Title
Exploring Urban Design Theory: A Qualitative Study Integrating "Autism-Friendly Environments" As an Emerging Perspective

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Exploring Urban Design Theory:
A Qualitative Study Integrating "Autism-Friendly Environments"
As an Emerging Perspective

THESIS

submitted in partial satisfaction of the requirements
for the degree of

MASTER OF URBAN AND REGIONAL PLANNING

by

Daniyel Danica Grancich

Thesis Committee:
Professor Scott A. Bollens, Chair
Professor Tim-Allen Bruckner
Professor Wendy A. Goldberg

2014

DEDICATION

To

Chris

who taught me how to think

a proverb

Wisdom calls aloud outside
She raises her voice in the open squares
She cries out in the chief concourses
At the openings of the gates in the city
She speaks her words

Proverbs 1:20-21
New King James Version

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In addition, a thank you to the Multidisciplinary Design Program (MDP) and to its pioneers (staff, mentors, and students alike) who continually bring ASD to the forefront of discussion through their innovative research.

ABSTRACT OF THE THESIS

Exploring Urban Design Theory:
A Qualitative Study Integrating "Autism-Friendly Environments"
As an Emerging Perspective

By

Daniyel Danica Grancich

Master of Urban and Regional Planning

University of California, Irvine, 2014

Professor Scott A. Bollens, Chair

This study explored Autism Spectrum Disorder (ASD)-friendly environmental design standards as an emerging urban design theory. The research sought to articulate ASD-friendly design guidelines derived from the literature, as well as investigate the relevance of ASD-friendly design to real-world environments.

A systematic review was utilized to determine cohesive ASD-friendly design standards from the body of literature, defined as design features agreed-upon by at least 50 percent of the empirical studies included in the systematic review. An observational study was designed in order to test whether ASD-friendly design guidelines are applicable to non-ASD individuals, and how they play a part in determining utilization of plaza locations.

Three unique plaza locations at the University of California, Irvine Main Campus were photographed over three days, yielding 94 total photographs; 58 of these photographs were included in the analysis.

The systematic review identified eight design features from the literature: low stimulation, predictability/consistency, retreat space, wide circulation spaces/proxemics, natural light and/or avoiding flickering/buzzing lights, low noise levels, minimization of "fascinators," and use of low-arousal colors. The observational study found that an increase in number of users increases opportunity for social interaction, the presence of more than one personal greatly increases social interaction, retreat space and sufficient shade from sunlight were the most important design features among the ASD-friendly design features tested, and ASD-friendly design criteria need to be weighted based on empirical findings.

Introduction

Research Problem

Concern regarding the interaction between individuals with autism spectrum disorder (ASD) and the built environment has arisen among numerous scholars as well as architectural practitioners in developing a framework for constructing so-called ASD-friendly environments. Recently, the concept of creating safe zones in the built environment for *sensory sensitive* individuals including those with ASD has been pioneered by movie theaters - first in the UK with ODEON's "sensory friendly" cinema nights,[1] then in the US with a partnership between AMC and the Autism Society of America for a "sensory friendly" films program.[2] In the scholarly literature, much discussion centers on specific architectural recommendations for homes and classrooms of ASD individuals. Much of the architectural literature, however, gives no compelling scientific basis for their design recommendations. The other relevant literature (primarily taking from psychology) offers insights based primarily on information of appropriate design features gleaned from caretakers, teachers, parents, and medical professionals. I know of little work on this specific topic that provides information directly from individuals with ASD. This being said, there are certainly many gaps in the existing literature and much opportunity for future research. It should be kept in mind that ASD-friendly design theory is an emerging perspective in the earlier stages of development as a field of inquiry.

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[1] http://www.guardian.co.uk/film/filmblog/2011/aug/08/autistic-children-autism-friendly-films
[2] http://www.autism-society.org/get-involved/events/sensory-friendly-films

Approaching urban design from the perspective of ASD-friendly environments is an emerging body of literature and a sub-field of urban design theory. ASD-friendly design also blurs lines between disciplines, resulting in a new inter-, multi-, and trans-disciplinary field. Theories on designing for ASD are diverse – sometimes conflicting – and may overlap with existing design theories. ASD-friendly design intends to fill a gap (or gaps) among existing design theories in creating spaces specifically with ASD individuals in mind, although other sensory sensitive groups may also benefit from facets of the built environment being constructed more mindfully. Designing indoor and outdoor spaces for individuals with ASD is a challenging task, and one that draws up many research and practical questions that require exploration and ultimately resolution.

Research Question

There are three broad research questions appropriate to my discussion of ASD-friendly design; each question presents a different path to resolution. On a basic level, these questions can be summarized as questioning the *necessity*, *equity*, and *relevance* of ASD-friendly design. Whether ASD-friendly design is necessary and equitable is largely answered from a thorough review of the relevant literature. While these first two questions will be discussed at length, the third question is paramount: is ASD-friendly design relevant (by this I mean *applicable*) to ASD individuals? A companion question is whether ASD-friendly design is genuinely specific; that is to say, are these designs relevant *only* to individuals with ASD, or are they universal in nature? Although ASD-friendly environments are touted as being specific to individuals with ASD – making *universality* the primary potential rival explanation for any success of these environments – there is an argument that ASD-friendly environments may vary in their success between ASD and non-ASD individuals (*neurotypical* individuals) *by degree*: in this case, ASD-friendly design would be appropriate for people regardless of ASD status (much like the goal of Universal Design), but would have *greater* success in relieving anxiety, inducing calm, and increasing functionality in individuals with ASD than among neurotypical individuals. Although some of these questions are well beyond the scope of this paper, they are nonetheless relevant to the present discussion.

The primary research questions *within* the scope of the present paper include the following:

1. How is ASD-friendly design theory conceptualized?
2. Does ASD-friendly design theory help us understand human behavior *vis-à-vis* the built environment in a plaza setting?

The goal of 1) is to critically evaluate the literature for a way of clearly defining the central concepts and theoretical bases for ASD-friendly design theory. This can also allow us to determine the novelty and necessity of the emerging ASD-friendly design perspective, and implicitly suggests that we need to validate whether ASD-design theory is substantively different from other existing urban design theories (e.g. Universal Design). The goal of 2) is to determine the explanatory power of ASD-design theory regarding human behavior in a plaza setting.

It is slightly counterintuitive to investigate, as I do, the explanatory power of ASD-design theory on human behavior utilizing *neurotypical individuals* in a plaza setting (rather than individuals with ASD). Both ethical and feasibility concerns come into play performing the study on ASD individuals, and investigating whether ASD-friendly design theory is relevant to use of settings within the built environment in neurotypical individuals directly addresses the primary potential rival explanation of universality. By choosing the research questions detailed above, this study directly addresses two major potential rival explanations: 1) ASD-friendly design theory is universal; that is to say, it is not specific to individuals with ASD, but is a general competing urban design theory for understanding human-environment interactions (regardless of its origins); and 2) ASD-friendly design theory is not a genuinely unique, original theory; rather, it merely includes elements already addressed in other established urban design theories (such as Universal Design), regardless of whether it is applicable to ASD individuals or not. To clarify, 1) argues that ASD-friendly design theory is *not only* applicable to individuals with ASD, in that this design theory also helps us understand neurotypical human behavior. 2) argues that ASD-friendly design theory is not a unique urban design theory, whether or not it is applicable solely to ASD individuals, neurotypicals, or both groups. While 2) can be answered from probing the literature, 1) requires a novel study in order to shed light on the issue. Both aspects are explored in the present paper.

Importance of Current Research

Contribution

The ASD population is rapidly growing. Between 2002 and 2006 there was a 57% increase in ASD prevalence (CDC data); in 2002 1:150 children was diagnosed, in 2004 1:125, in 2006 1:110, in 2008 1:88. More recently, figures closer to 1:50 have been suggested by the Centers for Disease Control and Prevention (CDC). There is dispute regarding the etiology of the secular rise in ASD (Schieve et al., 2011). What is relatively agreed-upon, however, is that the increase in ASD prevalence cannot be explained by diagnostic artifact alone (e.g. over- and/or misdiagnoses) (Blaxill, 2004). As ASD becomes more prevalent in our society, we must explore new ways in integrating individuals with ASD into mainstream culture and community; one of the ways in which we can achieve this is by designing the built environment to accommodate individuals with ASD, while also maintaining design that is also relevant to and appropriate for neurotypical individuals.

This study explores whether ASD-friendly design theory has explanatory power for human behavior in a plaza setting. This observational study fills in a gap of the existing ASD-friendly design literature by investigating whether ASD-friendly design theory is applicable to neurotypical populations. The existing literature has already determined – with varying degrees of success – that ASD-friendly environments are appropriate for individuals with ASD (although there are problems with many of these studies; this will be discussed at length through the literature review). The present paper seeks to determine whether the primary potential rival explanation, universality, is a viable rival explanation. The present paper cannot prove or disprove whether ASD-friendly design is also applicable to neurotypical individuals, but it can provide evidence supporting or refuting this assertion. The literature review is extensive, and can assist in exploring whether ASD-friendly design theory is in fact a substantively unique urban design theory. Searching for answers to all of these questions – how to define ASD-friendly design theory, whether ASD-friendly design theory is a substantively different theoretical concept than similar urban design theories, and if ASD-design theory explains human behavior within the built environment – fills important gaps in the ASD-friendly design literature, and will assist in either supporting or refuting the two major potential rival explanations to ASD-design theory.

Theoretical and Conceptual Framework

Multiple theoretical and conceptual bases are required for this investigation. Although this is not an advocacy-based exploration, ADA-related and neurodiversity advocacy theories do play an important part in understanding the complex relationships between individuals with disabilities (including ASD) and the built environment. Affordance theory from environmental psychology also plays an important role in understanding many human-environment interactions. It should be stated clearly at this point that neurodiversity is an advocacy movement that has spurred on the development of ASD-friendly environments. The purpose of this research is not to act as an advocacy conduit for the neurodiversity movement. However, since emerging concepts of neurodiversity and the advent of ASD-friendly environments are inextricably linked, the neurodiversity literature must be considered as a premise for ASD-friendly design guidelines.

The built environment – especially the urban environment – cast as anxiety provoking (proposed by myriad researchers from Freud onward) has permeated urban planning for some time (at least since the advent of modern cities), and also has a place in the discussion. New neuroscience research (Lederbogen et al., 2011) suggests that city living is associated with greater anxiety and other mental health comorbidities.

Given this renewed appreciation for the influence of the built environment's role in human functionality, I assert that particularly susceptible populations should be taken into consideration. ASD individuals have higher comorbidity for anxiety disorders than the general population (Gillott et al., 2007), and the intrinsic anxiety related to ASD itself makes many environments problematic for individuals with ASD (Gomot et al., 2011; Loveland, 2010). Related to these phenomena is the assertion that "[f]ear is the main emotion in autism" by lauded animal science researcher Temple Grandin, who herself has ASD (Grandin, 1997). The concept of ASD individuals exhibiting prey animal-like instincts, inhibitions, and behaviors will be examined in detail throughout the proposed study.

It is worth taking a moment to discuss the neurodiversity movement in more detail. Neurodiversity is essentially the notion that individuals with ASD should accept themselves and be accepted by others as *different* rather than disabled. Cascio details neurodiversity as a movement "that posits ASD as naturally occurring, and even positive, neuro-variations in human cognitive wiring" (Cascio, 2012). From certain neurodiversity perspectives, ensuring an ASD-friendly environment may be more an issue of human - rather than disability – rights (other neurodiversity proponents may claim ASD-friendly environments are not necessary at all). Brownlow and O'Dell (2009; citing Smukler, 2005) bring up the salient point that traditionally the medical view of autism has dictated that ASD is a disease that requires a cure. In counterpoint to this, neurodiversity offers the option that ASD (at worst) is a disability that requires accommodation, and (at best) is a unique evolutionary development laden with both positive and negative attributes for the individual with ASD.

Specific Aims of Current Research

The specific aims of the present paper are to identify a cohesive central perspective for ASD-friendly design; to determine whether ASD-friendly design theory is a unique, necessary theory that fills a void within the general disability design literature; and to investigate the real-world application of ASD-friendly design theory in explaining human behavior in a plaza setting. As the present study is largely exploratory, additional insights may develop through the pursuit of the current research.

Introduction to the Literature

Literature Review Overview

The literature is discussed in three unique parts: Part One explores general background information important to the topic of autism spectrum disorder (ASD) in general (Section (a)), as well as relevant studies involving human-environment interactions among both neurotypical groups and other sensitive populations (i.e. patients with Alzheimer's disease) (Section (b)). For easier reading, the articles cited in the first part of the literature review are discussed alphabetically within Sections a and b, respectively:

-General literature directly relevant to diverse aspects of ASD

-Literature relevant to the central topic, but not ASD-specific

Part Two of the literature review identifies particular papers that investigate the use of ASD-friendly environments, and list specific recommendations for producing ASD-friendly environments. Section (a) covers the non-empirical literature on ASD-friendly design, and Section (b) explores the empirical literature. Seven empirical ASD studies cited in Part Two, Section (b) are later included in a compilation defining what constitutes ASD-friendly design (there are ten empirical papers, but three fail to meet the inclusion criteria and thus cannot be included in the compilation). Using Venn diagram intersection logic, design features and elements of the built environment considered ASD-friendly by the existing literature are gleaned from these seven empirical papers resulting in a single list of what, for the purposes of this study, I refer to as ASD-friendly design theory. This list approximates a single, central perspective within the ASD-friendly literature. Again, for ease of reading, the articles cited in the second part of the literature review are discussed alphabetically within Sections a and b, respectively:

-Non-empirical studies on ASD-friendly environments

-Empirical studies on ASD-friendly environments

Part Three is the final part of the literature review: in Section (a) I explore the level of agreement within the empirical ASD-friendly design literature through a brief systematic review; Section (b) is dedicated to discussing the emerging ASD-friendly design *theory* compiled from the seven appropriate empirical studies are articulated in Section (b). ASD-friendly design theory is an emerging perspective within the field. The ultimate purpose of this paper is to critically evaluate ASD-design theory as an emerging urban design theory *vis-à-vis* primary source data to determine what – if any – bearing this theory may have on explaining actual human behavior in a real-world environment.

Part One

Part One, Section (a): General Literature on ASD

Part One, Section (a) of the following literature review deals with general literature directly relevant to diverse aspects of ASD. While these references may be only tangentially related to ASD-friendly environments, they are necessary to provide an introduction to a broad range of issues involved in the study of ASD. ASD is a complex and ever-more common disorder – perhaps more strikingly relevant to this paper is that research finds even neurotypical individuals (in stark contrast to ASD, *girls* in particular) engage in behaviors once thought of as defining ASD: *emotional atrophy* is the term given to social deficits seen most commonly among young females who engage in high levels of "virtual" contact (e.g. technology-assisted communication); this social deficiency is thought to be on the rise (Nass, 2012). With an increase in both ASD itself and ASD-like behaviors among neurotypical individuals, a comprehensive study of the nature of ASD as well as identifying those environments most beneficial to management of ASD symptoms is well in order.

Brownlow and O'Dell offer an interesting perspective on the "theory of mind" account for ASD, and express how this paradigm assumes a "deficit model" of ASD (Brownlow & O’Dell, 2009). Theory of mind is defined as "the ability to attribute mental states...to oneself and other people as a means of explaining behaviour" (Brownlow & O’Dell, 2009; citing Tager-Flushberg, 1999). In developmental psychology, ASD is often understood through the lens of theory of mind philosophy; this explanation assumes that ASD individuals lack capabilities intact in neurotypicals. Brownlow and O'Dell critically examine this paradigm from the perspective of the neurodiversity movement - neurodiversity is the neurodevelopmental equivalent to movements calling for acceptance and tolerance of other categories of diversity, including "gender, class, and race" (Brownlow & O’Dell, 2009; citing Singer, 1999). More recently, other categories including sexual orientation, religion, and (most pertinent to the current discussion) disability status have gained more prominence in diversity movements. This discussion is of central importance to ongoing questions of whether ASD is genuinely a disability/abnormality/deficit, or whether ASD individuals should be considered "different" rather than sufferers of medical pathology.

Cascio studies neurodiversity from the perspective of the phenomenon of "autism pride" among mothers of children with ASD; the narratives these mothers construct are inherently neurodiverse, and tend to express positive ideas about ASD while resisting negative ideas about ASD (Cascio, 2012). Cascio also details the paradigmatic differences between groups such as Autism Speaks (which actively seeks a "cure" for ASD) compared to Aspies for Freedom (an outspoken self-advocacy, neurodiversity-oriented grassroots organization that embraces ASD as a novel evolutionary development).

