas (i.e., suburban mall, suburban residential street)—which were the lowest scored PTOD environs—tended to be associated with the poorest reported emotional responses. Contextualizing these findings within the Theory of Affordances (ToA), it was discussed how PTOD concepts may directly support positive environmental interactions among adolescents (e.g., through scale features such as places to sit/socialize), and that potential differences in responses to designs (e.g., the impacts of built vs. natural imageability) may be due to some variation in the perceived affordances that different PTODs offer adolescents. Recommendations from this study for practitioners suggested that urban designers could consider how PTOD concepts like imageability in

different natural forms, or complexity in built forms, may be incorporated in future projects to support adolescent mental health.

7.2.4 Manuscript #4: Online Survey – Individual Design Evaluation

Research Question/Objective: *What are the relationships between each of the five specific PTOD concepts (i.e., imageability, enclosure, scale, transparency, complexity) and adolescent mental health indicators (i.e., positive affect, negative affect, calmness, anxiousness, perceived restorativeness, mental demand)?*

Role in Triangulation (from Table 1.6.1): *Identifying population-level trends in adolescent emotional responses to the varying prominence of specific urban design concepts*.

Aiming to investigate the implications of specific pedestrian design concepts and specifically their group-level associations with adolescent emotional responses, Chapter 5, examined the same adolescent mental health indictors as the previous chapter but in this case in reference to the five specific PTOD concepts themselves (i.e., imageability, enclosure, human scale, transparency, complexity). Unlike the last chapter, the PTOD concepts in this article were conceptualized, analyzed, and discussed as individual design features which varied in their degrees of prominence across the six different urban areas that were scored and videotaped. Both unadjusted and adjusted LMMs were again run for the analysis of this manuscript. Two broad trends appeared to emerge from these analyses. The first noteworthy trend in the findings was that the PTOD concepts seemingly have the strongest and most consistent associations with improved positive affect and reduced negative affect. Meanwhile the second trend was the specific design concepts of scale, complexity, and transparency appeared to have the most consistent impacts across the emotional response outcomes of adolescents. Situating these results within the ToA, it was speculated that PTOD concepts may correlate the most with positive and negative affect as they are intended to support active transport more so than restorative or calming experiences. It was discussed that scale and complexity may be such noteworthy design concepts for adolescents as a result of the former potentially aiding in reducing feelings of being overwhelmed, and the latter potentially eliciting feelings of fascination that engage adolescents with their surroundings. Implications for practice posited that urban planners may find value in these results through considering implementing more human scale and complexity designs to support socialization opportunities or design more aesthetically preferable public spaces for adolescents. Public health education professionals, it was suggested, may find value in using these

results to aid those with mental illnesses (e.g., anxiety disorders) regarding developing strategies that encourage more potentially positive environmental experiences.

7.2.5 Manuscript #5: EMA Survey Investigation

Research Question/Objective: *What are the associations between specific PTOD and CA concepts and adolescent mental health indicators (i.e., emotional responses)?*

Role in Triangulation (from Table 1.6.1): *Examining the direct associations between real-world examples of urban and architectural design concepts and adolescent emotional responses*.

Lastly, the EMA survey study of Chapter 6, which sought to quantitatively examine the first-hand emotional responses of adolescents to real-world pedestrian designs and CA examples, presents the results of in-situ surveys completed via smartphones and tablets by 70 adolescents while traversing six urban areas scored for their PTOD quality and observing three real-world CA concept examples. The surveys were conducted near and in downtown Kitchener, Ontario, took roughly 50-55 minutes to complete, and were collected in the late summer and early fall of 2021 as well as the late spring and early summer of 2022. Unadjusted and adjusted LMMs were run to analyze the associations between the six settings and the mental health indicators of interest, as well as the specific links between biophilic architecture and perceived restorativeness/mental demand, symmetries and calmness/anxiousness, and fractal patterns and positive affect/negative affect. Central findings of the study illustrated concurrent significant increases in positive affect and calmness responses in relation to the bluespace and greenspace areas, as well as significant decreases in negative affect in the same spaces. Conversely, the commercial street and transit station areas were generally associated with more strained emotional responses (e.g., significant increases in mental demand, decreases in restorativeness). Findings related to the multimodal trail and residential street settings—more mixed built and natural areas—were varied but importantly featured a significant decrease in negative affect in relation to both spaces, as well as an increase in calmness in the trail. The CA concept analyses additionally indicated that incidences of biophilic architecture (i.e., urban garden) appear to possess the potential to simultaneously improve restorativeness and mitigate demand. Discussions of these results outlined that the observed trends across the PTOD models may potentially reflect a proclivity or preference among adolescents for more natural forms of enclosure, imageability, and complexity in design, and that these place preferences may owe to their reflecting more ‘serene’ settings. Practice implications of note suggested that planners could focus future efforts

on the development of areas frequented by adolescents (e.g., school and recreation areas) via designing such spaces to more prominently feature natural forms of enclosure (e.g., tall trees, ivy walls) or complexity (e.g., colorful gardens, shrubs) to improve the emotional experiences of teens.

7.3 Substantive Research Contributions

Chapter 1 summarized that this dissertation's synthesis will be framed within the Theory of Affordances (ToA) and developed through a combination of exploratory sequential and triangulation mixed methods that converge on key shared points across the contained manuscripts (Figure 1.6.1). Substantive research contributions were thus developed through linking the original outline of the topic under study, the ToA frame, and general points of convergence across the manuscripts. As described in section 1.4 of the introduction, the adolescent mental health and urban design relationship was conceptualized as:

> … the self-regulation and emotions, and to a lesser extent the relationship between body and mind, that contribute to an internal state affecting overall function through recognizing and investigating the dynamic, socio-relational, and multi-level aspects of the adolescent mental health and urban design relationship.

In keeping with the above outline and to ensure the compliance of this synthesis with the interdisciplinary (i.e., an interactive perspective that seeks to analyze, synthesize, and harmonize links between disciplines/fields/methods into a coordinated and coherent whole (Choi & Pak, 2006)) approach of this dissertation, the cross-study triangulation of research contributions offered here is presented in reference to two overarching points, within which several more exact ideas are discussed. The two overarching research contributions of this dissertation are: 1) a detailed documentation of the mental health implications of design quality and composition with respect to affording positive social contexts and interaction opportunities, emotionally engaging public spaces, and active use experiences; and 2) a comprehensive exploratory investigation of the mental health implications of adolescent perceptions of and emotional responses to urban designs which resulted in the identification of trends suggesting a seeming emphasis regarding usage opportunities, safety, distinctiveness, visual richness, and positive affect experiences (see Table. 7.3.1). In light of the proxy noted earlier regarding the link between emotional responses and overall mental well-being and the onset of mental disorders in younger populations (see page 18), the longitudinal implications of this research are important to consider in light of understanding the potential impacts one might accrue by means of the repetitive exposures incurred via their lifestyle and socio-geographic contexts.

Before proceeding, there are two points that should be explicitly outlined to properly frame the ensuing contributions. The first concerns the reliability of the triangulation. Results pertaining to both the positive/healthy and negative/unhealthy emotional responses of adolescents from the same two place analyses conducted in Chapters 4 and 6 were relatively similar in direction, strength, and statistical significance. More precisely, the same trail and bluespace areas were evaluated in both Chapter 4's online survey and Chapter 6's EMA, and their subsequent analyses of the same 12 emotional responses illustrated relatively similar emotional outcomes. In fact, the only major exception to this general convergence was the perceived restorativeness responses of adolescents in the trail space (EMA survey Ch. 6: $\beta = .669$, $P = .195$; Online survey Ch. 4: $\beta = 3.103$, $P = <.000$). Such convergence suggests good reliability in adolescents' responses across the different methods.

Table 7.3.1 List of Substantive Research Contributions

Contribution Point	Discussion(s)/Example(s)
Outline of novel relationships between design quality and compositions and adolescent mental health, and how these factors have implications concerning affording: 1. positive social contexts, 2. interpersonal interaction opportunities, 3. emotionally engaging opportunities, and 4. active use opportunities. ➢ Implications for adolescent <u>sense of place, place attachment</u>.	• Physical characteristics of an area can reflect a variety of enabling or inhibiting affordances that influence how adolescents emotionally engage with a space. • Designs implications beyond the built or physical environments—they also afford social environments. Designs that afford more social opportunities and active uses (transparency; e.g., shopping), or have shared use (i.e., multiple person) potential, for adolescents seem to better support positive outcomes. • Higher aggregate PTOD quality tended to be linked with more encouraging emotional responses. Slower-speed designs (human scale; e.g., wider sidewalks), designs that minimize distraction (enclosure; e.g., tall trees), and designs that feature diversity in presentation (complexity; e.g., multiple design styles).
A first attempt to detect associations between adolescent emotions and urban designs. These links tend to most positively relate to design affordances characterized by: 1. usage opportunities, 2. safety, 3. distinctiveness, visual richness, and 4. positive affect experiences. ➢ Implications for adolescent <u>place preference</u>.	• Human Scale/Transparency: physical street features (e.g., benches, street barriers), natural street features (e.g., street trees, planters), active uses (e.g., shops, restaurants, parks), and higher proportions of transparency seem to provide public space usage opportunities and safety for adolescents. • Imageability/Complexity/CA concepts: the distinctiveness of an area's design (e.g., historical character, non-rectangular form(s)), collective presentation diversity (colours, architectural styles), and level of detail or ornamentation style may support adolescent mental health through reflecting preferred place designs as they tended to be associated with positive emotional responses among adolescents.

And second, it should be noted that the decision to make the dissertation's operationalization of the environment-mental health relationship about exploring design concepts—which is to say, the choice to focus on a set of urban and architectural design concepts rather than other urban morphology notions like density or neighbourhood character—facilitated component analyses with some level of applicability beyond the cultural bounds of this research. Accepting that such characteristics like density have rightfully been critiqued for oversimplifying the variety of urban

morphologies present in many cities and regions throughout the world (Keil, 2017), and that some of the primary research articles of this dissertation do discuss their findings in ways that allude to broad morphological notions (e.g., suburban/urban based on visual built density), the main thrust of these analyses still remains centred on the prominence or quality of the PTOD concepts. Therefore, while acknowledging that urban morphologies can range from the inverted metropolis (e.g., San Francisco) where the pull of adjacent suburban spaces dominate a smaller central city (Walker & Schafran, 2015), to suburbs on the frontier (e.g., Fort McMurray), to dense informal suburbs (e.g., Mumbai) which facilitate different distinct "suburbanisms" (i.e., suburban ways of life) (Keil, 2017), the operationalization of this dissertation's analysis toward examining design concepts (e.g., complexity) may allow for the following research and methodological contributions to be applicable to multiple—though certainly not all—urban contexts.