Dinishak and Akhtar probe the notion of "mindblindness" as a metaphor for ASD individuals' apparent lack of normal theory of mind development (Dinishak & Akhtar, 2013). The most relevant aspect of this discussion to the proposed study is that ASD individuals typically engage in certain stereotyped or "meaningless" behaviors that may include behaviors driven by anxiety and/or discomfort. One such anxious ASD behavior is known as "furtive eye movement," which is strikingly similar to prey animal behavior (Dinishak & Akhtar, 2013). Dinishak and Akhtar question whether these assumedly "meaningless" behaviors are actually adaptive; the construct that *Homo sapiens sapiens* is biologically a predatory species may color our perception when confronted with individuals we consider (at best) idiosyncratic or (at worst) pathological, whose behaviors more closely imitate those of prey species. The paper concludes with an unanswered, thought-provoking question about the nature of ASD, and whether this spectrum of disorders is a "deficit," or merely a "difference" (Dinishak & Akhtar, 2013).

The existence of anxiety-driven ASD behaviors discussed by Dinishak and Akhtar is central to the topic of ASD-friendly environments in that it may later assist in articulating substantive explanations for why ASD individuals may require mindfully designed environments.

Donohue, Darling, and Mitroff delve into the issue of multisensory processing in ASD individuals (Donohue et al., 2012). Their findings suggest that deficient multisensory processing ability in ASD individuals plays a role in the "overstimulation" phenomenon experienced by many people with ASD. It should be mentioned that much of the architectural and design literature calling for ASD-friendly environments attempts to minimize excessive overstimulation in the built environment; this will be discussed at length in the subsequent areas of the literature review. The research article makes a claim that broadens our perspective regarding how many individuals may be affected by issues pertaining to multisensory processing deficits:

> [t]hese results provide insight into the nature of multisensory processing while also revealing a continuum over which perceptual abilities correlate with symptoms of autism and that this continuum is not just specific to clinical populations but is present within the general population. (Donohue et al., 2012)

This underscores the potential need for ASD-friendly environments within the general population (whose environments are much more difficult to control), rather than only among clinical populations (whose environments are more readily controllable) – the vast majority of individuals with ASD today are not confined to clinical or institutional settings.

Gillott and Standen give insight not only into the high comorbidity of anxiety disorders in ASD individuals, but that specific triggers of anxiety in this population include "the inability to cope with change" as well as sensitivity to "sensory stimuli" (Gillott & Standen, 2007). Both of these specific triggers may contribute to anxiety produced by the built environment, especially if that environment is unfamiliar.

Also notable is the discussion of anxiety in high-functioning autism peaking in late adolescence and early adulthood – this supports the need for more research of an often overlooked demographic with ASD: adults. Particular fear of change regarding locations is mentioned. Perhaps most important is the study's declaration that "[a]lthough there are conceptual concerns around the insight capabilities of individuals with autism, it would be valuable to find ways to obtain individuals' views on their own anxiety" (Gillott & Standen, 2007); the authors go on to suggest that development of such a measure may benefit from including visual aids such as photographs or other image-based media.

Gomot and Wicker's review article contains a helpful neurobiological discussion on how the ASD brain interprets interaction with the external environment.
This discussion comments on how human adaptation includes the ability to predict future events and consequences. The "proactive brain" theory from cognitive neuroscience is applied to ASD, and describes the human ability to generate predictions based on "existing scripts, which are the result of real...[and] expected experiences" (Gomot & Wicker, 2011). Individuals with ASD may lack fluidity of achieving this schema-based prediction model, and may be related to their general dislike for change. The "extreme male brain theory" of ASD from psychology (Baron-Cohen et al., 2002), although it has largely fallen out of favor within the academic psychology community, implies that ASD individuals are competent with rule-based prediction models that behave orderly and as expected – the real-world environment is a dynamic system and unpredictable, and therefore creates limitations in understanding and prediction in ASD individuals.

The more recent "intense world theory" (Markram et al., 2010) offers an alternate understanding of the nature of ASD rooted in neurobiological hypersensitivity, resulting in a world that is perceived as "intense, fragmented and aversive" (Gomot & Wicker, 2012).

Grandin's semi-autobiographical analysis examines similarities between animal behavior and autism, including the assertion that fear is the primary emotion in both prey animals and individuals with ASD (Grandin, 1997); recall the predator-prey argument by Dinishak and Akhtar (2013). Grandin is herself autistic, but may rely too heavily on her own subjective, anecdotal experiences and have a tendency to incorrectly generalize from her own perception – despite this limitation, her discussion is nonetheless valuable when appreciated more as a single case study. The effect of novelty on animals and ASD individuals are explored as it is related to fear response. Grandin argues for extrapolation between similarities in animal and human behavior.

Jordan offers an interesting introspection of ASD within the education system in the UK. Although ASD-friendly environments are mentioned, no recommendations for such environments are given, and Jordan's primary focus is on the psychosocial and pedagogical aspects of teaching and educating children with ASD (Jordan, 2005).
Even so, Jordan does attend to certain key aspects pervasive in the ASD-friendly design literature: such environments should "reduce stress for children with ASD" and minimize excessive novel stimuli (Jordan, 2005). Jordan's call for further research into ASD-friendly environments is timely, although not even a cursory investigation into the existing ASD-friendly design literature was undertaken.

Affordance theory rivals theory of mind in investigating ongoing explanations for ASD functionality and perception, and includes the concept of "affordances for physical interactions with the environment" (Loveland, 1991). Loveland explores what it means to have ASD when defined as the inability to "discover the affordances of the human environment," or to "[do] so only imperfectly" (Loveland, 1991). "[H]umans...perceive the affordances of symbols" (e.g. language) (Loveland, 1991); this definition of human is problematic for autism, as the inability to perceive or *correctly perceive* the affordances of symbols (i.e. social, cultural, linguistic) is central to the diagnosis of ASD (I trust ASD and being human are not taken as mutually exclusive – proponents of neurodiversity would retort that perception of the affordances of symbols is necessary for *some* types of humans, but that ASD individuals are simply a *different* type of human, rather than an *incorrect* type or something implicitly or explicitly *nonhuman*).

Part One, Section (b): General Literature on Human-Environment Interactions

Part One, Section (b) discusses papers relevant to the topic at hand that do not directly address ASD. Like the previous section, I will detail the literature alphabetically, dedicating more time to studies of particular interest to the present paper. Many of the following articles investigate how the built environment affects *some* population, although these populations do not have ASD.

Almquist, Kelly, Bromberg, Bryant, Christianson, and Montori offer results from a randomized trial in which the patient-physician interaction was altered via restructuring of the interior design of the consultation room. Since the researchers found that "[t]he design of the consultation room affects the clinical encounter" (Almquist et al., 2009) in neurotypical subjects, this study provides evidence that design is an important component of human interaction, at least in specific contexts. The present paper is more interested with relatively permanent design features in the built environment than interior design and changeable decór; however, there is an applicable aesthetic discussion relevant to ASD especially when considering the potentiality for ASD-friendly interior design and decorating.

Although the research of Lederbogen, Kirsch, Haddad, Streit, Tost, Schuch, Wüst, Pruessner, Rietschel, Deuschle, and Meyer-Lindenberg does not directly address ASD, the implications of urban environments negatively affecting mental health in the general population is certainly valuable. The finding that "anxiety disorders are more prevalent in city dwellers" (Lederbogen et al., 2011) is particularly interesting. The "link between cities and social stress sensitivity" (Lederbogen et al., 2011) implies the influence of the built environment on human functionality. I propose that the overwhelming overstimulation a neurotypical non-native city dweller experiences when first interacting with an urban environment may be analogous to ASD environmental overstimulation experiences in general (whether urban or non-urban).

Pineda offers an evaluation of current ADA regulations based on the legal definition of disability as "physical or mental impairment that substantially limits one or more major life activities"; the author argues that this definition is limited in that it fails to account for a "spatial context" of disability (Pineda, 2008). This being said, Pineda argues for a change of mentality on how we view disability: "rather than maintain that person A is disabled without consideration of the environment, we ought to think of person A as being disabled with respect to environment E" – resulting in a flexible, dynamic definition of disability that is "spatially relative" and consistent with the social ecology paradigm (Pineda, 2008). The advocacy argument that "justice for disabled people in space" should be paramount to planners is well taken (Pineda, 2008); however, the pragmatic feasibility of adopting this definition is unclear. In many ways this theoretical perspective dovetails nicely with the current state of thought in the neurodiversity movement.

Rapoport and Kantor argue for the psychological need for "complexity and ambiguity in environmental design," stressing that humans typically are more psychologically fulfilled by "open-ended, complex, involved, allusive" urban forms (Rapoport & Kantor, 2007). This is in direct contrast with the existing literature on ASD-friendly environments, and it implicitly details what may be fundamental differences between ASD and neurotypical experiences *vis-à-vis* the built environment. Rapoport and Kantor argue that (assumedly for neurotypicals in general) an architectural aesthetic demanding "clarity, lucidity, simplicity" results in "reducing sensory input to low levels...[leading] to a lack of interest in [the] environment" (Rapoport & Kantor, 2007). The authors allude to the modernist ideal of architectural form – which places a premium on clean lines, grid-based design, and utilitarian function – as in some ways alienating those humans interacting with such environments. The need for a "minimum of complexity" (Rapoport & Kantor, 2007; citing Ehrenzweig, 1953) is related to the human desire to explore and otherwise engage with the built environment. The potential for radically different environmental needs of neurotypicals and ASD individuals should be kept in mind when discussing the need and procedure for ASD-friendly environments, and whether these two diverse sets of needs can be met simultaneously.

Ulrich identifies stress as "a major obstacle to healing" in a clinical setting in his review of interior design and wellness (Ulrich, 1991). Ulrich details his "theory of supportive design" (Ulrich, 1991) that is largely interested in limiting patients' stressors through conscious planning of the changeable built form (e.g. interior design). Although the present paper is not specifically concerned with either interior design or clinical settings, Ulrich raises relevant points in what he identifies as necessary antecedents for a low-stress healing environment: 1) Sense of control; 2) Social support; and 3) Positive distractions in physical environments. The latter includes access to nature as a healing setting. In contrast to these guidelines, Ulrich also identifies design features that serve as "negative distractions"; these undermine the facilitation of healing in that they "assert their presence, are difficult to ignore, and are stressful" (Ulrich, 1991). He states that design features are "more likely to be negative and stressful if the...designed distraction...is stimulating, arousing, and characterized by uncertainty" (Ulrich, 1991). This foreshadows the second part of the literature review, in which I will discuss those design features identified by the existing literature as problematic for ASD individuals - the literature specifically identifies features that are over-stimulating and -arousing as problematic for individuals with ASD (it should be kept in mind that in order to gauge what constitutes an ASD-friendly environment, it is necessary to first understand what is considered “unfriendly” to individuals with ASD). In light of

Rapoport and Kantor, I hypothesize that ASD-friendly environments may need to find a centralist position in which design features and urban form are interesting enough to engage the individual (ASD or neurotypical) without over-stimulating or provoking anxiety in ASD individuals. Future studies may determine whether these two goals can be feasibly achieved in unison, without promoting one at the gross expense of the other.

To refer again to issues purported by the neurodiversity movement (which has been integral in the advancement of developing ASD-friendly environments), I explore Young's essay on the "politics of difference" of Seyla Benhabib (Young, 1999). Young states that Benhabib's position on the problems of "corporate identity" (Young, 1999; citing Benhabib, 1998) extends to ADA regulations in that the corporate (or collective) identity of disabled individuals may not be unified across all disabilities, may not be relevant to individuals with a specific category of disability (i.e. those who do not consider their diagnosis a "disability"), and may actually provoke inadvertent social exclusions as an undesired consequence of advocacy. The discussion includes comment on whether there is a "culture of people with disabilities" (Young, 1999); there may not be a unified culture across all disabilities, but according to adherents of the neurodiversity movement, there is some consensus among ASD individuals who identify with the movement. In a way, the call for ASD-friendly environments by proponents of the neurodiversity movement seems almost contradictory: many individuals who identify as "different" rather than "disabled" promote environments designed specifically with their neurobiological differences in mind, which is at times difficult to distinguish from the ADA perspective of designing spaces with specific disabilities in mind. The depth of this distinction may be beyond the scope of the present paper, but it is nonetheless an important aspect to bear in mind when discussing implementation of ASD-friendly environments.

Zeisel, Hyde, and Levkoff (1994), and later Zeisel, Silverstein, Hyde, Levkoff, Lawton, and Holmes (2003) investigate environmental determinants of behavioral outcomes in Alzheimer's disease special care units in clinical settings. The researchers identify environment-behavior "E-B model concepts" as: 1) Exit control; 2) Wandering paths; 3) Individual away places; 4) Common space structure; 5) Outdoor freedom; 6) Residential character; 7) Autonomy support; and 8) Sensory comprehension (Zeisel et al.,1994). The 2003 study operationalized E-B model concepts identically, and found results indicating that "physical environmental design features correlate with behavioral health, even when individual and nonenvironmental facility characteristics can be seen interacting with the...physical environment" (Zeisel et al., 2003). The next part of the literature review discusses what design features have been identified by ASD researchers as problematic for that particular population; there is some striking resonance between the Alzheimer disease and ASD studies, although the two disorders should not be taken as being medically similar to one another.

Part Two

I will now discuss the literature directly relevant to ASD-friendly environments in a structured format. I have currently identified many papers directly addressing the central issue of designing ASD-friendly environments; however, the type and quality of

these papers varies dramatically, and there is a scarcity of empirical studies within the existing literature. All relevant papers specifically address design guidelines for individuals with ASD, largely from an architectural perspective; some of the papers review earlier studies that themselves identify design features problematic to ASD individuals and/or issue design guidelines for ASD-friendly environments.
Non-empirical papers will be discussed in Section (a); as the non-empirical papers vary widely in type, this will be addressed within the summary and discussion of each relevant paper. These non-empirical papers will be discussed alphabetically *within* each of the following subsections (listed from lowest to highest study quality, respectively): editorial, “place study” (this will be defined later), and meta-analyses. Each of these papers offers concrete recommendations for constructing ASD-friendly environments, but widely vary in rigor of research resulting in these recommendations. A lone example of government standards for ASD-friendly environments is included, but does not strictly conform to any of the aforementioned categories, and is placed after the bulk of the non-empirical papers for sake of convenience.

Ten of the existing papers on ASD-friendly environments are empirical studies (three of which do not meet the inclusion criteria, leaving seven useable papers).
These ten empirical studies will be discussed Part Two, Section (b), and the seven complete studies are later used to compile a list of design features and elements that hallmark ASD-friendly design. Like Part One of the literature review, papers are attended to alphabetically; non-empirical papers will be discussed first in Section (a),

attending to the aforementioned subsections; followed by the ten empirical papers on ASD-friendly design in Section (b).

Part Two, Section (a): Non-Empirical ASD-Friendly Design – Editorial

In Part Two, Section (a), the first subsection of the non-empirical papers includes "editorial" papers. These are papers written from the perspective of personal and/or professional experience – anecdotal in nature – or they lack either adequate citation to constitute a review paper, robust research design to constitute a scientific study, or both. Although there is valuable information available from these papers that can be used as a springboard for more substantive work, these papers also highlight the need for better and more adequate studies investigating ASD-friendly environments; the editorial papers specifically remind me in the present paper to take care to thoroughly explain the systematic way in which I operationalize the notion of "ASD-friendly environments," using the intersection of design features and elements from the empirical literature in order to construct an overarching definition of guidelines for such environments.
This process fills a major gap in the existing literature.

Beaver writes (literally he *speaks*, as this paper is transcribed from a talk he gave at an international ASD symposium) as an architect-practitioner with field experience in retrofitting and designing spaces for individuals with ASD (Beaver, 2006). Like many of the "editorial" papers, Beaver writes from anecdotal experience – which, although his experiences may have pragmatic value, does *not* hold to the requisite level of scientific rigor required for firm recommendations on ASD-friendly design – and includes a “feedback study” (Beaver, 2006) in which staff from a particular institutional ASD setting provide *post hoc* feedback on the effectiveness and appropriateness of the design. Like much of the ASD-friendly design literature, this feedback study lacks direct input from those individuals affected most by ASD-friendly environments: actual individuals with ASD.