7.3.1 Urban Design Composition and Adolescent Mental Health

The first of the two overarching research contributions of this dissertation is the detailing of distinct design-emotional response relationships across the four studies which together support the notion that urban designs, via both their overall quality and the composition of specific designs, can impact adolescents' mental health. This first overarching contribution may have implications for adolescent place attachment and sense of place. Prior to this dissertation's work, salient criticisms levelled against the scholarship examining adolescent mental health and urban environments has argued that the existing evidence is heavily weighted towards greenspace studies (Fleckney & Bentley, 2021), and that this narrow scope of study has resulted in limited insights pertaining to other forms of public spaces and environmental interactions that may impact the mental health of this cohort. Chapters 3 through 6 address this critique through examining adolescent emotional response in reference to a selection of different designs in the form of real-world and video examples that correspond with built, natural, and more mixed spaces. Synthesizing findings from these chapters explicates multiple potential pathways through which a place's design details, overall quality, and specific compositions may impact the emotional responses that inform adolescents affective relationships to different public places. Collectively, it seems that the quality and composition of physical designs in public places appear to have considerable implications for adolescent mental health through the *types or nature of emotional engagement opportunities* they present. Such insights importantly reflect potential adolescent-specific place attachment considerations that diverge from the

more robustly studied preferences of adult populations, and thus offer planners, urban designers, and public health practitioners with more demographically appropriate design recommendations.

Scholarship regarding place attachment (i.e., emotional bonds one has with a place) and sense of place (i.e., human relationships to place) phenomena between individuals and specific areas has put forward that people often choose to interact with or live in environments that are congruent with their self-concept or that they positively relate to (Shamai, 1991; Twigger-Ross & Uzzell, 1996). Such relational bonding processes with places are consequential for mental health as they have long been argued to reflect universal affective ties that fulfill fundamental human needs (e.g., Relph, 1976; Tuan, 1974) as well as deeply emotional and moving connections that can impact peoples' overall functioning (Brown et al., 2003; Hidalgo & Hernandez, 2001). The attachments one may develop to specific places can also translate into feelings of pride, one's general sense of well-being (Harris et al., 1995), or significant affective feelings (Brown & Werner, 1985). Findings of this dissertation suggest some of the paths through which urban and architectural designs may influence these or similar processes with respect to adolescents and ultimately impact their mental health.

Places' design compositions which afforded adolescents *positive perceived social contexts* (i.e., a place to hang out, socialize, linger) appeared to support healthy emotional experiences among adolescents. The prominence of specific concepts like human scale and enclosure concepts in particular were reputed to be significant designs with respect to the perceived social environment and interaction affordances that connect adolescents to public spaces. As alluded to variously in the integrated article discussions, these design affordances may improve adolescents' emotional bonds with local environments centrally because they enhance the usability of public places, offer opportunities for spontaneous social interactions, prompt more spatial/place contemplation than places which adolescents cannot use or linger in, or help facilitate calming interpersonal experiences of 'being away' (natural enclosure). To better illustrate this point, findings from Chapters 3 and 5 indicate that an assembly of human scale design features (e.g., area furniture, navigational aids, wide paths/sidewalks) in an area seem to reinforce each other's appeal and collectively support opportunities for positive social experiences or prolonged visits or interactions—a similar sort of mutual design reinforcement idea to the "sidewalk ballet" described elsewhere (see Jacobs, 2007). Unlike older adult populations which have been reputed to draw heavily from factors like cumulative memories int their place attachment understandings (Phillipson, 2007), it might be that positive social affordances related to design are especially important for adolescents given their lack of familiarity

and pre-existing comfort with public spaces. Meanwhile, greater enclosure in place designs, and especially instances of natural enclosure, also appeared to be efficacious with respect to fostering social interactions via extended stays or affective benefits. On this point, Chapter 3's expanded discussions related to enclosure in design suggested that higher levels of natural enclosure (e.g., tall overarching or concealing arrangement of trees) in the composition of an area's design helped reduce distractions and keep focus within a space, reflecting an experience that could consequently afford adolescents a calming place to enjoy together or 'be away' from things. By identifying these types of afforded social opportunities, this dissertation contributes novel insights related to delineating potential pathways through which place designs can afford important social and interpersonal interaction opportunities that positively connect or attach adolescents with their local environments (i.e., enhances their sense of place, place attachment).

Collective findings from this dissertation as well found that place design quality and composition can impact adolescent mental health through the *number and types of emotional engagement opportunities that they afford*. Here this dissertation's research might outline a number of potential place attachment factors between specific urban designs and adolescent emotions. As it has been documented that many individuals' favorite places tend to be those that have high restorative potential because these are locations where one can feel relaxed and forget their worries (Gifford, 2014), the cross-study findings of this research suggest that public places high in enclosure and complexity designs, and especially in natural forms, seem to afford multiple, high-impact, and positive emotional engagement opportunities for adolescents. However, perhaps more intriguingly, built urban environments which contained unique or distinctive visuals (i.e., imageability) also appeared to afford relatively more positive emotional engagement opportunities for adolescent as well (e.g., inviting responses in Chapter 3). Corroborating this finding, similar dynamics seemed to be true specifically in relation to higher levels of complexity (e.g., colours, architectural styles) and imageability (e.g., historical building frontages, non-rectangular form(s)) as they were linked with generally more salubrious emotional responses (Chapter 5). In reference to physical design ornamentation, humans possess advanced recognition and processing of naturalistic patterns (e.g., tree-like structures, floral ornamentation) (Coburn et al., 2019; Salingaros, 2014; Verbeek & de Waal, 2002), as well as contours or curvature (Taylor et al., 2005; Vartanian et al., 2013). Chapters 3 and 6 of this dissertation posit that the CA concept of biophilic architecture appear to be an ornamentation style that adolescents positively emotionally engage with as well. In this way the dissertation's

findings illuminate that the nature and number of emotional opportunities afforded by a given place, and which can consequently potentially impact the place attachments of adolescents, can vary significantly in their impact(s) depending on the design composition and quality of the place.

The results of this dissertation also present original findings outlining that those urban designs and compositions which *afford more active use opportunities* for adolescents seem to better support positive emotional outcomes, and could subsequently contribute to more healthful place attachments. This dynamic may perhaps represent one of the clearer divergences regarding important adolescent-specific (i.e., not adult) urban design affordances. To this end, it has previously been observed that younger groups tend to think of place in relation to informal social groups while older groups may emphasize more immediate home concerns (American Association of Retired Persons, 1997; Rowles and Watkins, 1993); designs which support more informal activities, active uses for groups, or larger social gatherings might consequently be of greater utility or value to adolescents. To perhaps most clearly illustrate this point the example of streetscape design is used here. Streetscapes designs have been highlighted as an important aspect of the public social realm as they provide places for individuals to engage in various interactions and for communities to cultivate a distinct sense of place (Manzo, 2018). Not only can streetscape features improve health (Maas et al., 2006), but certain designs (e.g., selection of street furnishings) can support or encourage the development of positive social relationships, feelings of belonging (Forrest & Kearns, 2001), and general social cohesion (Rios et al., 2012). Findings from Chapters 3 and 5 suggest that public spaces like streetscapes which are perceived as having more accessible affordances, such as higher levels of human scale and transparency designs, appear well suited to encourage the active use of places by, and social cohesion or feelings of belonging among, adolescents. Chapter 3's qualitative discussions specifically outlined that scale and transparency designs were perceived as generally creating comfortable and safe place dynamics (e.g., street barriers, benches, lights—scale designs), as well as being central to generating more interest in a place due to multiple activity options (e.g., shopping, restaurants, parks—transparency designs). Chapter 5's findings subsequently supported these discussions by delineating significant associations between the two aforementioned design concepts and positive affect (i.e., pleasant, joyful) responses. Taken together, this dissertation's research offers empirical evidence indicating that particular design compositions which encourage the active use of public places appears to positively impact adolescents' emotional states. These findings could consequently suggest additional potential pathways through which urban designs may impact adolescents' place attachment

processes, and subsequently how urban design conceptualization, policy, and implementation could be oriented in a manner so as to support the social and emotional development needs of this cohort.

7.3.2 Adolescent Perceptual Emphases Regarding Urban Designs

The second overarching research contribution of this dissertation is the undertaking of an exploratory examination of, or first attempt to detect, the links between precise emotional responses and distinct urban design concepts which found that adolescents tend to emphasize design affordances characterized by usage opportunities, safety, distinctiveness, visual richness, and positive affect experiences. Together these findings add to planning and landscape architecture literature by offering an improved understanding of specific design influences germane to adolescent place preferences—a noted concept that represents an important environmental factor in the general well-being (Korpela et al., 2002) and life satisfaction (e.g., Kaplan, 1995; Zelenski & Nisbet, 2014) of younger populations. Previously it has been argued that peoples' place preferences are centrally connected to environmental factors that fulfill their needs or feature 'welcoming properties' such as manipulable elements which can be reassuring, or the comfort of material in a place which can encourage or repel use (Salingaros, 2017). Alternatively, place and design preferences have been linked to theoretical literature that has suggested evolutionary bases for the human preferences for curves and patterns in design, as well as a disinclination for blank surfaces in design (Salingaros, 2018). However, presently little study exists which has sought to explore some of these ideas with respect to adolescent populations (Chapter 2). To this end, this dissertation's research resulted in the identification of several links between specific urban designs and adolescent emotion responses which might suggest potential design preference trends. Specifically, the findings observed in this dissertation suggest that adolescents seem to prefer places featuring those designs characterized by usage opportunities, safety, distinctiveness, visual richness, and positive affect experiences. Through delineating these potentially important urban design factors affecting adolescent mental health, and specifically as they may relate to adolescent place preferences, it is also discussed how built environments may be designed in the future to support the mental health needs of adolescents.

Triangulating across the exploratory analyses of this dissertation, it emerged that adolescent emotional responses seemed rather strongly linked to design affordances characterized by *usage opportunities and safety*—affordances most often linked to the concepts of human scale and transparency designs. Importantly, such designs and their associated emotional affordances may help

to support adolescent developmental needs like autonomy (Hoxworth, 2021) by aid in the development of pedestrian transportation networks that teenagers perceive as safer and more accessible, and thus more likely to utilize and explore. Related bodies of literature have previously reported that the presence of scale concepts like paths, proximity to parks, and the availability of playgrounds and sport facilities are environmental designs that can support adolescent physical engagement with places (Gardsjord et al., 2014), while larger use spaces (transparency) like school grounds featuring vegetation can also improve young people's experiences with places (Chawla et al., 2014). Building on the work of these other studies, the collective findings of this dissertation add that the inclusion or prominence of human scale and transparency design features in public spaces might support adolescent mental health through enhancing an area's perceived safety and encouraging the active use of various public settings. In particular, Chapter 3's findings expounded that human scale and transparency features such as both built street features (e.g., wider sidewalks, street barriers) and natural street features trees (e.g., planters, hanging flowers, front yard gardens), transparent street-level façade features (e.g., windows in façades at street level), and infrastructure maintenance/presentation (e.g., lack of mess/debris) were important perceived factors in space safety and usability, while the results of Chapter 5 likewise showed relatively larger and significant associations between decreases in negative affect and increases in both human scale and transparency. Taken with the existing mobilities scholarship on similar topics, this cross-study finding importantly contributes knowledge that makes clear several links between adolescent emotions and specific design concepts. These documented emotion-design associations may help in further outlining and identifying specific design-based factors that fulfill adolescent needs (e.g., autonomy or need for exploration via affording security in place), and subsequently inform their place preferences.