Speaking from his personal experience, Beaver offers the following recommendations for designing ASD-friendly environments; he considers the following design features and elements to be essential to ASD functionality in both children and adults: acoustics; ventilation; heating; lighting; color; planning/layout; maintenance; cleaning; and outdoor spaces (Beaver, 2006). These elements correlate to the need for low noise levels (Beaver indicates this is the paramount requirement in ASD-friendly design); high-level windows to discourage escape behaviors; underfloor heating to minimize safety hazards; avoidance of fluorescent and other lighting that has a tendency to flicker; colors that are appropriate to the desired level of stimulation in a particular room; intuitive circulation space and layout (curved walls are preferred); preferring friendly materials that may need continual maintenance to unfriendly (but more durable and robust) materials that are virtually indestructible; choosing materials for carpets, wall surfaces, and ceilings that are aesthetically pleasing while also being durable and easy-to-clean; and creating secure outdoor play spaces that can be inconspicuously observed by caretakers, fostering independence among those residents with ASD (Beaver, 2006). Many of these recommendations are echoed in other papers present in the body of literature – the final compilation of recommendations from the literature will be determined by the findings of the empirical papers, which carry more scientific robustness than the non-empirical papers; however, these editorial and other non-empirical papers are an excellent starting point for further research and investigation into ASD-friendly environments.

Harker and King (2002) offer the following guidelines for ASD-friendly environments: simple layout; space standards (allowances for personal space in communal areas such as common rooms); serviceable and hardwearing materials; light, acoustics, and noise (soft, natural light and low levels of noise and sound transmission are preferred); communication (utilization of picture-assisted interaction with the built environment is advised); furniture, fittings, equipment, and furnishings require special care to ensure safety, cleanliness, and longevity; and security and risk management – this includes the safety of ASD individuals interacting with their environments (Harker & King, 2002). It should be noted that although these recommendations overlap with many other pieces of literature among the ASD-friendly design *corpus* of work, the authors do not cite appropriately; this forced the present author's determination to relegate this piece to the "editorial" subsection of the relevant literature, in that the references required to ensure valid work cannot be substantiated. This being said, it is valuable that Harker and King made it explicit that "[w]hat follows will not apply to everyone. Certain behaviour patterns, compulsions or aversions may be moderated or exacerbated by the design of a house but this can be very individual" (Harker & King, 2002); however, the authors then state that the aforementioned guidelines are "a set of common considerations where special attention is needed" (Harker & King, 2002) where individuals with ASD are concerned. This is problematic, as there is no assertion as to *how* this “set of common considerations” has been assembled.

Humphreys is much cited by the relevant literature. From his personal experience with an autistic family member, Humphreys (himself an architect) identifies "bright light, unpredictable sounds, heat," and "obsession with detail over...order, sameness, stimulation, stability, and calm" (Humphreys, 2008) as potential environmental triggers and considerations for individuals with ASD. Humphreys suggests that "[c]omplexity can cause stress if it is not harmonious" (Humphreys, 2008), and his design guidelines reflect this philosophy. The design guidelines given are: minimal details and materials, proportion (e.g. scale), natural light, proxemics (e.g. personal space), containment (without excessive restriction), observation, and acoustics. Containment and observation in this context are related to spaces designed for children with ASD that require clearly delineated containment and adult observation to ensure the children's safety.

To summarize, Humphreys provides an often-cited paper that is not empirical in nature, although the author does mention his participation in a workshop with ASD schoolchildren that did engage with their input on the ASD-friendliness of their educational environment. Humphreys is potentially important as a theoretical basis for ASD-friendly environments, but provides no substantive empirical or scientific bases for his recommendations; rather, he appeals to esoteric theoretical architectural principles as the guiding force behind his conceptualization of what constitutes an ASD-friendly environment. His paper is an exemplar of those gaps in the literature that future research must seek to fill through more robust empirical study.

Paron-Wildes presents a very unique theoretical analysis based on the medical and psychological literature, but coming from the perspective of an interior designer. Her Wiley Publishers e-book series *Interior Design for Autism* comprises three texts, each pertaining to a specific stage in human development (childhood, adolescence, and adulthood) – within *Interior Design for Autism from Adulthood to Geriatrics*, Paron-Wildes articulates ASD *vis-à-vis* the built environment in the context of both neurofunctions specific to ASD and how this relates to the built environment, as well as detailing design features by types of spaces (Paron-Wildes, 2014). The former component focuses on issues relevant to ASD such as acute visual processing, impairment to incoming social stimuli, and asociality; the latter component is structured according to the physical design space itself and include the following domains: home, educational facilities, workplaces, and clinics, among others (Paron-Wildes, 2014). This novel dual foci designing for both the ASD individual as well as the specific built environment is a rich way to perceive the problem of defining and discovering ASD-friendly environments.

As part of a University certificate program in ASD, Plimley conducted a project with her students to design an ASD-friendly environment, basing design choices on current theory and practice relating to ASD (Plimley, 2004). Despite this effort to use the existing literature to produce design guidelines for ASD-friendly environments, this exercise falls short in that the subsequent paper does not cite the bases for students' design decisions, and it seems that the students did not use any systematic process by which to determine which design features and elements of the built environment are actually appropriate for individuals with ASD. This is unfortunate, as it seems the students *were* informed by much of the existing literature, but due to a lack of documentation and adequate research design, their design choices were ultimately made in a more or less arbitrary fashion. It should be noted that individuals with ASD were in no way consulted in making these design decisions; rather, certificate program students used their own knowledge of ASD to construct the following design guidelines: quiet, calm atmosphere; carpeted areas; absence of loud, sudden noises; planning for changes; visual structures; number of adults; and sensory needs: screening, transitions, light sensitivities, visual perceptions, diffused lighting, muted colors (Plimley, 2004). Little explanation is given for these guidelines, although one can see the commonalities between this list and recommendations from the existing ASD-friendly design literature.

Part Two, Section (a): Non-Empirical ASD-Friendly Design – Place Study

The next two papers are unique among the non-empirical literature. They are both more robust studies than the editorial papers, and follow a general "case study" design; however, since the basic unit of analysis is a *place* rather than an actual *case*, I have designated these as "place studies." *Place studies* follow case study methodology while using a physical location as the basic unit of analysis – the individual "subject" of the study is a geographic place, rather than a person.

Mostafa offers guidelines from the field in "housing adaptation" for ASD; that is to say, retrofitting residential contexts for a disability that requires very different design considerations than traditional special needs housing projects that "conventionally deal

[only] with issues of physical access" (Mostafa, 2010). Mostafa highlights the lack of consideration for disorders such as ASD in both UK and US disability design standards (Mostafa, 2010) – the latter will be reviewed later in this paper. Following a substantive review of both ASD and ASD-friendly design literature, Mostafa identifies residential locations as a void within an emerging literature that *does* consider both educational and outdoor spaces for individuals with ASD (Mostafa, 2010); Mostafa also considers the lack of opinions from ASD individuals on "ASD-friendly environments."

The place study itself investigates a group home in the Netherlands for individuals with ASD. Using the "sensory design model" Mostafa created in 2008 – informed highly by the relevant literature available at the time – the research details how highly individualized guidelines for a *specific ASD-friendly environment* could be utilized (Mostafa, 2010), rather than resting on generalizations assumed appropriate to *all* cases of ASD (Mostafa's 2008 work is included in the empirical section of this literature review). Despite this statement, due to the group home setting, the researcher found it pertinent to "create a group of general guidelines responsibly, [addressing] the most common issues" (Mostafa, 2010); it is unknown whether or not individual bedrooms and non-common living spaces were individualized further. The resulting recommendations are listed under five group headings, with specific guidelines addressing "the most common issues" related to ASD: spatial quality; spatial organization; spatial orientation; spatial integration: landscaping; and safety (Mostafa, 2010). These five group headings relate to those common issues identified by researchers prior to Mostafa: auditory, visual, tactile, proprioception, smell, and taste (Mostafa 2010; citing Mostafa 2008) – these are listed in *descending* order of prevalence and thus priority (Mostafa 2010).

Mostafa echoes Beaver (2006) in stating that

> [p]ossibly the most prevalent problem facing autistic users, environmental acoustics and their auditory impact play an important role in any design consideration for autism. (Mostafa 2010; citing Mostafa 2008 and 2006)

Although the present paper includes the findings from reviewing the relevant ASD-friendly design literature and identifying which design features and elements intersect between empirical studies, it should be noted that the literature to date clearly indicates that auditory – as well as other sensory sensitivities – are paramount considerations necessary in mindfully designing spaces for individuals with ASD.

Like all true place studies, Mostafa draws her conclusions from the *space* itself, informed by a theoretical basis for design on behalf of the inhabitants, but not using the inhabitants as the basic unit of analysis – one of the hallmarks of such place studies is that the individuals for whom a space is built and/or designed are not direct players in the study at all. Empirical research following any place study is necessary to validate the guidelines and recommendations – as well as the assumed outcomes – presented in the place study.

Architect Iain Scott constructs multiple place studies of four schools with the intent to design learning spaces for children with ASD (Scott, 2009). Multiple place studies in a single paper are methodologically fairly analogous to a multiple case study design: each place serves as the basic unit of analysis within the research, and the multiple cases together assist in developing an overall picture of (in this case) the specific ASD-friendly design recommendations issued by the research. Following a concise, yet thorough, review of the relevant literature, Scott draws the following "key issues" from the ASD-friendly literature: ordered and comprehensible spatial structure; mixing large and small spaces; greater user-control over environmental conditions; accommodating different, ASD-specific teaching methods; balancing security and independence; provide simple and reduced detailing; active end-user involvement in the brief building and design process; appropriate use of technology to aid the ASD learning experience; and appropriate technical specification. Scott then applies these guidelines to the four place studies to determine their ASD-friendliness.

Some of the elements Scott uses are non-environmental issues, which can create a research problem similar to Richer and Nicoll (1971); Richer & Nicoll designed the seminal ASD-friendly design study, but unintentionally invalidated their findings by combining experimental environment *and* teaching methods simultaneously, then attributing behavioral changes in their subjects *only* to the environmental changes (Richer & Nicoll, 1971). Interestingly enough, none of the literature that cites Richer & Nicoll mentions this "fatal" flaw. Another problematic aspect of Scott's list of design guidelines is that many of these guidelines come from the non-empirical – specifically the editorial – literature. The present paper is determined to move away from this reliance on anecdotal "evidence," instead favoring a more robust scientific approach in determining what constitutes (according to the existing literature) ASD-friendly environments.

Part Two, Section (a): Non-Empirical ASD-Friendly Design – Meta-analysis

The following two papers are meta-analyses that systematically review the existing literature on ASD-friendly design. The first review, Rahaman and Rahim (2011) was presented to an international conference on Universal Design (a design theory I will explore in much detail later), but only its abstract could be located. Even so, the abstract is useful in gaining a glimpse into the review itself: Rahaman & Rahim articulate that two major types of papers exist in the ASD-friendly literature – one "addressing the need for special treatment of the environment exclusively" (Rahaman & Rahim, 2011) for children with ASD (they include Mostafa (2008), Khare & Mullick (2008), Vogel (2008), and Paron-Wildes (2009) here); the other "actually has translated research based knowledge on this subject matter in to practice thus designing several school building [*sic*] for the target group" (Rahaman & Rahim, 2011) (they include Humphreys (2005), Whitehurst (2006; 2007), and Beaver (2010) here). This present paper disagrees with this dichotomy of papers, especially in that this sort of distinction does not take *research quality* into account. The second meta-analysis by Sánchez, Vázquez, and Serrano is *the* definitive review paper to date on ASD-friendly design literature.

Rahaman presented a paper at the 2011 International Conference on Universal Design in Built Environment at the International Islamic University Malaysia as a Master's candidate from the Department of Architecture – this review paper investigates the existing literature on designing inclusive space for autistic children (Rahaman, 2011), and although it does not substantially add to the present literature review, it was a means of locating otherwise missing papers, as well as confirming those researchers' names well-known in the emerging field of designing ASD-friendly environments.

In their review section from the book *Autism Spectrum Disorders – From Genes to Environment* (2011), Sánchez, Vázquez, and Serrano detail pioneering research (Richer & Nicoll, 1971) that strove to create ASD-friendly environments through "reduction of frustration, arousal, and flight behaviors" triggered by the built environment. Richer and Nicoll include design criteria such as: subdivision of spaces; safety and robustness of elements; minimal intrusion/maximum autonomy; durable elements and materials; controlled sensory stimulation including a retreat box and highly stimulating areas; and use of light dimmers (Sánchez et al., 2011; citing Richer & Nicoll, 1971). Ahrentzen and Steele (2009) set the following goals for their ASD-friendly spaces: "ensure safety and security; maximize familiarity, stability, and clarity; minimize sensory overload; allow opportunities to control social interaction and privacy; provide independence and choice opportunities; and foster health and wellness; improve own dignity; ensure durability; achieve affordability; and ensure accessibility and support" (Ahrentzen & Steel, 2009). Another architect from the UK, Christopher Beaver, has proposed ASD-friendly design features over several studies
(Beaver, 2003; 2006; 2010) - his strategies involve:

-Corridors designed as utilized spaces
-Ample spaces to facilitate proximity needs
-Use of curved surfaces (i.e. walls)
-Acoustics
-Safety
-Radiant heating; cross- and passive ventilation
-Safety windows
-Indirect, diffuse lighting; avoid fluorescent lighting
-Quiet rooms to calm overstimulated ASD individuals
-Sensory rooms and gardens
-Warm, but not overstimulating colour palate
(Sánchez et al., 2011; citing Beaver, 2003; 2006; 2010)

Beaver is designing specifically with children in mind, but many of these guidelines echo those given by other researchers for both ASD children and adults alike. Beaver interestingly brings up a salient point silent by other authors – he argues that an overly ASD-friendly environment may result in ill-preparing individuals with ASD for the outside world. He notes that the striking dissimilarity between the ASD-friendly environment and ASD-unfriendly environments (e.g. the world in general) may essentially be a difficult transition for ASD individuals *too* accustomed to safe-haven environments suited to their specific needs.

Sánchez, Vázquez, and Serrano articulate their own conclusions about their review of the design criteria, and identify five distinct realms which should be kept in mind while designing ASD-friendly environments: imagination, communication, social interaction, sensory difficulties, and behaviour and safety are the overarching themes present in all the major research reviewed by Sánchez et al. (Sánchez et al., 2011). What is strikingly similar about all these criteria are that they do not seem innately specific to ASD populations; this sounds much like a call for better "human scale" design in general, which brings up the question of Universal Design. “Universal Design” was coined by architect Robert L. Mace, but developed by Selwyn Goldsmith in *Designing for the Disabled* (1963), and is based on the following seven key principles:

1. Equitable use
2. Flexibility in use
3. Simple and intuitive
4. Perceptible information
5. Tolerance for error
6. Low physical effort
7. Size and space for approach and use
   (North Carolina State University, 2013)

Perhaps the design guideline set that will yield from future review of the literature will eventually be written for *humans*, both neurotypical and neurodiverse. One imagines through future research that such guidelines may include statements like "design should not hurt human eyes," and "places must not make humans generally feel unsafe or unwelcome"; a depth of specific design features that are either beneficial or harmful coupled with a breadth of architectural inclusivity may generate new thoughts on what sort of built environments are appropriate for humans in general.

Part Two, Section (a): Non-Empirical ASD-Friendly Design – Government Standards

This final subsection of the first part of the literature review details an example of government standards for ASD-friendly design. The United Kingdom (UK) “national autism standards” are intended for educational settings, and essentially only mention ASD-friendly environments in an act of tokenism. The national autism standards claim to cover “[e]nabling environments (how to create good classroom and school environments for pupils with autism)” (AET national autism standards), stating that

> [t]he general ethos should be to **adapt the setting** to the needs of the individual pupil with autism **rather than making the pupils fit the setting**. (AET national autism standards)

The "[e]nabling environments" section provides seven areas for potential audits related to diverse sets of guidelines (these guidelines are listed as documents available *outside* of the national autism standards itself); one of the issues here is that these various sets of guidelines may not entirely agree with one another, which may create confusion among educators attempting a DIY ("do-it-yourself") retrofit for ASD-friendly design. Critics of the UK national standards have also objected to the sparse standards for ASD-friendly design in the United States (Mostafa, 2010).

Part Two, Section (b): Empirical Literature on ASD-Friendly Design

Part Two, Section (b) discusses the empirical literature itself, which is at the crux of the present paper. Ten empirical papers on ASD-friendly design are discussed, seven of which are included in a compilation I will use to define "ASD-friendly design." The three unused papers do not meet the inclusion criteria, and as such have been discarded from use in the systematic review. Using Venn diagram intersection logic, ASD-friendly design features and elements within the built environment (as described by the literature) will be used to derive a single list that the present paper will utilize as a relevant proxy for a single, central theory of ASD-friendly design, and to concretely operationalize the term "ASD-friendly."