In a like manner the research from this dissertation detected that those *affordances characterized by their distinctiveness or visual richness* (i.e., imageability, complexity) appear to be quite effectual with respect to affecting adolescent emotional connections with places. As noted above, it has been argued physical place preferences may be connected to humans' evolutionary history with processing real-world instances of architectural details such as other naturalistic patterns (e.g., tree-like structures) (Coburn et al., 2019; Vartanian et al., 2013; Verbeek & de Waal, 2002), as well as more recently documented preference for visual diversity in landscapes more broadly (Chatterjee et al., 2021). The investigations contained within this dissertation offer empirical evidence regarding some of these relationships and their applicability to adolescent populations. Interpreted in

reference to place preferences, the findings of Chapters 3, 4, and 6 could be understood as suggesting that urban areas which more prominently feature both distinctive (imageability) and visually rich (complexity) elements in their aggregate designs are more likely to elicit healthier emotional responses among adolescents in part because they represent influential higher order[8] perceptual variables that convey positive emotions like fascination and contemplation. Moreover, and more precisely, Chapter 5 specifically documented concurrent significant associations between increases in complexity, and to a lesser extent imageability as well, and responses of positive affect (e.g., happy) and decreases in negative affect (e.g., sad) among adolescents, while Chapter 3's discussions regarding imageability suggested that the presence of natural (e.g., gardens) and built (e.g., bell tower) landmarks provided adolescents with important navigational aids that were reputed to be positively perceived. Together these triangulated findings appear to lend support to the previously theorized relationships, and especially the impacts of visually rich places or place designs on the emotional states of adolescents, and thus might suggest additional design-specific factors in adolescents' place preferences.

Finally, across the multiple studies of this dissertation it was found that adolescents' emotional responses to the specific notions of the examined PTODs and CA concepts were more likely to be characterized by *experiences of positive affect*. Such links are particularly noteworthy when considering how urban designs may support adolescent needs, and specifically their sense of belonging or identity (Hoxworth, 2021). Unlike adulthood, adolescence is a period of life characterized by change, uncertainty, and a desire to assert independence (Hoxworth, 2021); designing public spaces that elicit such positive affective experiences could be one mechanism by which place design might foster meaningful (e.g., positive pride, self-esteem) relationships among adolescents or encourage positive personal identity development (e.g., connection with character/quality of design). To this end, similar to the previous discussions which noted the potential primacy of need fulfillment in place preference, much of existing the scholarship pertaining to place preferences has also been based in the ecological perspective of embodied cognition which holds that human cognition is fundamentally linked to embodied experiences resulting from biological, cognitive, and social interactions (Varela et al., 1991). The environmental information

[8] To reiterate the definitions in Chapter 1: higher order variables are those used by the perceptual system as efficacious combinations of lower order variables; lower order variables being those typically closer to traditional psychophysics like wavelength, extent, intensity (Hochberg, 1998).

which individuals process is thus acquired from a variety of modalities and coded and stored through multiple processes including the subsymbolic (i.e., processing through sensory, motor, and somatic modalities) and symbolic (i.e., processing through visual and/or linguistic/verbal modalities) (Bucci, 2003) which often work in concert during environmental perception interactions (Bell, 1999; Bundy et al., 2002). Accepting the presence and contingent impacts of these processes, the combined findings of this dissertation's two in-situ studies (i.e., Chapters 3 and 6) put forward that adolescents may respond positively to and thus prefer areas with higher aggregate PTOD quality for reasons related to their sensory experiences like esteem (e.g., pride attached to local landmark—imageability), or subsymbolic aural (e.g., nature sounds, reduced artificial noise—imageability) or aesthetic (e.g., diverse building colours, area flora—complexity) inputs. Likewise, this dissertation's findings concerning the incorporation of biophilic architecture (also Chapters 3 and 6) in public places suggests that this form of ornamentation could be a positive architectural detail as it reflects an additional subsymbolic design input which contributes to informing adolescent place preferences. And while not conducted in-situ, the findings of Chapter 4's aggregate design quality evaluation could be interpreted in this context as showing that those places high in overall PTOD quality (e.g., pedestrian plaza) perhaps elicit more positive affect responses due to containing multiple important symbolic features (e.g., landmarks, pieces of public art), fewer negative subsymbolic aural inputs (mainly vehicular noise), more positive sensory experience inputs (e.g., calmer sights from natural enclosure), and/or better aesthetic properties (e.g., historic building façades or ornamentation). In identifying the seemingly robust connections between PTOD and CA concepts and positive affect responses among adolescents, this dissertation's exploratory analyses 1) offers original empirical evidence detailing the potential of pedestrian-oriented and visually detailed designs to influence adolescent emotional states, and in turn potentially influence adolescent place preferences and, consequently, 2) outlines potential pathways through which place design might support specific adolescent needs.

7.4 Methodological Contributions

The combined work of the five integrated articles of this dissertation contributes a theoretically informed and mixed methods investigation regarding a variety of precise links between urban designs and adolescent mental health indicators. Substantive methodological contributions of this work can be foremost gleaned from the overarching mixed methods structure of the dissertation, and secondly from the application of the theoretical frame to this research (see section 7.4.1). Beyond

these overarching structures, the dissertation also makes three more pointed contributions as it provides: 1) an explicit multifield literature review and synthesis of three relevant bodies of literature in service of comprehensively framing the adolescent mental health and urban environment topic (Chapter 2), 2) two primary analyses of in-situ adolescent emotional responses to distinct urban and architectural designs through the use of ecologically-oriented methods (Chapters 3 and 6), and 3) two complementary primary analyses of a set of mental health indicators and urban designs among a nationally representative sample of adolescents (Chapters 4 and 5) (see section 7.4.2).

7.4.1 Contributions of the Mixed Methods Structure, ToA Framework

With respect to the mixed methods structure of this work, arguably its most important contribution is the facilitation of a multi-study investigation that was particularly extensive (breadth) in its scope of the relationships examined (Curry & Nunez-Smith, 2015). Consequently, this structure produced a range of findings relevant to multiple ongoing academic, policy, and practice discussions and their associated audiences. This mixed methods structure also allowed for the dissertation to incorporate a broad range of discussions related to perceptual, socio-ecological, and environmental factors (Creswell & Clark, 2007) relevant to the examined relationships in its component manuscripts. Considerations such as professional definitions and practice and policy considerations (Chapter 2), first-person perspectives and understandings or experiences (Chapter 3 and 6), and group-level trends in emotional responses (Chapter 4 and 5) were similarly each incorporated, and together contributed a unique set of insights (Patton, 1990; Sayer, 1992) that the larger triangulation of this chapter has made use of in its interdisciplinary synthesis and discussions.

Applying the ToA as a theoretical framework likewise allowed for this dissertation to provide a coherent and consistently informed multiple manuscript investigation. Noting that previous work has highlighted the lack of theory-informed scholarship investigating built environment and mental health topics (e.g., Mair et al., 2008; Sloan, 2018), this dissertation contributes three separate studies, producing four manuscripts, that were framed within an explanatorily powerful framework. Across these studies the ToA informed the development of strategic research questions, selection of appropriate data collection methods (e.g., survey variables), framing of the discussion points, and range of constructive recommendations offered for future study. Perhaps most importantly, though, the use of the ToA allowed for the integrated articles in this dissertation to reliably speculate (Osanloo & Grant, 2016) on potential explanations regarding the environment-emotional response

links observed in the findings by providing a guide to interpret trends in the quantitative work and give meaning to the emerging results of the qualitative study. In this way the use of the ToA helped the integrated articles of this dissertation present more precisely framed evaluations which explicitly considered the interplay between perceptual dynamics, perception-environment interactions, and decision-making processes with regard to their respective research questions, For example, this can be observed in Chapter 5's discussions pertaining to the potential role of cognitive perception phenomena (e.g., fascination, 'situated experiences') in the documented relationships between emotions and concepts like complexity and imageability. These types of insights would likely not have been possible using the health and place frameworks alluded to in Chapter 1 (section 1.3.1) such as 'place effects on health' (Macintyre et al., 2002), healthy cities (e.g., Corburn, 2009), or 'relational geographies' (Cummins et al., 2007). Recognizing the several elements of mental health as outlined in the Galderisi et al. (2015) definition, the use of the ToA in this work afforded the research of this dissertation the opportunity to conduct a more precise analysis of the perceptual dynamics, perception-environment interactions, and embodied cognitive processes relevant to the urban design-adolescent emotional response relationship rather than, for example, exploring these findings with respect to shared neighbourhood compositional factors (as prioritized in various health and place frameworks).

7.4.2 Contributions of the Specific Integrated Articles, Interdisciplinary Approach

Each of the integrated articles in this dissertation also make their own methodological contributions. In order to adequately frame the topic of this dissertation and subsequently guide the direction of the ensuing primary research manuscripts, Chapter 2 provided an original multifield literature review and synthesis. In doing so Chapter 2 explicitly linked together the relevant fields of planning and public health—two fields that have been criticized for being too siloed with respect to other issues such as physical activity (Koohsari et al., 2013) and emergency response planning (Wolf-Fordham, 2020)—with the emerging area of neurourbanism. This deliberate cross-field synthesis contributed to the development of two novel guiding frameworks that delineated several possible paths for researchers and professional practitioners to collaborate and address the topic of urban environments and young people's mental health. With regard to the frameworks presented in this manuscript, the review and synthesis resulted in the addition of a fifth level (i.e., digital medium) to the SEM. The SEM is traditionally a four-level model which consists of the individual, interpersonal, community/environmental, and policy levels which can be used in the study of a range of social and

behavioural topics (Bronfenbrenner, 1977). Based on the materials of this review, it was decided that it was necessary to stipulate this new, digital level due to the increasing number of relevant interactions that take place on such mediums (e.g., social media), the availability of publicly accessible data, and the development of research methods that are designed to take advantage of digital platforms (e.g., sentiment analyses). In line with the dissertation's interdisciplinary approach, both frameworks also delineated a shared interactive conceptual model for individuals from across the targeted fields to use in future collaborations. Such collaboration opportunities, if acted upon, not only directly suggest multiple pathways (e.g., intervention designs, legislative aims) that may aid in supporting teams from different fields in further integrating their knowledge and methods, but also more broadly encourage the transcending of traditional professional and research boundaries in goal setting and strategy development regarding the topic of urban environments and young people's mental health.