In response to sparse data dictating governmental standards in the UK for ASD-friendly environments, Alvarez and Crabtree (2008) describe the "impact of different living environments – from large residential settings to small community-based houses – on the quality of life (QoL) of adults on the autism spectrum" (Alvarez & Crabtree, 2008). Their findings revealed that QoL was "higher in those living in smaller community-based houses when compared to those living in large residential settings"; QoL was defined as "life experiences, adaptive behaviour skills and level of challenging behaviour" (Alvarez & Crabtree, 2008). It should be kept in mind that small, community-based houses may have more than simply physical design qualities that diverge from large residential settings; the unknown differences that may be directly, indirectly, or not at all related to the built environment may serve as confounding factors to the findings of this study. The researchers concluded that small residential settings "provide greater predictability and consistency" overall, as well as more consistency within a small supporting staff team; they go on to state that "smaller residential settings may be able to develop more individualised communication protocols to support understanding" than their larger residential counterparts (Alvarez & Crabtree, 2008). The authors relay design features *per se* as an "additional factor" accounting for QoL in individuals with ASD – considering the "sensory differences individuals with autism experience" (Alvarez & Crabtree, 2008; citing Bogdashina, 2003), they recommend "providing a low stimulation, autism-friendly environment" (Alvarez & Crabtree, 2008).

Brand delves into building for individuals with ASD not only from an architectural perspective, but also from a practical construction standpoint. This study details "housing design for adults with autism" (Brand, 2010) through a charity in the United Kingdom. Listed among the "Key Findings" in the "Design Themes" section of the paper is the following comment on reduction of ASD "triggers" in the built environment: "Reduce the triggers of agitation and anxiety, by providing comprehensible, coherent spaces that meet the sensory needs of the individuals" (Brand, 2010).

The vagueness of the language is implicitly explained with the caveat that the "abilities and sensitivities of [ASD] individuals...vary greatly so reactions to the environment can differ...[G]roupings of behaviour have started to emerge from the research, but further study is required to prove their universality" (Brand, 2010). Like the signs and symptoms of ASD, ASD reactions to environmental stimuli can greatly vary between individuals; there is a need for comprehensive study of many individuals in order to identify which (if any) design triggers are shared throughout the ASD population. Brand labels subsets of triggers as "sensation," "perception," "refuge," and "empowerment" (Brand, 2010) – this labeling is reminiscent of the aforementioned work on Alzheimer's disease by Zeisel, et al. (1994; 2003). Brand articulates that design features problematic for ASD individuals are problematic due to the anxiety they produce. The specific guidelines constructed by Brand are given under each respective trigger subset:

> Sensation: Low arousal environments that minimize sensory overload; appropriate stimulation for ASD individuals with under-developed sensory sensitivities
> Perception: Navigable, easily-oriented environments; clear sensory cues that specify distinct spaces and uses; permeable interiors that are predictable and legible
> Refuge: Personalized private spaces for retreat and withdrawal if overwhelmed
> Empowerment: Environments in which stimulation can be calibrated by ASD residents according to their personal needs.
> (Brand, 2010)

Unlike many similar studies, Brand utilized interviews with ASD individuals themselves as well as professionals who work with individuals with ASD, and included an expert reference group and literature review. Brand is one of very few studies in the present literature review that make use of directly interviewing or otherwise engaging participants with ASD in order to originate and/or evaluate their design recommendations (e.g. empirical studies that give ear to ASD voices); it should be noted that some other studies utilize empirical observation of ASD individuals, but do not directly consult their subjects' opinions on what constitutes an ASD-friendly environment.

In summary, the Brand study is an empirical study that utilizes both interviews with and direct observation of adults with ASD – alongside data gleaned from the existing literature and an expert reference group – in order to prescribe recommendations for what constitutes an ASD-friendly environment. Like much of the existing literature, the study is qualitative in nature, but adds some level of robustness in its use of both direct observation and interviews with actual ASD individuals, rather than relying on expert opinion or secondhand experiential data alone.

Brooks and Tillotson (2009) offer another study included in the present literature review that integrates ASD perspectives as part of the assessment of ASD-friendly environments; this study was carried out October 2006-September 2009 as part of Brooks' Ph.D. work with the goal of developing "an optimal learning environment for a…class group with severe learning disabilities and autistic spectrum disorders" (Brooks & Tillotson, 2009). Modifications to the built environment studied include: "linear to curvilinear furniture style; fluorescent to daylight lighting; reflective to non-reflective surfaces; increasing robustness of furniture" (Brooks & Tillotson, 2009). Later changes include "the introduction of a new classroom group table and customised independent work stations" (Brooks & Tillotson, 2009); since this study was ongoing at the time the *précis* was written, final results are not known and this study is *not* included in the overall assessment defining ASD-friendly environments.

Khare and Mullick are interested in the principles of Universal Design and its relationship to designing spaces for ASD individuals. The study includes a novel approach to the problem and designs various tools by which to measure ASD-friendly environments: "[e]nvironmental assessment (EA) and performance measure for children (PMPA), validate the environment and performance inter-relationship, while design parameter rating scale (DPRS) rates the importance of environment for children with autism" (Khare & Mullick, 2009); the first of these measures – the EA – is essentially a checklist of environmental features. Like many similar studies, this is designed for learning environments and educational facilities for children with ASD; unlike other ASD-friendly environment studies, the purpose of Khare and Mullick is to develop "three testing tools to evaluate the design parameters" (Khare & Mullick, 2009) of an ASD-friendly environment. The eighteen environmental features ("design parameters") listed are: physical structure, visual structure, visual instructions, community participation, parent participation, inclusion, future independence, generous space standards, withdrawal spaces, safety, comprehension, accessibility, assistance, durability and maintenance, sensory distractions minimization, sensory integration, flexibility, and monitoring for assessment and planning (Khare & Mullick, 2009).

This study is somewhat complex – the three novel measures are operationalized as follows:

> The environmental assessment (EA) is a checklist of design parameters derived from the environmental design parameters for autism, and their presence is expected to improve education performance. The performance measure for pupil with autism (PMPA) is derived to test the performance of children, in presence of the parameters. Design parameter rating scale (DPRS) is developed to assess the importance of the parameters. Using this scale, parameters are judged by consensus amongst the experts to be beneficial for children with and without autism. (Khare & Mullick, 2009)

EA and PMPA data were collected from seventeen grade school classrooms in twelve schools within the United States in a "naturalized environment that is familiar and comfortable for children reflecting long term performances rather than one time attempt, from the therapist and teachers, who understand children and their action [*sic*] better" (Khare & Mullick, 2009); DPRS data were "collected from twenty experts working with severely autistic kids and also from thirteen regular education experts" (Khare & Mullick, 2009). In short, therapists and teachers measured the EA and PMPA observationally, while specific experts outside the observational classroom setting measured the DPRS. Since the EA is given in the context of an actual assessment, there is an implicit normative statement that these environmental features exemplify what is deemed suitable to an ASD-friendly environment, at least in the classroom setting. A more complicated rating scale is included to enable designers to consider environmental features missing from an existing educational facility, I assume with the intent to subsequently retrofit these environmental features where they are lacking through redesigns, or include them in original designs for learning spaces.

Although Khare and Mullick's results indicate that there is a "strong correlation between educational environment and performance" (Khare & Mullick, 2009), it should be noted that the researchers state that the findings "[confirm] that the design issues are not only favorable for autistic kids but are also beneficial for all school children"

(Khare & Mullick, 2009) – given that these measures are ranked and scored by teachers and therapists (and not "autistic kids"), this statement seems both premature and paternalistic, following the "expert knows best" model of environmental design planning for individuals with ASD. Though this study does utilize empirical observational methods, both the validity and reliability of the methodology as well as the results may be questioned, as they are entirely based on expert opinion, and the methods are not explicitly explained in a way that makes replication immediately possible. The claim that this study presents findings that are "evidence based" and "universally beneficial" seem a bit overreaching at this stage (Khare & Mullick, 2009); perhaps subsequent replication studies will shed more light on some of the obfuscation embedded within this (at times) incomprehensible study design.

Like much of the existing literature, McAllister and Maguire create design guidelines for ASD individuals in the UK; the topic of ASD-friendly environments is emerging more quickly across the Atlantic than it is currently in the United States.
In 2009, the UK Government Building Bulletin 102 (BB102) published standardized guidelines detailing design issues for children with ASD (McAllister and Maguire adopt these criteria in their guidelines):

> Simple layout: calm, ordered, low stimulus spaces, no confusing large spaces; indirect lighting, no glare, subdued colours; good acoustics, avoiding sudden/background noise; robust materials, tamper-proof elements and concealed services; possibly H&S [health and safety] risk assessments; safe indoor and outdoor places for withdrawal and to calm down. (McAllister & Maguire, 2012; citing BB102, 2009)

The focus of McAllister and Maguire's guidelines is on children with ASD and classroom environments that are specifically inclusive for these children in the learning context.

The robustness of this study relies on a government definition of appropriate design for ASD individuals without much scientific citation or justification. Much of the architectural and design literature proposes a specified built environment without offering substantial scientific evidence for the proposed design guidelines – this informs the present paper in agnostically questioning the criteria for ASD-friendly environments, as well as how these criteria are obtained.

To recapitulate, McAllister and Maguire provide ASD-friendly building guidelines based on government guidelines, recommendations of educators who work with ASD students, and theoretical architectural ideals, but has been "validated" (hypothetically) in a "case study to trial its effectiveness" (McAllister & Maguire, 2012). The case study was conducted through discussion and *in situ* design work with collaboration between teachers of students with ASD and architects – unfortunately, this is a major limitation of the study: it did not actually conduct an *in vivo* study of an ideal ASD-friendly classroom with ASD students present, but rather relied on the "expert" opinion of their teachers, which undermines the presumption that the case study actually was a scientific trial of the effectiveness of the "ASD-friendly" design. This again points to a major gap in the literature in the scarcity of empirical studies in general, and more pointedly of empirical studies engaging individuals with ASD in particular. Due to the lack of explicitly stated design guidelines within the text, this paper will *not* be included among the empirical literature from which emerges a theory of ASD-friendly design.

Mostafa conducts an observational study following an initial survey of parents and teachers who interact with ASD children. Both the survey and subsequent quasi-experiment involve the influence of design features on ASD functionality. Her discussion includes a "sensory design matrix" that pairs architectural attributes with ASD sensory issues (Mostafa, 2008). The architectural attributes identified are: "closure, proportion, scale, orientation, focus, symmetry, rhythm, harmony, balance, color, lighting, acoustics, texture, ventilation, sequence, proximity, and routine" (Mostafa, 2008). The matrix offers different design features tailor-made for specific sensory issues; the latter include: "auditory, visual, tactile, olfactory, and proprioceptive" (Mostafa, 2008) difficulties. Depending on the specific needs of the particular ASD individual, design recommendations (many, if not all are mutually exclusive) are offered on a more personalized basis. Mostafa's findings identified acoustics as the "most influential factor on autistic behavior, followed by spatial sequencing" (Mostafa, 2008); other elements such as "lighting, colors and patterns, texture, and olfactory issues" (Mostafa, 2008) were considered less influential by the surveyed sample, which consisted of teachers and parents, and *not* individuals with ASD.

Mostafa introduces the concept of "design intervention" (Mostafa, 2008) in improving the quality of life for ASD individuals. Implicit is the value judgment that architectural design must be inclusive for all people (this is taken well beyond what is legally required by ADA regulations). However, Mostafa also appreciates the concerns that current disability guidelines for the built environment do not have specific requirements for ASD. One can equally assert the lack of protective criteria for other "sensory sensitive" populations, including individuals with epilepsy and migraine – in fact, the immediate physiological medical consequences of an unsuitable environment are inarguably more severe for epileptics and migraineurs than ASD individuals, and one questions whether architectural guidelines for these groups are lacking largely due to the fact that epileptics and migraineurs do not have as powerful a lobbying force as do ASD individuals. It is also worth noting that both epilepsy and migraine are significantly more common than ASD: the CDC states that "10% of Americans will experience a seizure sometime during their lives,"[3] and the WHO estimates 47 percent of adults experience headache disorder globally,[4] while only "1 percent of the population of children in the U.S. ages 3-17 have an autism spectrum disorder,"[5] according to the Autism Society (note this last figure is consistent with known global prevalence of ASD; that is to say, most countries have close to a 1% prevalence for ASD).

Mostafa's assertion that architectural design is able to influence autistic behavior does not sound entirely far-fetched, but it does implicitly echo the archaic notion of architectural determinism (architectural determinism should be distinguished from environmental psychology; the latter is *not* an outdated field). Due to the heterogeneity of the ASD population, one wonders if boutique design for ASD individuals may result in architects using the premise as a way to profit from an emerging niche market – regardless of whether or not the architectural "improvements" are scientifically substantiated over extensive replication studies.

In summary, Mostafa's study utilizes both second-party (non-ASD participants consisting of teachers and parents of ASD children) interviews as well as an empirical observational study of ASD students in an actual educational setting in order to evaluate

[3] http://www.cdc.gov/chronicdisease/resources/publications/aag/epilepsy.htm
[4] http://www.who.int/mediacentre/factsheets/fs277/en
[5] http://www.autism-society.org/about-autism/facts-and-statistics

and validate her ASD-friendly design recommendations using appropriate quantitative methods. The study utilizes a quasi-experimental design consisting of both experimental (ASD children who received "design intervention") and control (ASD children who did not receive "design intervention") groups to compare between groups – this research design is by far the most scientifically robust of all the studies identified and located in the review of the literature at this time. Behavioral indicators were tracked in a pre-test/post-test design, further enriching the rigor of the study; based on the sample surveyed as well as the quasi-experimental observational study, Mostafa issues guidelines for ASD-friendly educational environments with the requisite measure of confidence – although her study is limited by a small sample size, "[t]he overall results of this study show promising indications of the possible improvement of autistic behaviour, as indicated by increased attention span, reduced response time and improved behavioural temperament, using an altered architectural environment" (Mostafa, 2008). This study is further validated by the fact that the researcher considers it "a first stage exploratory study" (Mostafa, 2008), with clear intentions to conduct a larger sample size study in the future and recommendations for future studies to use "randomized testing with a larger sample size and standardized possible confounder factors" in order to "verify its preliminary findings" (Mostafa, 2008).

Although the study lacks direct subjective perspective from individuals with ASD (to the contrary: one may argue that due to the quasi-experimental design, "actions speak louder than words"), Mostafa (rare among the existing literature) has conducted a strong scientific study that is seemingly capable of both replication and validation. The error in

Mostafa's study is not so much in the methods, but her conclusions: drawing from the basis of designing personalized spaces for unique individuals with ASD, Mostafa offers design guidelines that potentially encompass too much ground. For example, polar opposites are the hallmark of her recommendations; using her novel "Sensory Design Matrix" (Mostafa, 2008; Appendix B), the author offers 28 architectural guidelines, including: containment/openness, low ceilings/high ceilings, intimate scale/open scale, symmetry/asymmetry, balanced spaces/unbalanced spaces, bright colors/neutral colors/warm colors, indirect natural lighting/direct natural lighting, smooth textures/rough textures, cross-ventilation/closed ventilation, etc. (Mostafa, 2008). The basis for her criteria is a single (now outdated) theory on ASD from the 1970s (Delecato, 1974), which describes three variations of sensory experience in ASD: hyper, hypo, and interference types (Mostafa, 2008). Mostafa "matches" hyper-, hypo-, and interference-type ASD individuals with an appropriate stimulus and environment, resulting in an overly comprehensive approach to designing for ASD, in that essentially *all possible designs are* included. This "something for everyone" approach is problematic, as the researcher is potentially achieving success among individuals with ASD by over-inclusion, which has (in epidemiological terms) very high sensitivity (e.g. most/all ASD "cases" are "treated"), but extremely low specificity (most/all ASD "cases" are "treated" by virtue of *everyone* being "treated"). In short, this design guidelines model can succeed in being *anyone*-friendly (this begs the threat of universality, which I will address later), not just ASD-friendly.

Richer and Nicoll (1971) is considered *the* seminal ASD-friendly design study. This study transitions children in two groups (ASD and non-ASD) to a new dayroom environment in which they spend their day learning and playing. The differences between the new ASD-friendly environment and the original environment are noted. At first blush, this seems like a study with strong scientific methodology – rivaling Mostafa (2008). Two general goals for the ASD-friendly environment are offered: "[r]eduction of frustration and arousal," and "[r]eduction of flight behaviors and facilitation of approaches and rewarding social interactions" (Richer & Nicoll, 1971). The overall reception of this study by the more recent literature is one the fully accepts the study design as robust.