Chapters 3 (go-along interviews) and 6 (EMA surveys) of this dissertation contribute two field-based primary research analyses of adolescent mental health and urban design relationships. These two methods contributed to the development and presentation of unique in-situ findings that reflect adolescents' situated perceptions of and emotional responses to of different urban designs. Chapter 3's use of go-along interviews additionally afforded adolescent participants the opportunity to take on more active roles in shaping the progress and direction of their interviews (Garcia et al., 2012) by being more involved in guiding discussions about what they deem most important (J. Anderson, 2004) in the environments with respect to their present emotions. The go-along interview approach also added a layer of ecological depth by incorporating into the interview the influences of ambient noises, and unscripted interactions and discussions, allowing for more accurate context-driven interpretations of the environment and mental health relationship being examined (Trell & Hoven, 2010). Chapter 6's quantitative EMA methods likewise provided an in-depth analysis of adolescents' in-situ emotional responses to urban designs through these data collection methods facilitating the covering of multiple dimensions of the 'events' (e.g., kinesthetic inputs) relevant to the outcomes (Moskowitz & Young, 2006), minimizing participant recall bias, and reducing random error via collecting several data points at various geographic locations (Shiffman et al., 2008). Through using these methods in tandem, these two studies offer empirical research regarding the emerging topic of adolescent emotional responses to urban designs that accounts for a variety of situated environmental factors that are omitted in more traditional methods (e.g., standard sit-down

interviews). Finally, this amalgamating of complementary but coordinated methods also further supports the contributions of the interdisciplinary (Choi & Pak, 2006) aim of this dissertation by advancing a more complete understanding (i.e., first-hand descriptive and responses analyses) of the adolescent emotion-urban design relationship in ways that would have not been possible through a single or non-ecological methodological means.

Chapters 4 and 5 present two novel primary research investigations of group-level trends from a nationally representative sample of Canadian adolescents regarding their emotional responses to quantitatively scored urban environments of differing pedestrian infrastructure quality. Of note, at present, these two online survey studies appear to be some of the first theoretically informed evaluations of an adolescent mental health topic in relation to both built and natural settings that also control for a variety of covariates (Fleckney & Bentley, 2021). As such these manuscripts offer a topical and relatively robust evaluation of how adolescents emotionally respond to a number of distinct public spaces of varying pedestrian infrastructure quality (Chapter 4) and specific design concepts in particular (Chapter 5). In identifying these group-level trends, this dissertation delineates some of the first large-scale significant associations between adolescent mental health indicators and specific urban design concepts which, consequently, provides practitioners with potential innovative design strategies that may have more applicability relative to the work of this dissertation's other primary research manuscripts. Conversely, taken along with the manuscripts of Chapters 3 and 6, this organization of the primary research manuscripts of this dissertation in such a complementary manner (i.e., combine smaller scale in-depth along with larger scale group-level analyses) supports another core notion of the larger interdisciplinary approach of this dissertation: applying a holistic analytical scheme. This development eventually allowed for the final synthesis of the present chapter to draw from a more holistic analytical scheme that isn't subordinate to a singular discipline-specific approach or set of accompanying explanations (Choi & Pak, 2006).

7.5 Implications for Policy and Practice

Table 1.3.1 in Chapter 1 outlined that the theory-informed research of this dissertation could support various professional planning activities including enhancing practitioner knowledge regarding adolescent-friendly designs, informing practitioner perspectives to better consider adolescent relational dynamics in their policy deliberations, and promoting design and land use policies that facilitate improved adolescent mental health. Following up on these points, the variety of implications

for policy and practice in different fields and on different issues is summarized in Table 7.5.1. The pursuit of these objectives is organized according to three general areas: collaborations, planning and urban design endeavours, and public policy initiatives.

Table 7.5.1 List of Policy and Practice Recommendations

Audience	Point(s)	Example(s)
Collab.	• Foster transdisciplinary collaboration perspectives	• Develop complementary policy approaches for local issues • Learn from other local/regional/int'l. plans and strategies
Planning, Urban Design	• Focus on designing: aesthetically pleasing, visually diverse, and naturalistic public spaces	• Develop aesthetically pleasing spaces (i.e., *complexity* in both specific buildings and larger landscapes) • Maintain public area presentation, design for multiple preferred visual inputs • Integrate various forms of nature in physical design and larger public spaces (e.g., natural enclosure)
	• Link design knowledge to behaviour change promotion	• Environmental design interventions for frequently used spaces
	• Targeted programming via digital mediums	• Smartphone interventions for local environmental awareness, education • Parental education campaigns
Public Policy	• Link relevant local policy with environment-based strategies and/or interventions	• Adoption of Child Friendly Cities objectives with mental health targets • Support prevention and promotion efforts via pedestrian infrastructure

7.5.1 Cross-Sector Collaboration

Chapter 2's discussion can be understood as centrally suggesting that there is a need for practitioners in multiple fields to continue to develop transdisciplinary perspectives that seek to discern the relevant mental health concerns, developmental needs, and experiences of adolescents as they relate to their interactions with local environments and designs. Such a transdisciplinary perspective should be rooted in efforts that seek to integrate natural, social, and health science expertise relevant to an issue of interest in furtherance of transcending potentially cumbersome traditional boundaries (Soskolne, 2000); and subsequently develop projects in which collaborations create shared conceptual models of the issue at hand that holistically integrates each of their separate

disciplinary perspectives (Rosenfield, 1992). One potential worthwhile strategy that may be pursued in this regard by local planners, public health experts, and/or policymakers is to develop concurrent and complementary local design and infrastructure policies. Potential examples include pairing together some combination of pedestrian infrastructure legislation that aims to reduce ambient noise pollution to address sleep and annoyance issues (Tiesler et al., 2013) with mixed land use policies that improve access to health services and facilities (Feng et al., 2010) and/or promote social pursuits and active travel (Ahn & Fedewa, 2011), with design policies that aim improve the ease of urban navigation (e.g., wayfinding, signposting) which reduce stress and improve place usage (Chapter 3).

A second strategy in this context is for multifield collaborations to engage in co-learning processes that facilitate learning from successful examples in other contexts. Growing numbers of examples both domestically (Canada) and from abroad offer several interesting sets of strategies that interested local collaborations may learn from. Domestically, for example, Halifax, Nova Scotia has instituted a Regional Youth Advisory Committee which facilitates youth having the ability to voice their perspectives directly to local councils, enhances the viewpoint diversity of local government proceedings, and educates youth on relevant policies that affect them (Halifax Regional Municipality, 2022). Sault Ste. Marie, Ontario, meanwhile, runs a Mayor's Youth Advisory Council which administers a specific fund to support the council, educate youth in the community, and advocates on behalf of the local youth in related matters (Corporation of the City of Sault Ste. Marie, 2022). Alternatively, Vancouver, British Columbia has developed a Civic Youth Strategy that encourages youth participation in decision-making and policy development within the City via capacity-building programs and building youth-specific networks (City of Vancouver, 2010). International initiatives have also implemented innovative strategies in this domain. Ghent's (Belgium) child and youth friendly initiatives, for instance, feature an action plan that includes involving young people in drafting the Master Plan Ghent (City of Ghent, 2015), while Recife's (Brazil) child-oriented planning initiatives have resulted in establishing "children's priority zones" that seek to create safer travel routes for families to access essential services and provide public open spaces for unstructured play (Princeton University, 2019). Such strategies from these different examples represent valuable resources or blueprints that future collaborations can learn from and utilize in their own efforts to design more youth/adolescent friendly public spaces.

7.5.2 Planning, Urban Design

Planning practitioners specifically may foremost find use in the results of this dissertation to design public spaces or pedestrian infrastructure that increase emotional engagement opportunities for adolescents through 1) developing aesthetically pleasing spaces, 2) enhancing the visual richness and maintaining the presentation of public areas, and 3) integrating various forms of nature into urban designs. With respect to the first point, this dissertation and other existing research has both indicated that aesthetically pleasing public spaces and exterior architecture can elicit eudemonic (i.e., happy) emotional responses (Seresinhe et al., 2019), and that architecture characterized by a lack of biomorphic ornamentation (e.g., naturalistic patterns) can produce more negative emotional responses (Coburn et al., 2019). Regarding specific design recommendations seemingly connected with aesthetically public spaces among adolescents, Chapters 3 and 5 suggested that the prominence of complexity (e.g., variety of gardens or flora colours, building designs)—as well as imageability in some contexts (e.g., non-rectangular buildings, landmarks)—may be particularly beneficial for contributing to positive emotional states or experiences. Importantly, however, as recognized earlier in this synthesis, urban morphologies can be quite diverse (Keil, 2017) and thus this type of recommendation needs to be carefully considered in reference to different projects and spaces. With that said, in an effort to avoid the future development or remedy the current existence of visually effete urban areas, aesthetically pleasing design pursuits could range from the advancement of vibrant built commercial spaces in central areas (e.g., Willemstad; assorted building colours, styles, ornamentation, outdoor dining), to diverse natural spaces located throughout an urban area (e.g., Chicago Botanical Gardens; variation in flora and colour, landmarks), to built pedestrian areas with both architectural and natural richness (e.g., Karlovy Vary; varied building ornamentation and colour, considerable incorporation of nature into streetscape (street trees, parks, planters)) (see Figure 7.5.1).

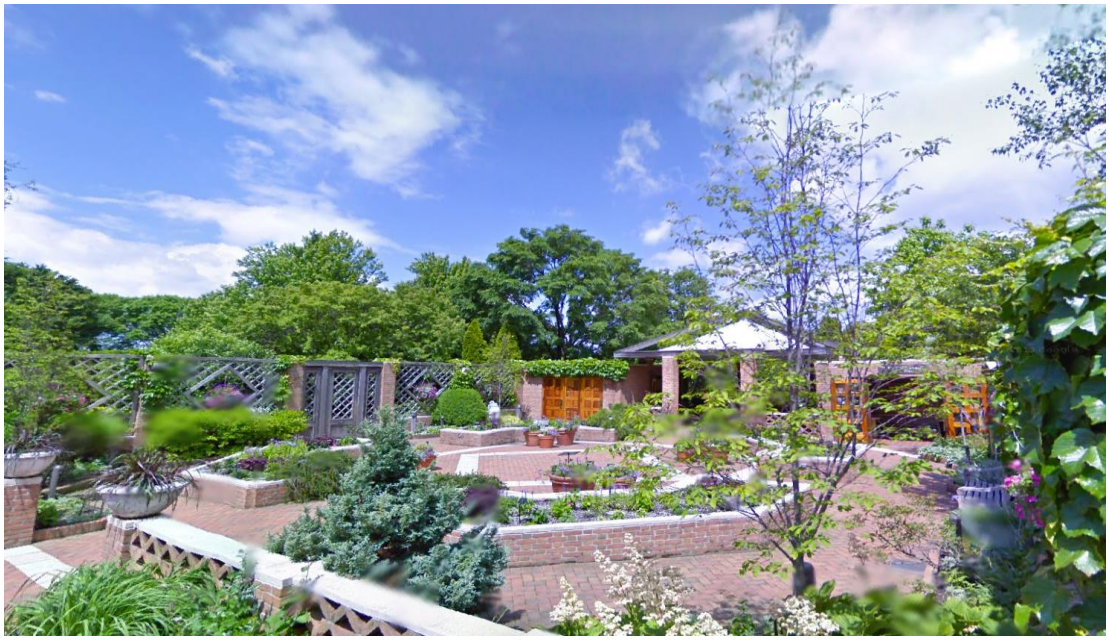
Concerning the second point above, results from this dissertation also generally indicated that the visual richness and overall presentation of spaces can potentially aid in public spaces eliciting positive emotional, and sometimes restorative, experiences among adolescents. Testimonies from Chapter 3 suggested that well-kept spaces or façades, as well as diversity in area colour schemes and designs, were particularly important to adolescents' experiences of public spaces—both the former (Hur & Nasar, 2014; Lee et al., 2017) and latter (Hadavi et al., 2015) findings having similarly been observed among adult populations. Considering the potential cross-cohort benefits of these designs, planners and urban designers could work to identify local urban environments lacking in complexity,

or more generally their overall presentation (e.g., monotonous residential developments, nondescript parks, hollow city plazas; again, see Figure 7.5.1), for targeted improvement projects such as those noted above. Another broader approach for planners to consider on this point, and one that has been taken up for other groups such as people living with dementia (PLWD), is to advocate for and design public spaces that contain multiple preferred visual inputs for adolescents. Similar to a recent review regarding PLWD, this dissertation's findings suggest that such a program could focus on designing spaces featuring wayfinding aids (human scale), maintaining points of interest (e.g., landmarks; imageability), with 'pedestrianized' streets that are distinguishable from typical roads (human scale), variety in building appearances (complexity), and public art (imageability) (Gan et al., 2021).

Figure 7.5.1 Comparison of Different Urban Morphologies by Visual Richness/Effeteness

Visually Rich/Aesthetically Pleasing Designs and Public Spaces

Higher quality built complexity reflected in varied architectural styles, colours, and building ornamentation (Breedestraat, Willemstad, Curaçao, Photo from: Google Maps ©2017)



Higher quality natural complexity reflected in varied types of flora and colours, along with being a ‘pedestrianized’ space (Chicago Botanical Gardens, Chicago, US, Photo from: Google Maps ©2011)

Higher quality complexity derived from a ‘pedestrianized’ space featuring an assortment of built designs and details, as well as naturalistic components (streets of Karlovy Vary, Czech Republic (small resort town), Photo from: Google Maps ©2019)

Visually Effete/Aesthetically Unattractive Designs and Public Spaces

Lower quality built complexity in a residential development characterized by monotonous designs and a simplistic colour palette (Suburbs of Amman, Jordan, Photo from: Google Maps ©2017)

Lower quality natural complexity in an urban park characterized by little diversity in flora types and colours, few pedestrian features (Genevive Park, London, Canada, Photo from: Google Maps ©2020)

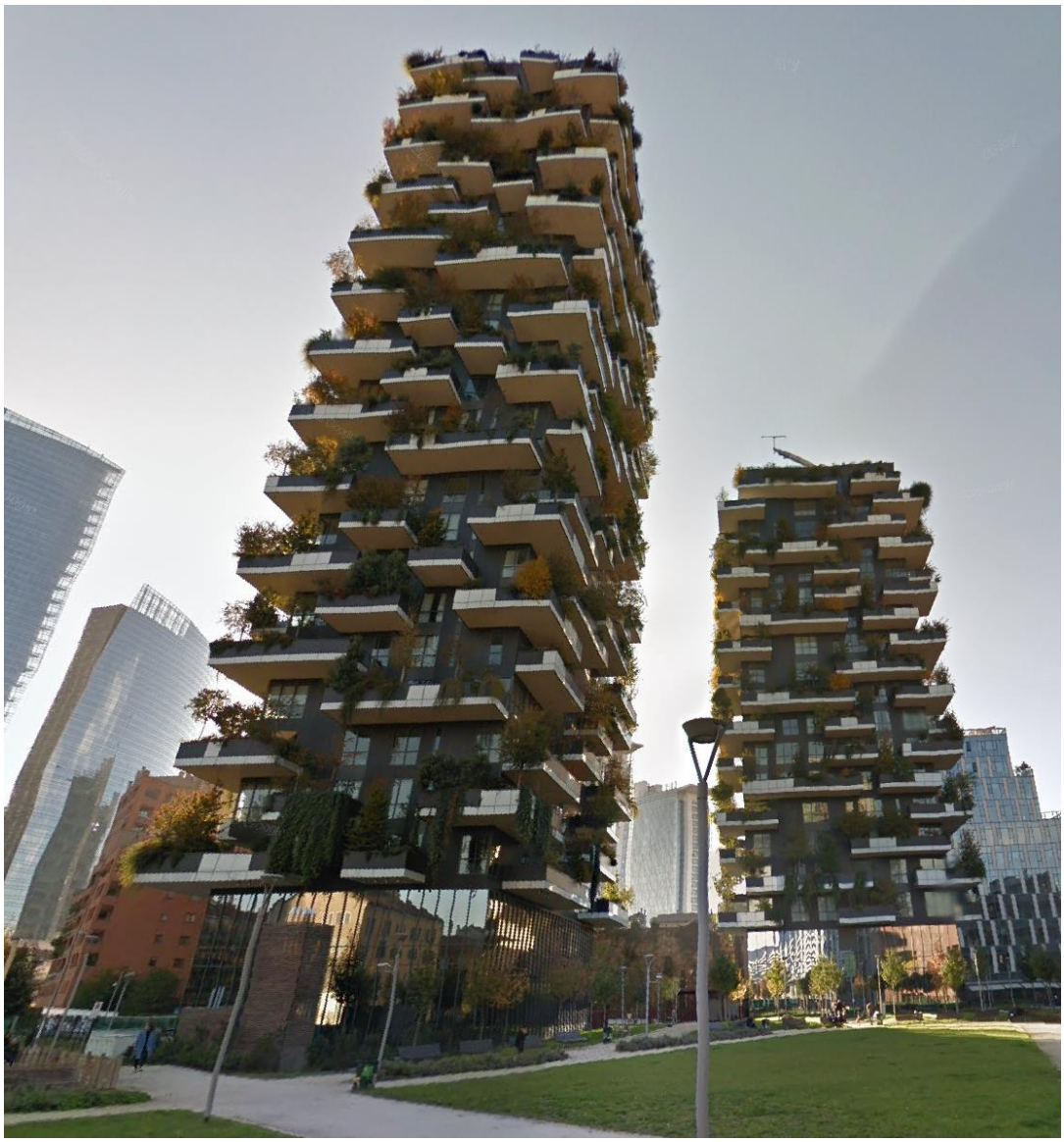
Lower quality built complexity in a city centre area featuring a lack of design diversity and detail, non-rectangular buildings (Square One, Mississauga, Canada, Photo from: Google Maps ©2021)

With regard to the third and final point listed at the start of this section, the findings of this work also suggest that planning practitioners could contemplate implementing various forms of nature into public space designs and exterior architecture ornamentation in service of supporting adolescent mental health. More pointedly, results pertaining to the biophilic architecture concept evaluated (Chapters 3 and 6) were, in multiple respects, consistent with previous scholarship that has argued more generally naturalistic improve aesthetic appeal and preference (Joye, 2007), and more specifically that buildings/exterior architecture which contain high densities of natural visual patterns are also more highly preferred than those with lower levels of such features (Coburn et al., 2019). To this end, this dissertation moves that the potential exists for planners to advance their focus on including CA concepts (notably biophilic architecture) and natural forms of enclosure designs into future projects to support adolescent mental health. Strategies aiming to deign spaces that incorporate such natural elements to support positive adolescent engagement with public settings in urban areas can also be pursued via a number of different manners/forms. For instance, planners seeking to institute such design concepts in their local contexts may consider applying these findings in various urban morphologies such as dense residential and commercial spaces (e.g., Milan and Singapore, vertical designs on high rises), parks and plazas in otherwise built-up urban areas (e.g.,

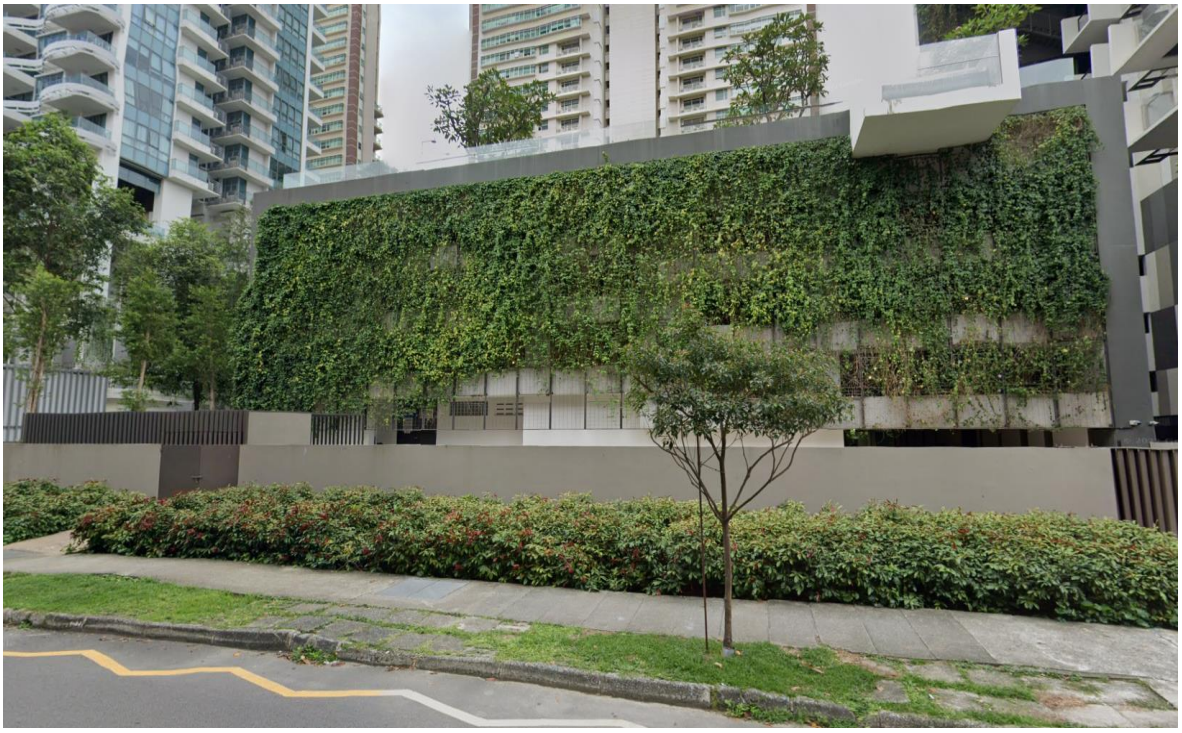
Changgyeonggung Palace, Seoul, high levels of canopies in built space), or central urban landmarks or points of interest (e.g., Argentine congress, Buenos Aires, multiple naturalistic ornamentation details incorporated into exterior architecture) (see Figure 7.5.2).