Unfortunately, there are key "fatal" flaws that are enough to entirely invalidate the findings of Richer and Nicoll. In fact, there are two key methodological flaws: first, both the ASD and non-ASD groups are comprised of children with various unknown developmental disorders, and it is unknown whether there is a significant difference in disorder type between the two groups (neither group is made up solely of children with or without ASD, and both groups are comprised of children that require care in a facility for mentally handicapped children); and second, the new environmental with which the children interact is introduced simultaneously to a entirely new method of pedagogy and behavior by the staff – therefore it is unknown whether the children's behavioral responses are being triggered by the new environment, or the new staff behavior (or by a synergistic reaction between the two). This causal ambiguity is best described graphically, as was done in an unpublished review of the study by Schuck (2014):

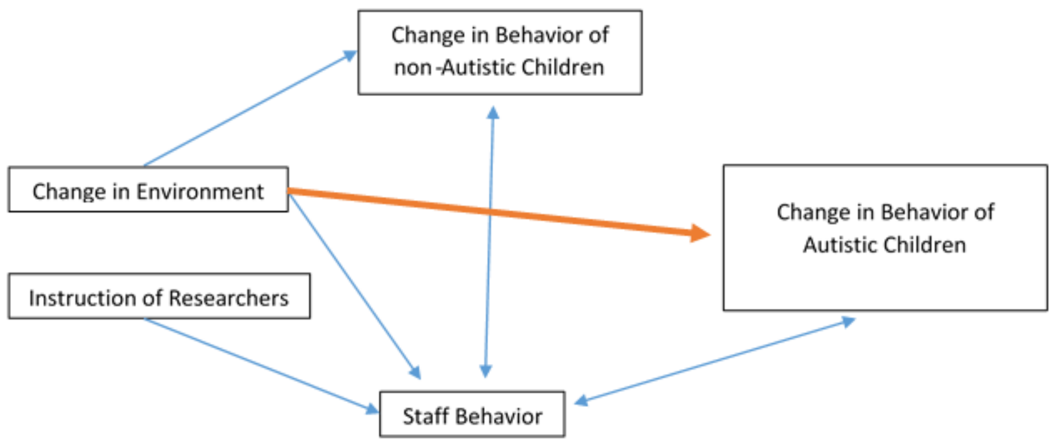

Figure 1: Causal Ambiguity in Richer & Nicoll, 1971 (Schuck, 2014)

This diagram represents the many possible causal pathways in Richer and Nicoll's study, emphasizing that the conclusions they drew from the research may be deeply flawed. Even within Schuck's diagram, one can posit even more layers of complexity: is there any feedback between the change in behavior between-groups (Autistic and non-Autistic children)? It is possible to imagine an even more complex web of potential confounding factors and causal ambiguity being derived from this study.

The latter problem is one we have seen earlier in this literature review. Introducing a confounding factor into the study seems to be the hallmark of certain ASD-friendly design studies. Richer and Nicoll clearly attribute any behavior change in the children *only* to the new environment, apparently defining the staff and their new behavior as part of the ASD-friendly environment; however, one cannot assert design changes as being associated (let alone causal) with certain (in this case, positive) behavioral changes in ASD individuals unless one has minimized confounding variables within the study. One must first demonstrate that the single manipulated variable has been the design environment itself, with all other things being equal (e.g. remaining unchanged). Apart from Mostafa (2008), there is considerable need for actual scientific rigor within future ASD-friendly design studies (quantitative and qualitative alike). This is a major limitation of the existing literature.

Sergeant, Dewsbury, and Johnstone detail the “shift from institutional living to community-based options” of “39 purpose-built housing units” using an “inclusive” (e.g. ASD-friendly) approach (Sergeant et al., 2007). The authors cite that “a variety of sources indicates [*sic*] that there is a correlation between environment, support structures and behavioural response for people with complex needs which affects the quality of life in living environments” (Sergeant et al., 2007). Like Richer and Nicoll (1971), many of the studies cited fail to separate potential causal links between environment, support structures, and behavior – this is a major detriment to a large volume of the ASD-friendly literature. At the time of publication, Sergeant, et al. state that this project is “currently the subject of evaluation” (Sergeant et al., 2007); regrettably, this evaluation has not been located – due to being incomplete, this study will *not* be included in the compilation of guidelines approximating a cohesive ASD-friendly design theory located later in the present paper.

Vogel offers a unique perspective in that it is one of the few papers that directly includes the subjective experiences and perspectives of individuals with ASD.

Vogel identifies "eight design standards and solutions" (Vogel, 2008) compiled from interviews she conducted with parents, teachers, therapists, and individuals with ASD. She suggests that these strategies can be adopted in essentially any interior space designed with ASD individuals in mind. These spaces must be: "flexible and adaptable; non-threatening; non-distracting; predictable; controllable; sensory-motor attuned; safe; and non-institutional" (Vogel, 2008). As with many of the other ASD-specific guidelines found within the existing literature, these criteria closely resemble both the tenets of Universal Design, as well as the recommendations given by Zeisel, et al. (1994; 2003) for use in clinical settings with Alzheimer's disease patients.

Vogel's study is an empirical interview-based investigation intended to develop "design standards and solutions gathered from interviews with people most directly affected by autism – parents, teachers, and therapists, as well as college students and adults with autism" (Vogel, 2008). Although not as scientifically robust as studies using at least observational or quasi-experimental methodology, the design recommendations indicated by Vogel do hold more weight than purely theoretical or indirect accounts of the needs of ASD individuals, due to the inclusion of individuals with ASD in her interviews to gain their perspectives directly and incorporate those highly relevant perspectives into her design guidelines.

In 2006 and 2007, two documents were released on a project to construct a "new building created as a residential living space for 12 children with ASD" (Whitehurst, 2006). The qualitative data are based on interviews with staff and families, which compare children's responses to the previous residential setting to the new facility; they were also encouraged to state "any aspects of the design which created problems" (Whitehurst, 2006). Uniquely among the literature, the ASD-friendly facility described by Whitehurst encouraged children with ASD to decorate their own bedrooms, even choosing their own wall colors; this may have enhanced subjective feelings of safety and control over one's environment (Whitehurst, 2006). In 2007, a one-year follow-up document included ASD children's perspectives on the new building (Whitehurst, 2007). The facility itself incorporates "specific features within the design of the building" (Whitehurst, 2006); these include: curvilinear design; specific colors; noise-reduction fabrics; non-fluorescent lighting; sensory suite; courtyard and outdoor canopies; specific floor coverings; specific bedroom design; under-floor heating; and circulation space (Whitehurst, 2007). These specific design features are supported by well-documented studies within the texts – Whitehurst is clear that these elements have been demonstrated to promote ASD wellbeing.

Part Three

Part Three, Section (a): Systematic Review of the Empirical Literature

There is not a clearly defined central perspective accompanying ASD-friendly design, except for the extremely general admonition for low stimulation; "low stimulation" is rarely operationalized, and some researchers personalize it to such a degree that their set of ASD-friendly environmental guidelines often encompass contradictory recommendations (Mostafa, 2008) – this results in something like a "cold-reading" (common among horoscopes), in that the guidelines are so vague, or so all-encompassing, that nearly *anyone* (including non-ASD individuals) will find truth in some variation of these recommendations. Often these guidelines simply list opposites in the interest of "personalization" (Mostafa, 2008). Despite the lack of a single, central theory for ASD-friendly design, many authors seem to cite overwhelming agreement within the literature. This is a fallacy. In the non-empirical literature, much of this agreement stems from minimal and overlapping citations; that is to say, the literature base is so small that any set of papers is highly likely to stem from a single "common ancestor," or set of common ancestors. This is not unique to the non-empirical literature, although it may be more common among these papers. A similar problem stems from different authors stating diverse "agreed-upon" design features of "highest importance" to individuals with ASD (Mostafa claims acoustics is the "most influential architectural factor on autistic behavior" (2008); Vogel claims design flexibility "is the first and most widely agreed upon standard" (2008) – to Mostafa's credit, she gleaned her assertion from a novel survey of parents of ASD children in her study; Vogel offers no citation whatsoever). Assuming the empirical literature is of higher study quality than the non-empirical literature, I have investigated the empirical literature to determine what – if any – design guidelines are shared across most or all of the relevant empirical papers. The results will be discussed at length, exposing a need for articulating (or developing outright) a cohesive, central theory for ASD-friendly design.

Although this portion of the study is hedged as part of the literature review, the research methodology of Part Three, Section (a) is consistent with a brief systematic review, following Khan, Kunz, Kleijnen, and Antes (2003). I will proceed by discussing the systematic review in the following order: introduction, methodology, results, and conclusions.

Introduction

A systematic review – common to epidemiology, unfortunately uncommon in many other fields – is a review that "is based on a clearly formulated question, identifies relevant studies, appraises their quality and summarizes the evidence by use of explicit methodology" (Khan et al., 2003). The systematic review is a type of meta-analysis the hallmark of which is the "explicit and systematic approach that distinguishes [it] from traditional reviews and commentaries" (Khan et al., 2003); strictly speaking, the entire literature review has been conducted in a systematic fashion. Khan, et al. go so far as to state, "[r]eviews should never be done in any other way" (Khan et al., 2003). Khan, et al. list five steps required for a robust systematic review: 1) Framing the question; 2) Identifying relevant publications; 3) Assessing study quality; 4) Summarizing the evidence; and 5) Interpreting the findings (Khan et al., 2003). The systematic review is both brief and novel in that it consists of a more strictly-defined review within a larger literature review, and poses a specific question necessary for (but not identical to) answering the overarching research questions posited at the start of the present paper. In this brief systematic review, I am interested in answering one question: what

"ASD-friendly" design guidelines are *shared* by the existing empirical literature? The answer to this seemingly simple question will allow us to develop a more detailed and accurate idea of what ASD-friendly design *theory* actually is.

Methodology

I refer to this review as an *embedded* or *nested* systematic review in that it is included as part of a much larger general literature review. My methods follow Khan, et al. as closely as possible, but some reinterpretation must be made due to the embedded nature of the review. The research question for the review has been explicitly stated in the introduction, and I have identified relevant work from an exhaustive review of the existing literature. It should be noted that the literature on ASD-friendly environments is not extensive, resulting in an extremely small number of papers (this is the primary reason a qualitative methodology was adopted for the present paper – the "sample size" of relevant literature was too small to warrant a quantitative meta-analysis or other statistical approach); however, the few general papers identified (and even less *empirical* papers) represent the basis of an emerging field of inquiry, and are thus important, despite their individual and collective limitations.

The empirical literature selected for this review has *not* been based on study quality – other than the assumption that empirical studies are more robust than non-empirical papers – however; I *have already* assessed the quality of the empirical studies within the general literature review. The inclusion criteria are straightforward: the papers must be *empirical*, *complete*, and *explicitly state design guidelines or recommendations* *for individuals with ASD*. Identified studies that were excluded are those among the non-empirical literature, as well as empirical literature that was either incomplete or did not state specific design guidelines or recommendations for individuals with ASD (of ten total empirical papers, three were excluded; two of which were incomplete (Brooks & Tillotson, 2009); (Sergeant et al., 2007), and one failed to offer explicit design guidelines for ASD individuals (McAllister & Maguire, 2012)). I have already assessed the quality of each paper in the larger literature review, but it should be clearly noted that – due to the small sample size (seven total papers) – I have neither weighted the results nor ranked by quality. A weighting and ranking system based on study quality would be recommended for future studies if a significantly larger number of empirical papers are located. For the purposes of the brief systematic review, I assume that the empirical studies are of approximately similar quality (each of their respective limitations was discussed previously in Part Two, Section (b) of the aforementioned literature review), and the purpose of assessment at this juncture is to determine which design guidelines presumed to be ASD-friendly are shared among the empirical literature.

This being said, it should be noted that four of the included studies were published in peer-reviewed journals (Alvarez & Crabtree, 2008; Khare & Mullick, 2009; Mostafa, 2008; and Richer & Nicoll, 1971); it is generally assumed that academic papers published in peer-reviewed journals are of higher quality than other papers. To take the potentiality for study quality difference into account, following the results for all seven papers (irrespective of quality), I highlight the design guideline convergence within the peer-reviewed papers only, to investigate whether there is a substantive difference between their findings and the findings of those empirical papers not published in a scholarly peer-reviewed journal. The findings solely from the peer-reviewed studies are indicated in the Results section of this systematic review, followed by the findings solely from the non-peer-reviewed studies. A discussed on the differences between these groups follows in the Conclusions section, including graphical representation of those key trends and differences in those guidelines and recommendations agreed-upon by the peer-reviewed empirical literature, compared to the non-peer-reviewed empirical literature; the possible explanations for these important differences should be kept in mind.

Alvarez and Crabtree (2008), Brand (2010), Khare and Mullick (2009), Mostafa (2008), Richer and Nicoll (1971), Vogel (2008), and Whitehurst (2006; 2007) have been included in the systematic review. In order to determine which (if any) design recommendations explicitly stated in the empirical literature were shared across multiple empirical studies, I performed an analog search of each paper for its stated guidelines, then matched any converging guidelines between papers. It should be made clear that due to the extremely small number of papers available, a kappa statistic is *not* appropriate in this context; rather, a rudimentary count of agreement between papers is utilized. This is *not* a form of inter-rater *reliability*, although it is a form of inter-rater *agreement*. The count will demonstrate which design guidelines are most agreed-upon by ASD-design theory researchers, but it will *not* determine the objective reliability of their assessments. For future studies, especially in the event that more relevant literature is identified, I strongly recommend using a statistical technique for inter-rater reliability if possible. For the purposes of the present paper, the focus is to *identify* design recommendations consistent between empirical studies within the existing ASD-friendly design literature.

Within-document searches were made by computer (using the native tool within Microsoft Word) to test for errors in the analog search. Using Venn diagram intersection logic, I documented which design guidelines were shared by multiple studies. Due to interpretation issues stemming from ambiguous language, I discarded any guidelines that were too vague to be justified as converging or diverging; that is to say, I intentionally erred on the side of non-convergence, when wording was not patently synonymous. Design guidelines that had less than 50 percent agreement within the included literature were also discarded. Of the seven papers included in the review, eight total design guidelines were identified that were shared by a minimum of four papers (minimum 50% agreement). The following design guidelines are shared (in varying degrees) by the empirical literature: low stimulation, predictability/consistency, retreat space, wide circulation spaces, natural light and/or avoiding flickering/buzzing lights (common among fluorescent bulbs), low noise levels, minimization of "fascinators," and use of low-arousal colors. These design recommendations have been listed in descending order of convergence. The operationalized definition of each recommendation will be discussed presently alongside the results of the review. The results are listed in an Excel file for ease of reference within Appendix 1, included at the end of the present paper.

Results

Low Stimulation

Low stimulation appears to be the most intuitive – but most poorly defined – design guideline offered by the empirical literature; it is also the single recommendation shared by *all* seven studies included in the systematic review (100% agreement; note: this is *not* a kappa statistic, but rather a literal, non-weighted percentage of agreement between studies). One of the major limitations of using the excessively broad term "low stimulation" is that nearly every other design recommendation identified can (at least hypothetically) be justified as simply being a feature of a low stimulation environment. This being said, as the only design feature explicitly recommended by all seven empirical studies, I felt it necessary to include it in the analysis; however, I am *not* assuming the other design guidelines (except where explicitly stated) necessarily falls *within* the category of low stimulation. Low stimulation is often defined in circular fashion: more than one paper operationalizes "low stimulation" as an "ASD-friendly environment," while offering the former as a *requirement for an ASD-friendly environment*. These logical errors should be noted carefully when reading the existing ASD-friendly design literature. For this guideline, the peer-reviewed studies have 100.0 percent agreement (4 out of 4 studies), as well as the non-peer-reviewed studies (100.0%; 3 out of 3 studies).

Predictability/Consistency

The ability for an individual with ASD to predict his or her environment – by designing an environment that is itself consistent and predictable – was shared by five of the seven empirical studies (71.4% agreement). This criterion was generally defined as an environment without unpredictable elements like sudden corners or abrupt transitions that interrupted discrete rooms and other clearly defined spaces. Although ASD individuals – like neurotypicals – require *some* level of stimulation, a marked element of sameness is recommended for the individuals with ASD. Predictability, consistency, and sameness appear to lessen the anxiety so common among people with ASD. The peer-reviewed studies have 75.0 percent agreement (3 of 4 studies), while the non-peer-reviewed studies share only 66.7% agreement (2 of 3 studies) regarding predictability/consistency.

Retreat Space

Retreat spaces (sometimes called "sensory suites") are typically small, enclosed spaces or separate rooms in which an individual with ASD can literally retreat from the social life of the group, often in order to accommodate a "meltdown." When retreat spaces are referred to as sensory suites, it is in reference to a low-sensory suite (sensory suites can also be designed for intentional heightened stimulation – I will refer to these as *stimulation suites*; this is *antithetical* to the definition of a retreat space, although these high-sensory suites do seem to have their place in designing for people – specifically children – with ASD). Five of the seven empirical studies included some sort of retreat space as a design recommendation for ASD individuals (71.4% agreement). Some retreat spaces are designed in such a way that the user can fully control the stimulus within the space, while others are more like traditional sensory-deprivation chambers; both types share the feature of being dimly-lit or dark, quiet, and separated from external stimuli. For retreat space, the peer-reviewed studies have 75.0 percent agreement (3 of 4 studies), while the non-peer-reviewed studies share only 66.7% agreement (2 of 3 studies).