Figure 7.5.2 Comparison of Naturalistic Designs and Ornamentation Examples

High Quality Naturalistic Design (e.g., Enclosure) and CA Concepts (e.g., Bio. Arch.)



Appreciable incorporation of biophilic architecture and naturalistic designs in a dense built-up residential area (Vertical Forest, Milan, Italy, Photo from: Google Maps ©2015)



Appreciable incorporation of street level green façade (biophilic architecture) in a dense built-up commercial area (Singapore, Photo from: Google Maps ©2022)

Higher quality natural enclosure in an otherwise built-up urban space (Changgyeonggung Palace, Seoul, South Korea, Photo from: Google Maps ©2015)

Built design with significant biomorphic (fractals; e.g., column details) and symmetrical ornamentation (Palacio del Congreso, Buenos Aires, Argentina, Photo from: Google Maps ©2021)

Low Quality Naturalistic Design (e.g., Enclosure) and CA Concepts (e.g., asymmetrical)

Built design with a lack of biomorphic or symmetrical ornamentation, lack of naturalistic design is less emotionally engaging (Buffalo City Court, Buffalo, US, Photo from: Google Maps ©2021)

Higher levels of built enclosure may have different mental health implications than comparable levels of natural enclosure (Suburban São Paulo, Brazil, Photo from: Google Maps ©2021)

Lower quality naturalistic design and enclosure in a city centre and pedestrian area is also less emotionally engaging (Boston City Hall Plaza, Boston, US, Photo from: Google Maps ©2021)

Findings of this dissertation may also be useful to planners and urban designers more interested in larger-scale health promotion or behavioural change topics. For instance, areas

frequented by adolescents could be targeted for future health promotion programs with an urban design component. Using the primary research of this dissertation, future environmental health promotion interventions could consider increasing the natural enclosure (Chapters 3 and 6), enhancing the diversity of built designs and colours (Chapters 4 and 5), and/or instituting biophilic architecture elements (e.g., urban gardens, green walls) (Chapter 6) in or around spaces that adolescents frequent (e.g., schoolyards, local parks, recreational areas) to support their mental well-being. Tailoring or personalizing interventions can also be particularly desirable as a programmatic feature (Noar et al., 2007) for health promotion initiatives. One targeted approach to mental health promotion among younger populations that has seen some promising results is smartphone-based interventions (Buttazzoni, Brar, et al., 2021). As it concerns urban design and adolescent mental health, future smartphone-based mental health promotion interventions could utilize this research (Chapters 3-6) through delivering a series of different strategies including: information about how pedestrian infrastructure can support adolescent mental health, updates regarding local park or recreation facility features to promote their usage, reminders about the benefits of regularly interacting with nature, or specific educational or awareness content (e.g., importance of outdoor or free play and socialization). Targeted programs and initiatives could alternatively focus on parental awareness and education topics regarding adolescent mental health and urban design. Parental education strategies might aim to highlight to parents/guardians examples of how pedestrian infrastructure can support adolescent free play and social development, such as bluespaces or pedestrian plazas offering social and leisure activity opportunities. In the context of digital mediums, other approaches could seek to develop digital resources and programs that deliver health promotions via pairing gamified interventions that promote behaviour change (e.g., techniques such as self-monitoring of behaviour, social support (Edwards et al., 2016)) with knowledge regarding the utilization of local active travel infrastructure or recreational spaces in furtherance of promoting adolescent mental health via engagement with local higher quality designed public places.

7.5.3 Public Policy

With respect to using the primary research of this dissertation to improve adolescent mental health, local policymakers may consider developing specific adolescent-oriented policies that include actionable mental health and well-being objectives. One such option is for policymakers to develop legislation that supports the design and maintenance of high quality and accessible local urban environments like those espoused in Child Friendly Cities (CFCs) ideas and goals. CFCs aim to

realize the rights of children at the local level through promoting a number of different objectives such as allowing younger populations to: participate in city/community and social life, live in a safe secure and clean environment with access to green spaces, meet friends and have places to play and enjoy themselves, and express their opinions and influence decisions that affect them (UNICEF, 2022). To this end, recent CFC initiatives in Canada like the City of Edmonton's have developed Access Design Guidelines that outline policies supporting the placement of wayfinding signage and the use of tactile strips to aid younger populations' accessibility to public spaces (City of Edmonton, 2017) to support the rights and well-being of adolescents in public spaces. Findings from this dissertation put forward a variety of additional potential urban design ideas that policymakers in different jurisdictions may be consider to support similar initiatives. For instance, local policies could consider goals or policies related to achieving a certain proportion of active uses for street level buildings (e.g., 50% of buildings on street x need to meet active use criteria (i.e., buildings with uses that generate significant pedestrian traffic)), maintenance requirements pertaining to worn-out or broken-down façades in public spaces (Chapter 3), or targets outlining higher levels of visual richness and human scale designs in pedestrian areas (e.g., required street furniture or signage for buildings on street x, or x number of landscape elements on street y) (Chapters 4-6). On the potential options for policymakers to pursue those aims similar to the CFC's, these may include applying PTOD and CA concepts to design public spaces that: facilitate more social lingering and leisure opportunities (e.g., Chapter 3 and 6), seek to mitigate artificial noise annoyance and facilitate present moment awareness through spatial arrangements (e.g., Chapter 3), or improve adolescent pedestrian safety through human scale designs like safety barriers or lower speed limits (e.g., Chapters 4 and 5).

7.6 Limitations

Despite the interdisciplinary approach and mixed methods structure of this dissertation, there are a few limitations to note regarding this work. Foremost, concerning the application of the ToA in this dissertation, the ToA is a primarily behaviour-based theory that is oriented toward providing theoretical context regarding personal social-cognitive behaviour phenomena. As a consequence of this theoretical framing, this dissertation's research collectively present little with respect understanding or examining the potential behavioural economic, personal financial, or household-level SES conditions or considerations that may be germane to and influence adolescent mental health urban design relationships. With respect to the literature review and frameworks in Chapter 2, while the review was explicitly aimed at being multifield in its orientation (i.e., planning, public health,

neurourbanism), other potentially instructive areas such as engineering and social and organizational psychology were not an explicit focus of the synthesis. As a result of this scope, the review is unable to speculate directly on connections to theory and practice in these additional areas. Another noteworthy limitation of Chapter 2's review and synthesis is it's relatively wider definition and application of "mental health" as a concept. As the manuscript strived to review relevant literature from the targeted fields of study in service of promoting research and practice collaboration, it consequently didn't limit its topics of interest to more narrow or refined areas of study (e.g., discussions regarding specific groups (young adults, children) or conditions (internalizing disorders, phobias)). Particularly of note, topics such as natural spaces and adolescent mental well-being (e.g., Zhang et al., 2020) have begun to develop relatively focused bodies of literature which may be more instructive for providing relatively more precise research and practice discussions but weren't specifically discussed in this review.

More broadly, there are a few particular limitations that apply across the ensuring four primary research articles of this dissertation. First, objective measures (e.g., EEG, fMRI) are increasingly being applied to study topics related to mental health and urban environments (Buttazzoni, Parker, et al., 2021); however, only subjective and self-report measures were used in the primary research of this dissertation. An important corollary of this is that as the primary analyses conducted in this dissertation rely wholly on self-report data as there is a lack of objective measure inputs in the final synthesis. Second, the geographic and cultural context of much of the primary research within this dissertation was local to a medium-sized Canadian city (Kitchener)—although there is some variance in the online survey (Kitchener and Toronto). The operationalization of the design scores (see Appendix 7.10.5 for full scoring tool) and the subsequent findings discussed here, as alluded to earlier in this chapter, may therefore be limited in the context of other urban morphologies such as those of more densely populated or global south cities. Third, the adolescent samples examined in this dissertation were not reflective or specific to groups with particular emotional disorders (e.g., panic disorders), and consequently this synthesis is relatively restricted with respect to its insights regarding adolescents with internalizing, externalizing, mood, or personality disorders etc. Likewise, the samples that were evaluated in this dissertation were evaluated as a cohesive cohort, and thus do not provide subgroup analyses such as specifically examining pre-pubescent adolescents (e.g., ~9-12/13 years old), teenagers (e.g., ~13-17), or young adults (e.g., ~18-19). The settings scored and analyzed in this work, and which were used as the exposures to

participants, were also only evaluated in reference to their condition in nicer weather conditions. Insights regarding the potential influence of seasonality in this research are also limited. Lastly, the analyses in this dissertation focused on the mental health indicators of positive affect, negative affect, calmness, anxiousness, perceived restorativeness, and mental demand. Many other theoretically relevant outcomes could also be examined in this area of study such as mood disorder variables (e.g., dysthymia, energy levels), cognitive avoidance/engagement indicators (e.g., distraction, worry), and aesthetic preferences or naturalness (e.g., water form/layout/expanse (Ibarra et al., 2017)).

7.7 Recommendations for Future Research

In Canada mental illness is not only a leading cause of disability (Institute for Health Metrics and Evaluation, 2015; Lim et al., 2008) but is also associated with an estimated economic cost of $51 billion per year (Lim et al., 2008). Moreover, given that in Ontario the disease burden of mental illness and addiction alone has been suggested to be 1.5x higher than all cancers combined (Ratnasingham et al., 2012) while the specific issue of children's anxiety has been estimated to cost the province roughly $421 million a year (Jeffords, 2019), this section endeavours to highlights a number of different paths for future urban design-based disease prevention or health promotion research. Suggestions for future research are organized according to multimethod or mixed methods study designs, individual and family level interventions, examinations of specific environmental interactions and exposures, inquiry into specific group topics, practice-focused research with planning and public health practitioners, and policy analyses (see Table 7.7.1).

Table 7.7.1 Summary Breakdown of Areas for Future Study

Area	Example Point(s)
Mixed methods, multimethod approaches	• Use of subjective (e.g., surveys, interviews) and objective (e.g., EEG, heart rate variability monitoring) measures to outline 'restorative' or 'stressful' places • Combine digital approaches (e.g., sentiment analyses, geolocated data) to explore place engagement trends
Environment-based interventions	• Develop and evaluate interventions promoting active travel to/from school, environmental awareness, parental education, mindfulness activities
Interactions and exposures	• Use ecologically stronger methods like EMA surveys, go-along interviews, physiological sensors (electrodermal activity), or combine ecological/field-based methods to study environmental exposures
Studying more specific groups, role of culture, theoretically relevant variables and outcomes	• Explore urban design and mental health links among internalizing/externalizing disorder groups • Operationalizing and examining the influence of 'groupness' with respect to the urban design quality/composition of public spaces • Include personality, motivation, general well-being, sex/gender variables in future analyses; investigate design and mental health links in relation to other outcomes and environmental factors
Work with practitioners	• Undertake integrated knowledge translation work with practitioners
Policy analyses	• Evaluate the inclusion of adolescent-oriented goals, concerns, considerations, and initiatives in relevant planning and public health documents, legislation, or policy reports

7.7.1 Mixed Methods Opportunities

With the topic of urban design and adolescent mental health still emerging, there are several general areas in which future research can build on the work of this dissertation. Perhaps the most fruitful area is the exploration of adolescent mental health and urban environments via multimethod or mixed methods approaches. As highlighted in Chapter 2, there are plenty of opportunities for future research to delineate specific 'restorative' and 'stressful' environments and their main exposure influences, or specific design or landscape affects. This inquiry may be undertaken via different

combinations of biophysical response (e.g., Aspinall et al., 2015) recording measures (e.g., electrodermal skin activity, EEG, heart rate variability), mobile (GPS) or VR technologies (Buttazzoni, Parker, et al., 2021), qualitative GIS or interview methods, or urban design oriented epidemiological assessments of common psychopathologies (e.g., anxiety disorders) among urban adolescents. Other approaches such as sentiment analysis methods (e.g., Roberts et al., 2019; Schweitzer, 2014) or geolocated and social media data analyses (e.g., Ilieva & McPhearson, 2018) could likewise be used in tandem to explore adolescent perceptions regarding environmental design preferences, place engagement trends or hierarchies (e.g., develop place preference hierarchies with respect to restorativeness), or decision-making processes regarding place usage behaviours.

7.7.2 Environment-Based Interventions

Future study may also be well advised to implement and investigate targeted individual- and family-level interventions that seek to increase the accessibility and understanding of urban design knowledge among adolescents and their parents, as well as to inform their behaviours. Having highlighted the potential of distinct urban designs to support mental health among adolescents (Chapter 3-6; practice implication in section 7.5), this information could be paired with promising delivery methods like smartphone-based approaches (Buttazzoni, Brar, et al., 2021) to target the mental health of adolescents by providing educational information and behavioural tips. For instance, such approaches in the future could be evaluated by pairing them with urban design information to promote and encourage more healthful environmental interactions among younger populations via regular reminders regarding ways to take advantage of local public spaces for ‘free play’ (e.g., improved social competence, emotional resilience (Smith, 2009)) or to limit exposure to local sources of excessive ambient noise pollution (e.g., paths away from major roads). Mindfulness interventions which seek to make use of local public spaces in service of supporting adolescent mental health could also be designed, implemented, and evaluated in the future. Mindfulness-based interventions implementing activities such as, for example, concentrating on listening to sound, mindful breathing, mindful stretching, sitting meditation, and yoga have demonstrated the ability to significantly improve children’s attentional self-regulation (Felver et al., 2017). Future work could develop programs that combine these activities with interventions that are undertaken and evaluated in supportive local pedestrian areas (e.g., bluespace, greenspace) to potentially augment their efficacy.

7.7.3 Studying Interactions and Exposures

The use of more ecologically valid methods in the study of adolescent mental health and urban design topics could be especially helpful in future study regarding impacts of different design exposures. Using the same methods as those of this dissertation, EMA surveys in the form of repeated in-situ measurements (Shiffman et al., 2008) could specifically examine the perceived greenspace quality or usability of spaces (Madzia et al., 2019), the restorative potential of different space designs (e.g., greenness of schoolyards), or the impacts of other green infrastructure examples (e.g., green walls) (Buttazzoni, Doherty, et al., 2022). In-depth mobile go-along interviews (Carpiano, 2009) may also be used to study the perceived accessibility of different public spaces or design concepts. Combining ecological methods is also a possibility to investigate the socio-spatial or network influences of different spaces (e.g., 'with who') (Kestens et al., 2017) related to adolescent mental health phenomena. For example, to examine the influence of social networks on common place behaviours or outcomes, future study could use repeated EMA surveys to capture health and other relevant psychometric data (Steinmetz-Wood & Kestens, 2015) and link them with ethnographic methods such as multiple field interviews to gauge the concomitant social or cultural influences that affect the behavioural or health outcomes of interest with regard to certain public places.

7.7.4 Studying More Specific Groups, Cultural Influences, Theoretically Relevant Variables and Outcomes

Noting the subgroup analysis limitations of this research along with mental health issues having been observed to significantly affect adolescents in different geographical and cultural contexts (Choi, 2018), the relationships between urban and architectural designs and adolescent mental health indicators should also be further explored among specific groups of adolescents. Particular groups of interest in this context include those with internalizing disorders as persistent issues have been linked to a higher risk of poor future psychiatric outcomes (Colman et al., 2007), and those with externalizing disorders as subsets of the condition have been associated with poorer future quality of life scores (Storch et al., 2007). Relatedly, future study may also want to consider opportunities to examine the potential impacts of culture in relation to urban design and public space perceptions among adolescents. For example, operationalizing culture via concepts such as 'groupness' (i.e., strength of an individual attachment to a larger group identity) (Brubaker, 2006), could help to delineate how cultural influences such as constructed and enacted group

identities (and potentially by extension their associated values, norms, attitudes) impact one's perceptions or usage of public spaces or pedestrian design concepts. Such insights regarding the potential role(s) and influences(s) that an individual's subscription (or lack thereof) to larger group identities (i.e., their 'groupness' considerations) could be of value with respect to providing much needed nuance regarding discussions of how urban designs functionally impact the well-being of those traditionally classed with rigid social identities linked to physical conditions (e.g., 'physically limited') or ethnic categories (e.g., 'ethnic minority'). Previously discussed environment-based and mindfulness initiatives, as well as cognitive behavioural therapy informed (e.g., coping strategies, mood enhancement (Oud et al., 2019)) interventions, could make use of local environments or pedestrian infrastructure and potentially be of value to these adolescent groups diagnosed with internalizing or externalizing disorders. Other field-based studies could seek to devise targeted investigations in different public settings for specifically diagnosed groups to evaluate for additional benefits that outdoor, pedestrian, or natural spaces may provide regarding improved calmness or energy levels, or reduced worry or rumination.

Similar to expanding the number of groups being evaluated, additional theoretically relevant variables and outcomes should be also explored in this research context. Of note are personality (e.g., Big Five Inventory (John & Srivastava, 1999)), motivation (e.g., Behavior Regulation Exercise Questionnaire-3 (Cid et al., 2018)), well-being (e.g., Somatic Complaint List (Jellesma et al., 2007)), and sex/gender considerations could identify more specific risk or behavioural factors affecting environment-emotional response relationships. Regarding outcomes, new concepts such as place immersion that outline potential ways in which experiences of place can take on a more submerging quality (Buttazzoni, Ellard, et al., 2022) may also be worth exploring regarding adolescent experiences of or emotional responses to places. Place immersion concepts may offer new ideas and perspectives that researchers can consider with respect to promoting and eventually designing more engaging places for younger pedestrians. For example, current notions of pedestrian-friendly designs often emphasize of "lengthy stays" (i.e., activities involving a stay at a location) or "edges as staying zone(s)" (i.e., places that offer prime opportunities for sitting or standing) (Gehl, 2013). Future research exploring the immersion quality or potential (e.g., foster intimacy, mitigate the distractions/rhythms of everyday life) of different public spaces that adolescents frequent could help to improve understandings of how adolescents engage with different designs, or capture different

potential metaphoric and/or expressive meanings (Robinson & Pallasmaa, 2015) that they specifically apply to spaces when engaging with them.

7.7.5 Working with Practitioners

Supporting the study of adolescent mental health and urban design in the future may also be undertaken through researchers working with practitioners via integrated knowledge translation activities. Integrated knowledge translation is a process of research co-production between academic researchers and knowledge users wherein multiple strategies are brought together to address common topics and issues through, first, generating relevant knowledge (see Appendix 7.10.6 for example knowledge dissemination material), and, second, refining this developed information to improve its practical applicability (Kothari & Wathen, 2017). Put simply, integrated knowledge translation processes aim to bring together those who 'use' research (i.e., practitioners) and those who 'do' research (i.e., academics) (Bowen & Graham, 2013) in service of generating more applicable knowledge through directly integrating knowledge users—who have often times been excluded from such processes—into the knowledge generation and refinement processes (Kothari & Wathen, 2017). As it concerns the topic of urban design and adolescent mental health, future integrated knowledge translation processes could seek to connect researchers with local urban planning and public health practitioners to undertake a variety of activities. Namely, future activities could include working together to document a wider array of adolescent group needs (e.g., self-esteem, negotiating personal identities) or real-world constraints (e.g., place safety, usability) that designers should be aware of in future projects, recognize policy opportunities to advance adolescent mental health via local design or zoning amendments/updates/proposals, and identify shortcomings in current practices. Such pursuits could represent important opportunities to improve local institutional knowledge on the topic as well as develop innovative practices that have a clear applied value to practitioners.

7.7.6 Policy, Other Secondary Data Analyses

Finally, analyses of secondary data forms such as policies or other legislative documents in future study could help to assess the inclusion of adolescent-oriented goals, concerns, considerations, and initiatives in policy. Document analyses are a qualitative research method that could be particularly useful in this regard as they involve the coding, synthesizing, and theorizing of collated data to develop empirical knowledge about a specific subject area (Liamputtong & Ezzy, 2006). This approach could be used to outline shortcomings in relevant areas of local, state, or federal legislation

pertaining to various urban design and adolescent mental health topics. As was outlined in Chapter 2, future research could seek to conduct document analyses that review and appraise local zoning or pedestrian infrastructure policies/documents regarding their inclusion of adolescent health topics, and subsequently potentially link them to active transport or lifestyle goals as a method to promote improved mental health. Other document analysis topics potentially worth investigating include analyzing extant strategies from different geographical settings related to supporting youth or adolescent councils, recreational facility accessibility and quality measures (e.g., similar to the City of Edmonton's CFC work referenced above), community education initiatives for younger groups (e.g., workshops, community meetings), and local wayfinding and navigation infrastructure oriented towards younger populations. Analyses of these topics may be an effective method through which to document common policy themes and rationale, success testimonials, implementation strategies or resources, program outlines/scopes, and effective complementary approaches used in different contexts that guide subsequent literature review, intervention, or integrated knowledge translation ventures.

7.8 Conclusion

To examine the nature of the relationship between specific urban design concepts and adolescent mental health indicators this dissertation undertook five separate research manuscripts. Using an interdisciplinary perspective to conceptualize the adolescent mental health and urban environment relationship as dynamic, socio-relational, and multi-level, this dissertation applied a variety of methods including qualitative go-along interviews, online surveys, and EMA surveys to explore these different aspects of the relationship. Findings from the four primary research articles were interpreted within the ToA to improve the consistency of the inferences across the various methods of the different studies. Apropos of the collective findings, this dissertation's work indicates that high-quality pedestrian infrastructure designs and building ornamentation can positively impact adolescent mental health. Practical implications were offered to planners, policymakers, and public health practitioners, while future research opportunities were detailed for inter/transdisciplinary collaborations. All told, at a time where more adolescents than ever before are growing up in urban environments—a development which has important implications for their health—this dissertation offers a timely investigation of and important first step toward more precisely understanding the complex nature of urban design and adolescent mental health relationships.