Wide Circulation Spaces/Proxemics

Four of the seven empirical studies agreed that wide circulation spaces – thoroughfares that may easily become bustling or busy – are indicated in designing for individuals with ASD (57.1% agreement). This is largely on the basis of *proxemics*, which illustrates a need to design mindfully for a specific trait common to many individuals with ASD: many ASD individuals have an extremely low tolerance for being in too close of contact with others, and their sense of personal space is heightened. Proxemics (from *proximity*) is the study of a specific form of nonverbal behavior in both humans and animals; it studies (on a very basic level) the proximity in which one human/animal maintains from others (Hediger, 1955; 1969). In reference to more sophisticated human-human and human-environment interactions, proxemics has been defined as the "interrelated observations and theories of man's use of space as a specialized elaboration of culture" (Hall, 1966). It is extremely interesting – and revealing – that the use of proxemics within the ASD-friendly design literature mirrors the more basic definition used in observing animals, which includes (in animals): flight distance, critical distance, personal distance, and social distance (Hediger, 1955; 1969). Noted cultural anthropologist Edward Hall (who coined the term "proxemics" in 1963) postulates, "flight distance and critical distance have been eliminated in human reactions" (Hall, 1966). Most of the ASD-friendly design literature emphasizes personal space (note: this is *not* synonymous with personal *distance* in animals), although (as has been seen in the larger literature review) flight distance does seem extremely important in understanding thresholds of anxiety in ASD individuals. The peer-reviewed studies have 75.0 percent agreement (3 of 4 studies), while the non-peer-reviewed studies share only 33.3% agreement (1 of 3 studies) regarding wide circulation spaces/proxemics.

Natural Light and/or Avoiding Flickering/Buzzing Lights

Apart from the notion of a retreat space, which is by definition a space utilized by "opting-in" when required, the other specific recommendations within the set of ten (somewhat) agreed-upon design guidelines that seem most intuitive to the idea of "low stimulation": specific lighting, sound, visual stimulation (other than lighting), and color schemes are all only convergent in 57.1% (4 of the 7 empirical studies each) of the literature included in the systematic review.

Light-centric ASD-friendly design guidelines offer a variety of strategies to avoid the sensory sensitivity to light not uncommon in ASD. Most of the design literature calls for some combination of increasing natural light (often from high windows; this is often featured more as a security feature for children who may sneak out of a low window, and it is not agreed-upon within the literature) while decreasing any light sources that annoyingly flicker and/or buzz (this is typical of fluorescent lighting, and can trigger migraines and even seizures in two other – often overlooked – sensory sensitive groups:

migraineurs and epileptics, respectively). For natural light and/or avoiding flickering/buzzing lights, the peer-reviewed studies have only 25.0 percent agreement (1 of 4 studies), while the non-peer-reviewed studies share 100.0% agreement (3 of 3 studies).

Low Noise Levels

Although noxious sound is implicated in much of the ASD-friendly design literature as decidedly ASD-unfriendly, the empirical literature does not reach complete agreement about noise specifically, although *all* of the studies included in the systematic review do agree that “low stimulation” as a general concept is a necessary condition for ASD-friendly environments. Like lighting and other forms of excessive visual stimulation, and specific color schemes, the need for low noise levels is only agreed-upon by 57.1% (4 of the 7 empirical studies) of the included literature. It may be that low noise level is assumed to be tacitly included in the requirement for “low stimulation” in ASD-friendly environments; even so, there is a need for the literature to be more exacting in operationalizing definitions for statements such as “low stimulation,” which can quite easily be interpreted to mean many things by different readers. The peer-reviewed studies have only 25.0 percent agreement (1 of 4 studies), while the non-peer-reviewed studies share 100.0% agreement (3 of 3 studies) for low noise levels.

Minimization of "Fascinators"

The term "fascinator" is not explicitly used in the empirical literature, but has been adopted here to mean any extraneous visual stimuli that can provoke obsessional response in human beings, especially in those with ASD. In more common usage, a fascinator is something used (especially in women's clothing and accessories) to attract attention. This is precisely what can occur in ASD individuals with certain unnecessary visual stimuli. Architectural and interior design features that for non-ASD individuals may be interesting or aesthetically pleasing may be overly distracting for individuals with ASD. Over half (57.1%; 4 of 7) of the empirical literature includes some definition of fascinators as inappropriate in ASD-friendly settings, although how fascinators are defined varies. Regarding the recommendation to minimize "fascinators" in ASD-friendly environments, the peer-reviewed studies meet the minimum 50.0 percent agreement (2 of 4 studies), while the non-peer-reviewed studies only share 66.7% agreement (2 of 3 studies).

Use of Low-Arousal Colors

Scientific studies have demonstrated that ambient colors (e.g. painted walls) can contribute to a wide variety of behaviors, and that certain colors can be classified as either calming or arousing. The ASD-friendly design literature often invokes these findings to support conscious use of specific colors in order to assist in controlling stimulation level when designing for individuals with ASD. Four of the seven (57.1%) empirical studies included in the review recommend the use of low-arousal colors in

ASD-friendly environments, although not every study explicitly indicates which colors are best-suited for such environments. It should be emphasized – as in the case with the use of stimulation suites – that individuals with ASD (like all humans) *do* require stimulation; however, high-stimulation cannot be *continual*, and so low-stimulation environments are considered recommended as a baseline, with higher levels of stimulation relegated to separate spaces such as specially-designed stimulation suites (these always have an opt-in policy, whereas high-stimulation design as a baseline would require opting-out). The peer-reviewed studies have only 25.0 percent agreement (1 of 4 studies), while the non-peer-reviewed studies share 100.0% agreement (3 of 3 studies) in terms of use of low-arousal colors.

Conclusions

The marked differences between the three groups detailed – *all* empirical studies, *peer-reviewed* empirical studies, and *non-peer-reviewed* empirical studies – is striking. Although I am not performing this investigation from a statistical inter-rater reliability perspective, qualitative analysis can be nonetheless revealing. Low stimulation is the only design guideline agreed-upon with certainty between-groups (100% agreement); following low stimulation are predictability/consistency and retreat space, which both received 71.4 percent agreement among all empirical papers, 75.0 percent agreement among the peer-reviewed empirical papers, and 66.7 percent agreement among non-peer-reviewed papers. It is clear that in this case, the peer-reviewed papers have slightly greater agreement than exists among all papers (up 3.6%), and the non-peer-reviewed papers have considerably less agreement than exists among all papers (down 8.3%). Minimization of “fascinators” has 57.1 percent agreement for all groups, 50.0 percent agreement from the peer-reviewed group, and 66.7 percent agreement for the non-peer-reviewed group. This is the last design feature for which there is some consistency between groups: the peer-reviewed papers have less agreement than all papers (down 7.1%), while the non-peer-reviewed papers have considerably more agreement than all papers (up 9.6%). Although within these first four design features (low stimulation, predictability/consistency, retreat space, and minimization of “fascinators”) there is less than 10 percent discrepancy in either direction between all empirical papers and peer-reviewed papers or non-peer-reviewed papers, there is an apparent trend that marks a difference between the peer-reviewed studies and non-peer-reviewed studies *vis-à-vis all* empirical studies included in the systematic review: the agreement differences between all studies and the peer-reviewed studies, and between all studies and the non-peer-reviewed studies *move in different directions*. That is to say, there is a slight polarization between the peer-reviewed and non-peer-reviewed studies. This difference becomes more marked in regard to the last four design guidelines.

Wide circulation spaces/proxemics, natural light and/or avoiding flickering/buzzing lights, low noise levels, and use of low-arousal colors all share 57.1 percent agreement among all empirical studies included in the systematic review, but there are drastically different results when the peer-reviewed studies are made distinct from the non-peer-reviewed studies. In regard to wide circulation spaces/proxemics, peer-reviewed studies share 75.0 percent agreement (17.9% higher than the total), while non-peer-reviewed studies share only 33.3 percent agreement (a 23.8% decline from the total). For natural light and/or avoiding flickering/buzzing lights, low noise levels, and use of low-arousal colors, peer-reviewed studies agree by only 25.0 percent (a 32.1% drop), while in each case 100.0 percent of the included non-peer-reviewed studies are in agreement (an increase of 42.9%). These huge disparities between groups are specifically related to the issues centered on light, sound, and color – these elements are all (interestingly) arguably attributes of a low stimulation environment, on which all empirical studies included in the systematic review agree. If light, sound, and color are considered elements of low stimulation, then there remains only one issue on which the peer-reviewed and non-peer-reviewed studies radically disagree: wide circulation spaces and proxemics. As one can see from this analysis, the way in which statements such as "low stimulation" are operationalized can create major differences in the interpretation of the literature.

Part Three, Section (b): Establishing an ASD-Friendly Design Theory

Part Three, Section (a) detailed those design guidelines that were agreed-upon by at least fifty percent of all empirical studies included in the systematic review; eight major design recommendations were identified, and the level of agreement between empirical papers for each design guideline was discussed. These eight guidelines are: low stimulation, predictability/consistency, retreat space, wide circulation spaces/proxemics, natural light and/or avoiding flickering/buzzing lights, low noise levels, minimization of "fascinators," and use of low-arousal colors.

Based on the results of the brief systematic review above, a low stimulation environment is *the* essential component of ASD-friendly design, according to the relevant empirical literature; however, "low stimulation" is still ill defined. Aside from the guideline to minimize "fascinators," those design elements that seem most related to low stimulation (light, sound, and color) are also those with the lowest level of agreement between the peer-reviewed study and non-peer-reviewed study groups. This being the case, there is a strong argument that ASD-friendly design theory is still only loosely defined, and requires more stringent operationalization in future studies.

Despite these inherent limitations, for the purpose of the observational study, I operationalize design features as "ASD-friendly" if they fall into any of the following categories: predictable/consistent, contains a 'retreat space,' wide circulation spaces/generous proxemics, natural light, low noise levels, minimization of "fascinators," and use of low-arousal colors (low stimulation is not used, as it may be a proxy term for other – more specific – design features either listed above or unknown). As the observational study is conducted in open-air plaza settings, each of the aforementioned terms must itself be operationalized in order to remain relevant in this specific setting (in fact, some may be found irrelevant, and will be excluded from the study design). However, reinterpretation cannot be too tangential, resulting in a definition that is substantively different from its original meaning within the ASD-friendly design literature.

Study Design and Methodology

Introduction

The study design has two distinct parts: the systematic review, and the observational study. The systematic review has been contained within the greater literature review, and its design and methodology have been described in that part of the present paper. The observational study consists of a qualitative comparison of ASD-design theory (interpreted as the results of the systematic review) with human behavior in a plaza setting. It is this observational study to which we now must turn our attention.

Operationalizing Concepts

Considering the nature of the observational study, the key operational definitions we must discuss are those design elements gleaned from the systematic review. There are eight distinct design features: predictability/consistency, retreat space, wide circulation spaces/proxemics, natural light and/or avoiding flickering/buzzing lights, low noise levels, minimization of "fascinators," use of low-arousal colors. Each of these design details must be operationalized in order to apply them to the observational study setting, while attempting to maintain definitions that are as objective as possible (it is not possible to assure replication of subjective experiences, and so the operationalized definitions must be as strictly-defined and precise as possible).

Predictability/consistency is largely defined as symmetry for the purposes of the observational study. *Retreat space* is defined as any nook or other similar feature that allows an individual seclusion from the general social environment. *Wide circulation spaces/proxemics* is straightforward, defined as wide streets and/or paths, as well as seating that provide ample space between individuals. Cramped open-air spaces would be the antithesis. In the case of *natural light and/or avoiding flickering/buzzing lights*, since the observational study takes place during daylight hours in an open-air setting, I assume all locations will have natural light as the primary light source; however, some areas may have more natural shade or shadow due to canopy trees, overhanging roofs, and other features of the built environment. *Natural light* is defined as any light that is not man-made in its source, but the man-made environment *will* affect natural light *vis-à-vis* humans using a given plaza – the three plazas (all located within the engineering areas of the University of California, Irvine Main Campus) will be compared to one another in regard to natural light. Specifically, shade trees and canopies of any kind will be noted, since shadow varies by time of day. Since the bulk of the ASD-friendly design literature is interested in indoor locations, I assume that too much stark natural light is as undesirable as too much darkness; these findings will be discussed at length in my detail of the observational study.

Noise levels are generally greater in the outdoor environment, compared to the indoor environment. The observational study is conducted via still photographs, and so the primary data does not include sound. For this reason, *low noise levels* must be excluded as a design criterion for the analysis. I recommend that future studies capture audio on-site, or measure noise levels in real time using a decibel counter.

Minimization of "fascinators" for our purposes is defined as a space that has minimal visual distractions for the individual experiencing the plaza. That is to say, there are few bills (flyers) posted on walls, sides of buildings, etc., and the space is generally unmarred by visual interruptions such as randomly placed public art and other distracting features. There is research suggesting water features may be soothing to individuals with ASD, but none of the empirical papers included in the systematic review indicated this (cite). For this reason, I must assume that water features in direct view of individuals within a given plaza is also a form of "fascinator," and could be distracting to an individual with ASD. *Use of low-arousal colors* is the final design feature from the systematic review; pink, purple, and grey have all been demonstrated to be low-arousal colors: "[s]hades of pink and purple have been found to be the most positive colours," and "[g]rey has also been widely used as this has been shown to be a neutral and non-reflective colour which provokes neither a positive nor negative reaction" (Whitehurst, 2007). For the purposes of the observational study, I define low-arousal colors as any muted color. These operationalizing concepts will serve as a sort of checklist with which I can compare the three different plaza settings over a period of three days.

Variable Measurement and Unit of Analysis

The individual is the unit of analysis for the observational study.
The observational study consists of using primary source data (e.g. photographs) to determine the number of individuals utilizing a given plaza at a distinct moment in time;

following this assessment (number of people using a given plaza), I am interested in exploring whether or not specific "ASD-friendly" design features are present/absent at the plaza site. Whether ASD-friendly design features are present or absent will be measured in a binary fashion (e.g. simply "present," or "not present"). I can then determine whether (in this small convenience study) ASD-friendly design features are *associated* with plaza utilization. It should be made extremely clear that causality *cannot* be established through this observational method, nor does this study claim to demonstrate causation.

Data Collection and Analysis Methods

Secondary data of ASD-friendly design theory has been collected through an extensive literature review. Primary data for the observational study was collected by photographing actual human behavior in three distinct plaza settings at the University of California, Irvine (UC Irvine or UCI) Main Campus over three days: 94 total photographs were collected over two consecutive Wednesdays and the Monday between them; 58 of these photographs are useable for the analysis (originally there were four plaza locations scouted and shot, but one of which became unfeasible to include during the course of the study due to the inability to shoot this particular plaza on one of the three scheduled field research days). Day of the week was constant (Wednesdays) with one Monday control to check for time effects; time of day was held as constant as possible given buffer time needed for any unanticipated technical difficulties. Weather was constant – sunny and clear – on all three days. The style of photography follows William H. Whyte's "fly-on-the-wall" viewing of plazas in New York City (Whyte, 1980).

Analysis of the primary source data has already been largely addressed; the analysis is qualitative in nature (like Whyte's seminal study, it may also be loosely considered "quantitative" in that it contains a literal count), and is largely exploratory. The purpose of this analysis is to investigate whether human behavior in a plaza setting can be explained by ASD-friendly design theory – this does not imply that other theories are not applicable to explaining this behavior, nor does it infer causality.

Internal and External Validity

There do exist threats to both internal and external validity due to the nature of this observational study. This study does not have broad external validity (e.g. generalizability); however, as an exploratory study, the study does offer the opportunity to make basic observations on the intersection of human behavior and environmental design features, from which understanding of how this specific human-environmental interaction takes place (human behavior *vis-à-vis* ASD-friendly design theory) can be gained, as well as generate hypotheses and concepts for future research. As an observational study that utilizes a small convenience "sample" (due to the qualitative nature of the study, sampling logic does *not* strictly apply, although the terminology is often useful) of individuals at UC Irvine's Main Campus (I assume these individuals are students, and that they are neurotypical), the results cannot articulate *why* people utilize a given plaza setting in a specific way (such as seating choice and preferred areas of congregation) – nevertheless, one can gain insight through such a simple research study on the design features associated with the utilization choices *these specific individuals* made in an open-air plaza setting.

Despite the statements above, it should be remembered that this is a *qualitative* study, and as such, abides by rather different rules than a quantitative analysis. Generalizability is replaced by *transferability*, or the ability for one particular study's results to "transfer to situations with similar parameters, populations and characteristics" (Lincoln & Guba, 1986). Related to this concept is the notion of *ecological validity*: highly controlled laboratory experiments are not readily generalizable to real-world scenarios, whereas more naturalistic studies have higher ecological validity, which may be thought of as relevance to the real world (Brewer, 2000). Ecological validity and external validity are independent (Shadish, Cook, & Campbell, 2002); as such, even a small observational study such as the study described in the present paper *can* offer valid and relevant results to the real world.

Internal validity can be threatened in many ways; for this particular study, there are different threats to internal validity that occur at different times during the collection and analysis of the primary source data. During collection, the largest threats to internal validity are: observer effect and confirmation bias (the latter in the form of "cherry-picking," which can also be a bias in the analysis stage). Observer effect can occur whenever individuals know or realize they are being studied or observed by an outsider. For the purposes of the current study, I was extremely careful while performing the photo-documentation to remain as invisible as possible; this largely consisted of collecting photographic data from relatively far distances using a telephoto lens (allowing the researcher-photographer to photograph subjects in a natural setting from a distance far enough that it was unlikely the subjects were aware they were being observed). In the field, this did not emerge as a viable problem, but the threat was nonetheless present. Confirmation bias was likely to emerge as "cherry-picking" data – in this case focusing on specific subjects more than others for either conscious or unconscious reasons – and I combatted this potential bias by shooting all plazas within a 5-10 minute window, which allowed enough time for the researcher-photographer to photograph the entire plaza (360 degrees of data), but did not allow for excess time that could lead to lingering on specific subjects, or waiting for an individual to sit down, stand up, or perform some other action. The researcher-photographer held a strict schedule of arriving on-site, setting up minimal photographic equipment, shooting the plaza as it was at that instant (essentially performing a visual cross-sectional of the plaza), and moving on. I followed a strict protocol of *never* waiting for a behavior to occur, but rather shooting the photographs as behaviors naturally occurred in that slice of time, regardless of what behavior was occurring at any particular moment (this technique itself can cause data collection/analysis problems).

During the data analysis stage of the present paper, a variety of threats to internal validity were also present. The central potential bias was that at any stage of defining, operationalizing, and/or utilizing the concept of "ASD-friendly design," that I was in error. In order to minimize this potential bias, I first derived the definition of what an ASD-friendly environment is directly from the relevant literature (examined in the systematic review); the systematic review itself could potentially be flawed, especially in failing to include all relevant empirical literature – in order to avoid this threat, I performed a relatively expansive, if not exhaustive, general literature review in order to identify all potentially relevant studies. Using the empirical literature to operationalize the concept of an ASD-friendly environment allows me to be fairly confident that I am simply espousing to measure *what is contained within the literature*, and not directly measuring the actual validity of the contents of the literature; however, by constructing an observational study that explores the potential for the major rival explanation to in fact be correct, the current study may shed some light on the content validity of the results of the literature itself. Another serious potential threat is that there could be an error in the *application* of the operationalization of ASD-friendly design criteria to the photographic data – in order to avoid committing this error, I clearly operationalized each criterion identified from the literature, and applied these criteria as binary measures to the plaza environment captured in the photographic data. I expect that other "raters" attempting to replicate my findings will be able to do so following my definitions and study protocol; even so, there always exists the potential for error.

Plausible Rival Explanations

The plausible rival explanation for the notion of ASD-friendly design as described by the literature is two-fold, one rival explanation directly impacting the literature, and another directly impacting the observational study results. The plausible rival explanation affecting the literature is that the reported results of ASD-friendly design within the literature is actually a function of ASD-friendly design merely being encompassed by – or an artifact of – other established urban design theories such as the concept of Universal Design; in essence, this would be a sort of confounding in that sense that what is believed to be a result of "ASD-friendly design" is actually a function of another design theory that is *not* necessarily related to ASD at all. The plausible rival explanation for the apparent relevance of ASD-friendly design to individuals with ASD is that what the literature is calling "ASD-friendly design" is actually universal (this should not be confused with Universal Design, which is a specific urban design theory); that is to say, the design guidelines for ASD-friendly environments are in reality simply more human-friendly in general, and so generate positive results and feedback from *most or all* individuals, *including* individuals with ASD (but not *specific to* individuals with ASD).

Rather than explicitly attempting to "debunk" the major plausible rival explanation for the observational study, the intent of this study is to explore whether the threat of universality is in play – this is a major justification for using observational subjects *without* ASD (e.g. neurotypical individuals). If ASD-friendly design theory *is* applicable to individuals *without* ASD, we are forced to question whether ASD-friendly environments are genuinely specific to individuals with ASD. Future studies may explore this in greater depth, detail, and (following the exploratory study) with a more rigorous scientific approach. A secondary justification for utilizing neurotypical subjects is the growing ubiquitous nature of neurotypical individuals exhibiting ASD-like behaviors: as was mentioned much earlier in the present paper, a phenomenon known as *emotional atrophy* is becoming more and more prevalent among (particularly young female) neurotypical individuals. This behavior – or set of behaviors/lack thereof – is a form of social deficit that has been linked to high use of technology-assisted communication (Nass, 2012). In this phenomenon, neurotypical individuals lose social proficiency as they over-utilize forms of communication that are *not* face-to-face in nature; the constellation of social deficiencies in many ways parallels, but does not fully meet the criteria for, ASD. Given this phenomenon, it seems pertinent to consider ASD-like, non-social behavior among the subjects of the current study – for this reason, whether each individual subject within the observational study was engaged in social or non-social behavior has been documented, and will be discussed in the Results section of the observational study analysis.

Observational Study

Study Results

The observational study was performed from May to June 2014 over two weeks: two consecutive Wednesdays and the enclosed Monday. Climate was consistently sunny and warm, and photographic data were collected between the hours of 1:00PM and 2:00PM on each day. Subjects were determined by arbitrary convenience, that is to say that my research protocol was essentially to observe and document a particular area at a specific time each day, regardless of the behavior of potential subjects; sufficient distance was maintained in order to deter awareness of subjects' being photographed, which may have presented a problem with observer bias. The researcher-photographer held to a strict time limit of 5-10 minutes maximum per area in order to prevent "cherry-picking" potential subjects, which could bias the findings of the study.

94 total photographs were captured at four different plaza locations within the Engineering area at the University of California, Irvine Main Campus during the regular session of Spring Quarter; these photographic data were not taken during either Midterm or Finals Weeks, which could have led to a significantly different number and behavior of potential subjects. 58 unique photographs were ultimately included in the study, with the remainder being unusable due to near-duplication and/or lag-time between photographs in the same plaza, resulting in the sudden inclusion of "new" subjects or omission of subjects originally found within the photographic frame (e.g. the camera's field of vision) – care was taken during the analysis stage to ensure that the photographs included in the study results are genuinely unique and (to the best of my knowledge) do not suddenly omit or insert new subjects into the photographic frame. A fourth location within the Social Sciences area of UC Irvine's Main Campus was not used due to lack of consistency between days (e.g. I was unable to capture data for this area on all three days, and thus excluded this location from the study; it was also determined that it was best to document plazas that were all located within a general area of campus, and so I focused the study on the Engineering area of the Main Campus at UCI, which includes multiple plazas).

Six of the eight design features that hallmark ASD-friendly design (taken from the brief systematic review previously detailed) were explored. These have already been operationalized: predictability/consistency, retreat space, wide circulation spaces/proxemics, natural light (*and* presence of shade), low noise levels, minimization of “fascinators,” and use of low-arousal colors. Low stimulation and low noise levels were not used in the study analysis, as “low stimulation” cannot be operationalized *vis-à-vis* the relevant empirical literature without using multiple of the other design features listed to describe low stimulation; low noise levels were not taken at the time of study photography, and therefore audio data could not be analyzed. It remains a question whether low stimulation is comprised of all or only some of the other design features gleaned from the empirical literature through the systematic review (or if other design features are a factor) – future studies may decided to investigate how to more precisely define “low stimulation,” as this seems to be the *ultimate* criteria for ASD-friendly environments; however, it is only nebulously defined within the literature.

For each field study day, each of the three locations was photographed; this resulted in three blocks of data comprising three locations each: Engineering Tower (ET), Engineering Gateway (EG), and the California Institute for Telecommunications and Information Technology (CalIT2). Data will be compared *within groups* and then *between groups* – specific note is taken of any perceived patterns that may arise from these data. It should be stated that this study is largely exploratory, and for this reason has more likelihood to be used in *hypothesis generation*, rather than being able to *statistically* demonstrate associations; of course, patterns unearthed by qualitative means are possible, and can imply an association that should later be tested by quantitative methods.

For ease of reference, these blocks of data are referred to as Blocks A, B, and C (Wednesday 05/28/14, Monday 06/02/14, and Wednesday 06/04/14, respectively), and each location within these blocks will be listed as Locations 1, 2, and 3 (ET, EG, and CalIT2, respectively). Please reference the full data table in Appendix 2 for complete information. Design features are indicated as a binary (Yes/No), for presence or absence of each design feature; please note that a "Yes/Present" response does *not* always indicate a positive (ASD-friendly) feature, and likewise a "No/Absent" response does *not* necessarily indicate a negative (ASD-unfriendly) design feature: in the case of "fascinators," the ASD-friendly response is the *absence* of this design feature/detail. Depending on how many ASD-friendly responses are given for these six design features, each *location* is issued a score from 0 to 6, with 0 being the *absence* of all ASD-friendly design features as well as the *presence* of all ASD-unfriendly design features (this is a location that is *optimally ASD-unfriendly*), while a score of 6 indicates the *presence* of all ASD-friendly design features as well as the *absence* of all ASD-unfriendly design features (this type of location is *optimally ASD-friendly*). In the future, a similar study (or studies) should be conducted with ASD individuals for comparison with a neurotypical group.

Other data included in the analysis are raw number of subjects *utilizing* the plaza (I define utilization as actually *interacting* with the built environment; therefore, individuals merely passing through the location were *not* treated as subjects within the study), number of subjects seated versus standing or in some other posture/engaged in another activity, number of functional groups gathered within the plaza, and the number of individual subjects engaged in social activity (i.e. face-to-face talking, performing non-solitary activity) compared to the number of subjects engaged in definitionally solitary or non-social activity (i.e. looking at cell phone, sitting alone, reading). Finally, a functional ranking was developed *within* each group, listing which locations are *high* social environments, *moderate* social environments, and *low* social environments. A comparison *between* groups is also detailed. It should be restated here that although associations between the ASD-friendly design features and subject behavior can be made, causality *cannot* be inferred from these observational data. The following results were drawn from the observational study, and will be examined in sequential order of date, timestamp, and location.

Block A: Wednesday, 05/28/14

Location 1: 1:00PM, Engineering Tower (ET)

Four of the six ASD-friendly criteria are met (this location lacks a retreat space as well as sufficient shade from direct sunlight). Although the space is intensely symmetrical, it has a highly institutional quality; although this is not one of the ASD-friendly design criteria derived from the systematic review, it is well worth noting, as spaces in the built environment with an overtly institutional quality are discussed in much of the ASD design literature, and is generally deemed ASD-unfriendly (Sergeant et al., 2007; Vogel, 2008). A single individual was observed in this space. This subject was seated and engaged in solitary, non-social activity. Of the three locations observed on 05/28/14, this location is considered a *low* social environment (here I define "low social environment" as less than 50% of subjects engaged in social activity; "moderate social environment" as at least 50% but less than 70% of subjects engaged in social activity; and "high social environment" as at 70% or more subjects engaged in social activity).

Location 2: 1:15PM, Engineering Gateway (EG)

Six of the six ASD-friendly criteria are met, making this the most "ASD-friendly" location (according to the systematic review findings from the empirical literature). Like ET, this space is also highly symmetrical, but lacks the severe institutional quality found in ET. Seven individuals were observed: four were seated (57.1%), three were standing or in another (non-seated) posture, and two distinct groups of two or more subjects were clearly present. Five of seven (71.4%) subjects were actively engaged in social activity; two subjects were occupied by non-social activities. Of the three locations observed on 05/28/14, this location is considered a *high* social environment.

Location 3: 1:30PM, California Institute for Telecommunications and Information Technology (CalIT2)

Four of the six ASD-friendly criteria are met (the location lacks symmetry and the eye-level deep brick color of the building is *not* considered an ASD-friendly color). Eight individuals were observed: six were seated (75.0%), two were standing or in another (non-seated) posture, and three distinct groups of two or more subjects were clearly present. Six of eight (75.0%) subjects were actively engaged in social activity; two subjects were occupied by non-social activities. Like EG, of the three locations observed on 05/28/14, this location is considered a *high* social environment. It is interesting to note that within Block A, there is a polarization of social levels between the three plazas studies; in short, there were no moderate social environments, only high and low. The overall architectural design – as well as the *age* of the relevant built structures – is strikingly different between the low and high social environments; both high social environments have been constructed relatively recently, and lack the general institutional quality of the older, low social environment. This may indicate that newer architectural design more appropriately meets the needs of a more broad range of individuals, thus inviting more utilization by multiple subjects. This type of observation is relevant in hypothesis generation resulting from this early exploratory observational study.

Block B: Monday, 06/02/14

Location 1: 1:30PM, Engineering Tower (ET)

The design features of the built environment remain the same on all three days of the study; this being said, please refer to Block A, Locations 1-3 for a relevant discussion on the number of ASD-friendly criteria met by each location *vis-à-vis* the systematic review findings of the empirical literature. Note that on 06/02/14, *all* locations had timestamps that were set back 30 minutes from the first field observation study day (05/28/14); this was due to technical difficulties, and was not anticipated despite ample preparation. As on 05/28/14, a (different) lone individual was observed in the ET plaza: this subject was seated and engaged in solitary, non-social activity. Of the three locations observed on 06/02/14, this location is considered a *low* social environment.

Thus far consistency with the ET plaza environment is observed in that this particular plaza seems to foster non-social activity, as well as minimal use of the space by an extremely limited number of individuals. Potential confounding factors may include the number of active classes at the time of photography in each of the plazas, as well as the distance of each plaza from parking – issues such as these must be taken into consideration in future studies, with plazas *matched* as closely as possible on certain variables in order to minimize the effects of unanticipated potential confounding variables.

Location 2: 1:45PM, Engineering Gateway (EG)

Recall that EG met *all* six criteria for ASD-friendly environments, as derived from the empirical literature. Twenty-two individuals were observed (by far the most subjects utilizing a given location on any of the three study days): thirteen were seated (59.1%), nine were standing or in another (non-seated) posture, and five distinct groups of two or more subjects were clearly present. Nineteen of twenty-two (86.4%) subjects were actively engaged in social activity; three subjects were occupied by non-social activities. Of the three locations observed on 06/02/14, this location is considered a *high* social environment; of the three locations in Block B, EG had the highest amount of social interaction (note that on 05/28/14, CalIT2 was the location with the highest amount of social interaction; the possible mechanisms behind the level of social interaction of each environment (and changes thereof) will be discussed in the Discussion section).

Location 3: 2:00PM, California Institute for Telecommunications and Information Technology (CalIT2)

Eleven individuals were observed at the CalIT2 plaza: nine were seated (69.2%), two were standing or in another (non-seated) posture, and three distinct groups of two or more subjects were clearly present. Eight of eleven (72.7%) subjects were actively engaged in social activity; three subjects were occupied by non-social activities.
As on 05/28/14, this location is considered a *high* social environment.

Block C: Wednesday, 06/04/14

Location 1: 1:30PM, Engineering Tower (ET)

1:30PM has been adopted as the starting time for all subsequent locations, following the timing of 06/02/14; the thirty-minute difference has not been determined as a major contributing factor in the presence or absence of subjects, or as a mechanism for social interaction and/or utilization of the spaces. This being said, it is entirely possible that the 30-minute shift is associated with an increase in the number of subjects for *certain* plazas; however, since this does not hold true for *all* plazas studies, I do not assume this is the case. In striking contrast to the first two observational sessions, six individuals were observed: four of whom were seated (66.7%), and all of whom were engaged in social activity (100%) as part of two groups that appeared to be a division of a larger group dynamic. ET demonstrated its ability to act as a *high* social environment, being the single *most social* location observed on 06/04/14 – it must be noted that the fact that *all six* of the individuals observed at ET on 06/04/14 being part of either one of two divisions of a *single social group* may present a confounding variable that is altering the data for ET to appear like a true increase in level of social interaction *associated with the location*, when in fact this may not actually be the case. In short, the cohesive single social group may present an appearance of greater social interaction for this location, but may have little to do with the location itself; this may be a function of the internal nature of the particular social group observed.