7.9 References (Chapters 1 and 7)

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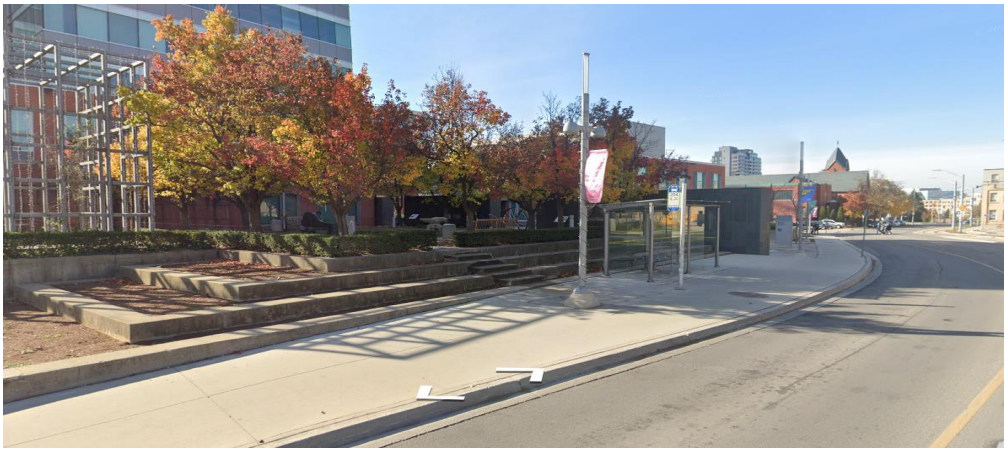
7.10 Appendices

7.10.1 Route Images*

*All images are screen captures from Google Street View (public domain)

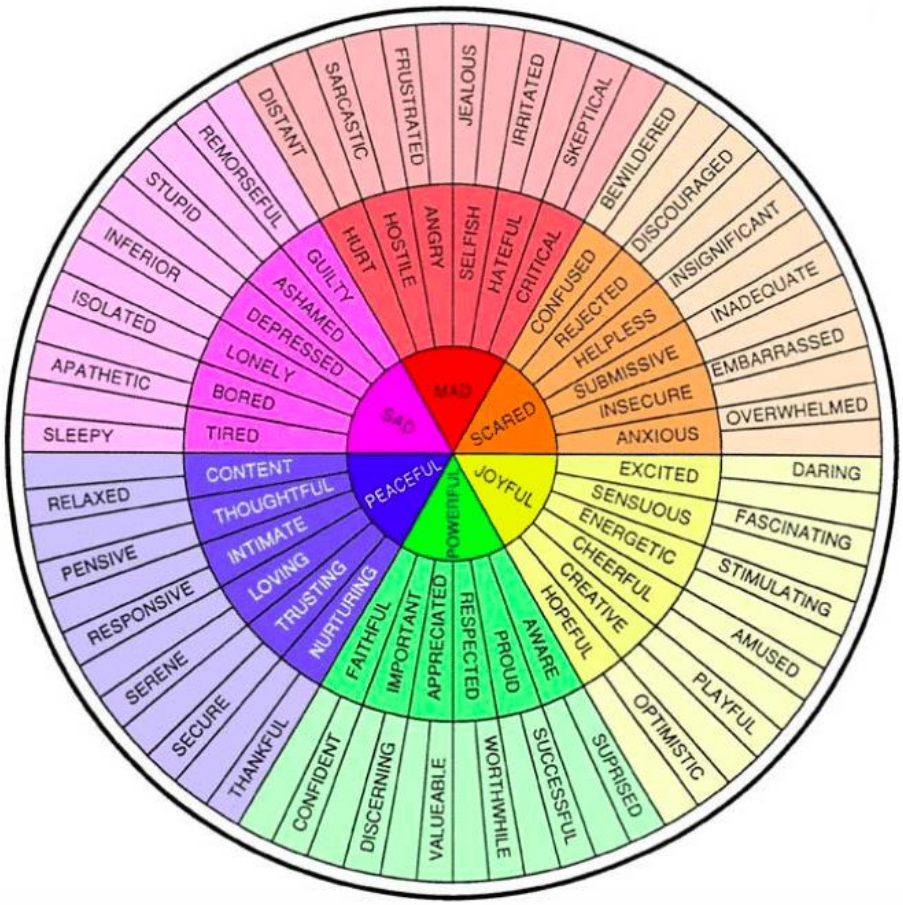
Urban Trail	
Residential Street	

Urban Bluespace	
Urban Greenspace	
Transit Hub Area	

Downtown Street	
Biophilic Architecture (Urban Garden)	
Symmetries (Historic Building)	

Fractals (Church)	

7.10.2 Feelings Wheel



7.10.3 Go-Along Interview Guide

Introduction	Thank you for agreeing to participate in this study! During our walk, I will be asking you questions about how you feel in the different settings we will be walking through. To assist you with this interview, and specifically with answering the questions I will be asking, you will be provided a 'feelings wheel' which contains a list of descriptive words. If at any time you do not want to answer a question, or want to end the interview, please let me know and we can skip a question or end the interview. Remember, there are no right or wrong answers: we are interested in understanding how youth feel in different types of urban places they might go on a given day. When we write up the results of this study, we may eventually use one of your quotations and we need to protect your identity. So, before this interview, could please provide me a pseudonym (i.e., fake name) you would like to be referred to if we use one of your quotations in the final write-up? Answer: _____

Location	**Opening questions and prompts**	**Potential probing questions**
Setting 1: **Multimodal urban trail**	➢ Please just take a few moments to observe this environment. How do you feel on this trail?	➢ What, if any, specific **positive** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ What, if any, specific **negative** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ How would you describe the value of this place to you? Are there any features of this place that mean a lot to you?
Setting 2: **Residential street**	➢ Please just take a few moments to observe this environment. How do you feel in this streetscape?	➢ What, if any, specific **positive** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ What, if any, specific **negative** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to?

			➢ How would you describe the value of this place to you? Are there any features of this place that mean a lot to you?
Setting 3: **Urban bluespace**	➢	Can I get you to look at Victoria Park Lake for a few moments? How do you feel when you focus on the lake?	➢ What, if any, specific **positive** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ What, if any, specific **negative** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ How would you describe the value of this place to you? Are there any features of this place that mean a lot to you?
Setting 4: **Urban greenspace**	➢	Please just take a few moments to observe this environment. How do you feel in this park?	➢ What, if any, specific **positive** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ What, if any, specific **negative** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ How would you describe the value of this place to you? Are there any features of this place that mean a lot to you?
Setting 5: **Public transit hub area**	➢	Can I get you to look toward the downtown skyline (King St.) and the transit station for a few moments? How do you feel in this place?	➢ What, if any, specific **positive** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ What, if any, specific **negative** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to?

			➢ How would you describe the value of this place to you? Are there any features of this place that mean a lot to you?
Setting 6: **Commercial street**	➢	Can I get you to look at the façades (in this case, windows) of the buildings on this street for a few moments? How do you feel on this street?	➢ What, if any, specific **positive** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ What, if any, specific **negative** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ How would you describe the value of this place to you? Are there any features of this place that mean a lot to you?
Setting 7: **Central business district landmarks**	➢	Can I now get you to turn your attention to [St. Mary Church OR the Laurier Building OR the City Hall garden] for a few moments? How do you feel when you look at [the church's window and design patters OR the front of the Laurier building OR the garden]?	➢ What, if any, specific **positive** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ What, if any, specific **negative** emotions, feelings, moods do you feel in this space; what features/designs do you connect them to? ➢ How would you describe the value of this place to you? Are there any features of this place that mean a lot to you?

7.10.4 Route Setting Images*

*Video recording was a 360° video of each setting; photos only show a still photo from each of the recorded videos.

Urban Trail	
Bluespace	

Suburban Mall	
Suburban Residential Street	
Urban Market	

Urban Plaza	

7.10.5 PTOD Scoring Guide from Clemente et al. (2005)

measuring urban design qualities scoring sheet		auditor		
street	from	date & time		
step		recorded value	multiplier	(multiplier) x (recorded value)
imageability				
1. number of courtyards, plazas, and parks (both sides, within study area)			0.41	
2. number of major landscape features (both sides, beyond study area)			0.72	
3. proportion historic building frontage (both sides, within study area)			0.97	
4. number of buildings with identifiers (both sides, within study area)			0.11	
5. number of buildings with non-rectangular shapes (both sides, within study area)			0.08	
6. presence of outdoor dining (your side, within study area)			0.64	
7. number of people (your side, within study area)	Walk through 1			
	Walk through 2			
	Walk through 3			
	Walk through 4			
	Total			
	Total divided by 4		0.02	
8. noise level (both sides, within study area)	Walk through 1			
	Walk through 2			
	Walk through 3			
	Walk through 4			
	Total			
	Total divided by 4		-0.18	
			add constant	+2.44
			imageablity score	
enclosure				
1. number of long sight lines (both sides, beyond study area)			-0.31	
2a. proportion street wall (your side, within study area)			0.72	
2b. proportion street wall (opposite side, within study area)			0.94	
3a. proportion sky (ahead, beyond study area)			-1.42	
3b. proportion sky (across, beyond study area)			-2.19	
			add constant	+2.57
			enlosure score	
human scale				
1. number of long sight lines (both sides, beyond study area) *from above			-0.74	
2. proportion windows at street level (your side, within study area)			1.10	
3. average building height (your side, within study area)			-0.003	
4. number of small planters (your side, within study area)			0.05	
5. number of pieces of street furniture and other street items (your side, within study area)			0.04	
			add constant	+2.61
			human scale score	
transparency				
1. proportion windows at street level (your side, within study area)			1.22	
2. proportion street wall (your side, beyond study area) *from above			0.67	
3. proportion active uses (your side, within study area)			0.53	
			add constant	+1.71
			transparency score	
complexity				
1. number of buildings (both sides, beyond study area)			0.05	
2a. number of basic building colors (both sides, beyond study area)			0.23	
2b. number of basic accent colors (both sides, beyond study area)			0.12	
3. presence of outdoor dining (your side, within study area) *from above			0.42	
4. number of pieces of public art (both sdies, within study area)			0.29	
5. number of walking pedestrians (your side, within study area)	Walk through 1			
	Walk through 2			
	Walk through 3			
	Walk through 4			
	Total			
	Total divided by 4		0.03	
			add constant	+2.61
			complexity score	

7.10.6 Qualitative Results Infographic (Chapter 3)