Location 2: 1:45PM, Engineering Gateway (EG)

Fourteen individuals were observed at EG: four were seated (28.6%), ten were standing or in another (non-seated) posture, and four distinct groups of two or more subjects were present. Eleven of fourteen (78.6%) subjects were actively engaged in social activity; three subjects were occupied by non-social activities. Of the three locations observed on 06/04/14, this location is considered a *high* social environment, although not higher than ET (which had 100% social interaction, although the aforementioned confounding variable – single cohesive social group – may be in play in that instance) on the same field observation day.

Location 3: 2:00PM, California Institute for Telecommunications and Information Technology (CalIT2)

Ten individuals were observed at CalIT2: nine were seated (90.0%), one was standing or in another (non-seated) posture, and three distinct groups of two or more subjects were clearly present. Six of ten (60.0%) subjects were actively engaged in social activity; four subjects were occupied by non-social activities. Unlike the previous field observation days, CalIT2 drops from a high to *moderate* social environment for 06/04/14; this is the only plaza location that *decreased* in social interaction between observational study days (ET was the only location to *increase* in social interaction). The reasons for these changes on level of social interaction for each location will be discussed presently.

Discussion

Some key fluctuations – these are not necessarily patterns in the strict sense of the term – emerged from the findings of the observational study data. One of these inconsistencies was briefly discussed in the previous Results section: over time, certain plaza locations *increased* in social interaction observed, while others *decreased*. Engineering Tower had low social interaction on both Wednesday, 05/28/14 and Monday, 06/02/14, but increased drastically to high social interaction on Wednesday, 06/04/14. As was previously discussed, this does not appear to be a function of the half-hour lag between the first observation session and the other two, as other data contradict this explanation (namely, that 06/02/14 – which was conducted 30 minutes later than the initial observation – also found ET to be a low social environment; and secondly, that *after* the 30-minute setback, CalIT2 *decreased* in social interaction).
I seem to be able to assert that starting the last two days of observation 30 minutes later than the initial observational field study session is not a sufficient explanation for the changes in social interaction at any of the relevant plaza locations.

Both the change in social interaction at ET and CalIT2 will be discussed, respectively. ET revealed consistently low social interaction during the first two observation sessions, despite the following differences: the first session was on a Wednesday, the second on a Monday, and the first was conducted at 1:00PM, whereas the second started at 1:30PM. The only apparent differences between the first two sessions and the final session (the latter involving the drastic increase in social interaction) that may account for the change in social interaction are the number of subjects present, as well as the number of groups present – both of these differences are directly related to the *opportunity* for social interaction compared to the first two observation sessions. During the final session on Wednesday, 06/04/14, there were six subjects present (both previous sessions only had one subject present each), and these six subjects appeared to be organized in two separate groups – possibly sub-groups of one larger social unit. It is my hypothesis that the number of individuals present and nature of the group dynamic (rather than six individual subjects being at the same plaza location separately, which would incline each of them toward non-social activities) explains the increase in social interaction. This is unrelated to the design features of the built environment; however, I also hypothesize that – in a much larger study of the same plazas – one would find that ET tends to have generally lower numbers of individuals utilizing the plaza; I assert that this hypothesis, if confirmed, can be explained by the differences in design features of the built environment between ET and the other two (more modern, and generally more user-friendly) plaza environments.

CalIT2 was consistently a high social environment for the first two observation sessions, despite the aforementioned differences coupled with another key difference: on 06/02/14 there were only eight subjects at this plaza location, while on 06/04/14 there were eleven total subjects (it should be noted that on both of these days there were three distinct groups of two or more individuals present). On the final day of observation (06/04/14), there were ten subjects present at CalIT2, and once again three distinct groups present; however, on this final day of observation, the social interaction moved from high to moderate. I did capture one key feature that differentiates the high social interaction days from the single example of moderate interaction at this plaza location: the number of subjects who were *seated* increased from 75.0% during the first session and 69.2% on the second session to 90.0% on the final session. If a single variable *does* explain the change in social interaction at CalIT2, and if I captured this variable, the only variable that appears to be potentially associated with this change is the number of subjects seated. If this is the case, I would expect the same pattern to emerge for the other location that had a change in social interaction: in fact, ET *did* experience a *decrease* in percent of subjects seated (100% on 05/28/14 and 06/02/14, compared to 66.7% on 06/04/14) associated with an *increase* in social interaction (from 0% during the first two sessions to 100% on the final session).

This appears to be fairly convincing for a small sample until the patterns emerging from Engineering Gateway are investigated. EG experienced high social interaction on all three days (71.4%, 86.4%, and 78.6%, respectively), with the highest level of social interaction occurring on a day that also experienced a relatively low number of seated subjects (59.1%, during the second observation session). This figure is consistent with a the first day of observation, which experienced 57.1% of subjects being seated; the final session had only 28.6% of individuals seated, but did not experience the rise in social interaction of the second observation session. EG appears to be the exception to an apparent pattern, which brings the "pattern" into question (apart from the statistical fact that a series of three is required to *suggest* a pattern, and a series of five to *establish* a pattern). There is also the (probably high) possibility that a complex combination of different variables is associated with level of social interaction *at different locations*. There is no reason to assume that all locations must share those variables that predict, explain, or "cause" social interaction.

Adequate seating has been lauded as *the* factor in the success of public plazas at least since William H. Whyte's seminal 1980 book, *The Social Life of Small Urban Spaces*. Following Whyte, "success" is measured in number of users – and in many respects, the assumptions involved in this definition make intuitive sense: common sense suggests that people tend to linger in places that they prefer in some regard.
Common sense is not scientific fact, however, as has been exemplified by the related phenomenon of the disjunction between consumers' revealed and stated preferences.
Even if the assumption that revealed and stated preferences (when applied to plazas) are identical is accepted, greater numbers of users does *not* necessarily mean a livelier social environment, as the study has demonstrated. More users may increase the likelihood of social interaction, but is not synonymous with social interaction; rather the greater the number of users, the more *opportunity* there may be for social interaction.

In my own study, from the perspective of number of users and level of social interaction, *any number of subjects over one greatly increased social interaction*.
The study yields only one example (out of nine) that includes a plaza with more than one subject utilizing the space and lower than high social interaction (this is CalIT2 on the final day of data collection, which had moderate interaction despite ten subjects utilizing the space). Although the study is far from definitive in this regard, it may be a reasonable assertion that any plaza in which *people* (plural) are found genuinely utilizing the space can be considered a success in this respect.

It must be addressed whether adherence to ASD-friendly design features played any role in the relative success or failure of the three plazas studied. Both Engineering Tower and CalIT2 complied with four out of the six ASD-friendly design features yielded from the empirical literature; however, these two locations did not share *which* four design features to which they adhered. ET failed to provide retreat space or sufficient shade; CalIT2 provided both retreat space and sufficient shade, but is not as symmetrical as the other two locations, and has ground-level colors that are not considered ASD-friendly. ET – for all three observation sessions – had the lowest number of subjects present, and – for two of three observation sessions – had the lowest levels of social interaction (as previously discussed, the single instance of high social interaction at the ET plaza may have resulted from a confounding variable). It may be the case that rather than suggesting neurotypical behavior can be explained by an amalgamation of ASD-friendly design characteristics, it may be the case that *certain* ASD-friendly characteristics are important in neurotypical human behavior: in this case, the presence of retreat space and sufficient shade from direct sunlight. One wonders if the ASD-design features from the systematic review of the empirical literature would also suggest the need for weighting different design features among individuals with ASD.

In light of these results, it must be questioned whether the six criteria developed from the empirical literature in order to pragmatically operationalize "ASD-friendly environment," and "ASD-friendly design" are sufficient and actually representative of a single central ASD-friendly design theory. Of course, a checklist can only hope to *approximate* a theoretical or conceptual basis for design criteria, and the mixed results of the study seem to suggest that a simple checklist fails to sufficiently capture what is meant by ASD-friendly design (this is a bit ironic, as much of the ASD-friendly design literature itself utilizes simple checklists). Potentially the most promising result from the current study has been the unanticipated finding that different ASD-friendly design criteria may need to be weighted differently (at least for a neurotypical population; I hypothesize this will be the case for ASD individuals as well, although which design features will require stronger/weaker weights is unknown). Because retreat space and sufficient shade from direct sunlight appear to be associated (at least by qualitative comparison) with greater utilization of certain plazas in a neurotypical population, I may question whether universality remains a threat in explaining the success of ASD-friendly environments among individuals with ASD. Considering the results of this study, it seems likely that the relative importance of specific design features may differ between ASD and neurotypical individuals. Universality may be in play, but likely also require a caveat that although the same design features play a role in designing "friendly"

environments for individuals with ASD and for neurotypical individuals, I hypothesize that the relative importance of each design feature will differ between these two groups. This hypothesis can be discounted if it is subsequently found that both ASD and non-ASD populations require design features with identical weights. To my knowledge, there have been no empirical (or non-empirical) studies to-date that construct an evidence-based weighting system for different ASD-friendly design criteria.
Based on the findings of the current study, this is a required task for future research.

The results of the study can be summarized in bulleted format for ease of reference; however, please note that the following points are *highlights* and should be read together with the bulk of the text and relevant Appendices:

- Increase in number of users *increases opportunity* for social interaction
- Presence of more than one person *greatly increases* social interaction
- Retreat space and sufficient shade from sunlight were the *most important* design features among the ASD-friendly design features tested
- ASD-friendly design criteria *need to be weighted* based on empirical findings

Scope and Limitations

Scope and Delimitations of Proposed Research

The scope of the current research is limited by the fact that this study takes place as part of the exit requirements for a Master's Thesis, and not a Doctoral Dissertation. This influences time, budget, and experiential constraints. The current research and a variety of manuscript drafts have been conducted over a relatively short period of time, was entirely unfunded, and although it has been conducted by a capable Master's Candidate, the researcher inherently has less experience and training overall than would a doctoral counterpart. More importantly, the scope is also delimited by the nature of the research itself, and by the literature.

Potential Limitations

A major limitation of the current observational study is the relative lack of external validity; future research is required to replicate, validate, and expand the results and conclusions of the present paper. Although I am exploring whether ASD-friendly design theory is applicable to neurotypical individuals, I am limited in the conclusions I can draw due to the lack of a comparison group comprised of individuals with ASD. Due to these limitations, it is advised that the results and conclusions of this paper are used mindfully, appreciating the scope and limits of my research, and (hopefully) using this first small step as a springboard for larger inquiry into the topic of ASD-friendly environments and related design theory.

Human Subjects Ethics

Ethical Safeguards

Observational subjects were surreptitiously photographed in open-air plaza settings at the University of California, Irvine Main Campus. None of the subjects' identities are known, and these photographic data represent a naturalistic convenience study in which all subjects are completely anonymous. In the interest of privacy, these photographic data are included in Appendix 3, but are not present within the body of the text. Under no circumstances are these photographic data to be reproduced or disseminated in any way. The current research follows the UC Irvine Administrative Policies & Procedures, Physical Environment and Properties, Buildings and Grounds: General Use, Sec. 900-31: Guidelines for Filming and Photography on the UC Irvine Campus, which clearly states in Section 5 that "[a] permit is required to film or photograph on the UC Irvine campus with the following exceptions: [i]ncidental, unobtrusive filming or photography by UC Irvine faculty, staff or students creating work to be used for non-commercial, educational or administrative purposes."[6]

Implications for Future Research

Future research into ASD-friendly design theory should use study designs that can 1) demonstrate a difference (or lack thereof) between human-environment interactions in ASD individuals *compared to* neurotypical individuals, and 2) ultimately suggest or establish causality between design features in the built environment and specific human behaviors (regardless of whether these individuals have ASD or are neurotypical). Demonstrating that universality is not in action is a major consideration, and I advise that this is the next step following the current study; in the long-term, determining the most important design features – establishing an evidence-based 'best practices' for

[6] http://www.policies.uci.edu/adm/procs/900/900-31.html

ASD-friendly environments, if warranted by further investigation – for individuals living with ASD is paramount.

Conclusion

In conclusion, the current research embodies a much-needed emergent field of inquiry regarding appropriate design specifications for what is the fastest-growing developmental disability in the U.S.[7] – this being said, questions regarding the premise of designing specifically ASD-friendly environments still require robust answers.

The current research is merely the first step in what will hopefully become a field of great interest to other ASD researchers, public health professionals, ASD advocacy organizations, urban planners and designers, and architectural practitioners alike.

[7] http://www.autismspeaks.org/what-autism/facts-about-autism

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APPENDIX A: Systematic Review Results

	Design Guidelines							
Empirical Study	Low stimulation	Predictability/consistency	Retreat space	Wide circulation spaces/proxemics	Natural light and/or avoiding flickering/buzzing lights	Low noise levels	Minimization of "fascinators"	Use of low-arousal colors
Alvarez & Crabtree (2008)	*	*						
Brand (2010)	*	*	*	*	*	*	*	*
Khare & Mullick (2009)	*	*	*	*			*	
Mostafa (2008)	*	*	*	*	*	*	*	*
Richer & Nicoll (1971)	*		*	*				
Vogel (2008)	*	*			*	*	*	*
Whitehurst (2006; 2007)	*		*		*	*		*
	7:7 (100.0%)	5:7 (71.4%)	5:7 (71.4%)	4:7 (57.1%)	4:7 (57.1%)	4:7 (57.1%)	4:7 (57.1%)	4:7 (57.1%)

Peer-Reviewed Study	Low stimulation	Predictability/consistency	Retreat space	Wide circulation spaces/proxemics	Natural light and/or avoiding flickering/buzzing lights	Low noise levels	Minimization of "fascinators"	Use of low-arousal colors
Alvarez & Crabtree (2008)	*	*						
Khare & Mullick (2009)	*	*	*	*			*	
Mostafa (2008)	*	*	*	*	*	*	*	*
Richer & Nicoll (1971)	*		*	*				
	4:4 (100.0%)	3:4 (75.0%)	3:4 (75.0%)	3:4 (75.0%)	1:4 (25.0%)	1:4 (25.0%)	2:4 (50.0%)	1:4 (25.0%)

Non-Peer-Reviewed Study	Low stimulation	Predictability/consistency	Retreat space	Wide circulation spaces/proxemics	Natural light and/or avoiding flickering/buzzing lights	Low noise levels	Minimization of "fascinators"	Use of low-arousal colors
Brand (2010)	*	*	*	*	*	*	*	*
Vogel (2008)	*	*			*	*	*	*
Whitehurst (2006;2007)	*		*		*	*		*
	3:3 (100.0%)	2:3 (66.7%)	2:3 (66.7%)	1:3 (33.3%)	3:3 (100.0%)	3:3 (100.0%)	2:3 (66.7%)	3:3 (100.0%)

APPENDIX B: Observational Study Results

Date/time/location	W 05/28/14 1PM Tower	W 05/28/14 1:15PM Gateway	W 05/28/14 1:30PM CalIT2	M 06/02/14 1:30PM Tower	M 06/02/14 1:45PM Gateway	M 06/02/14 2PM CalIT2	W 06/04/14 1:30PM Tower	W 06/04/14 1:45PM Gateway	W 06/04/14 2PM CalIT2
Design features (Y/N)									
Symmetry	Y	Y	N	*	*	*	*	*	*
Retreat	N	Y	Y	*	*	*	*	*	*
Proxemics	Y	Y	Y	*	*	*	*	*	*
Natural light/Shade	Y/N	Y/Y	Y/Y	*	*	*	*	*	*
Fascinators	N	N	N	*	*	*	*	*	*
Low stim colors	Y	Y	N	*	*	*	*	*	*
Other data									
Raw Count	1	7	8	1	22	11	6	14	10
Number Seated (Percent)	1 (100%)	4 (57.1%)	6 (75.0%)	1 (100%)	13 (59.1%)	9 (69.2%)	4 (66.7%)	4 (28.6%)	9 (90.0%)
Standing/other	0	3	2	0	9	2	2	10	1
Groups (2+)	0	2	3	0	5	3	2	4	3
Social (# of #)	0 of 1 (0%)	5 of 7 (71.4%)	6 of 8 (75.0%)	0 of 2 (0%)	19 of 22 (86.4%)	8 of 11 (72.7%)	6 of 6 (100%)	11 (78.6%)	6 of 10 (60.0%)
Functional ranking	Most seated Least social	Least seated Mid-social	Mid-seated Most social	Most seated Least social	Least seated Most social	Mid-seated Mid-social	Mid-seated Most social	Least seated Mid-social	Most seated Least social

APPENDIX C: Raw Data


Calit2


Calit2
Building


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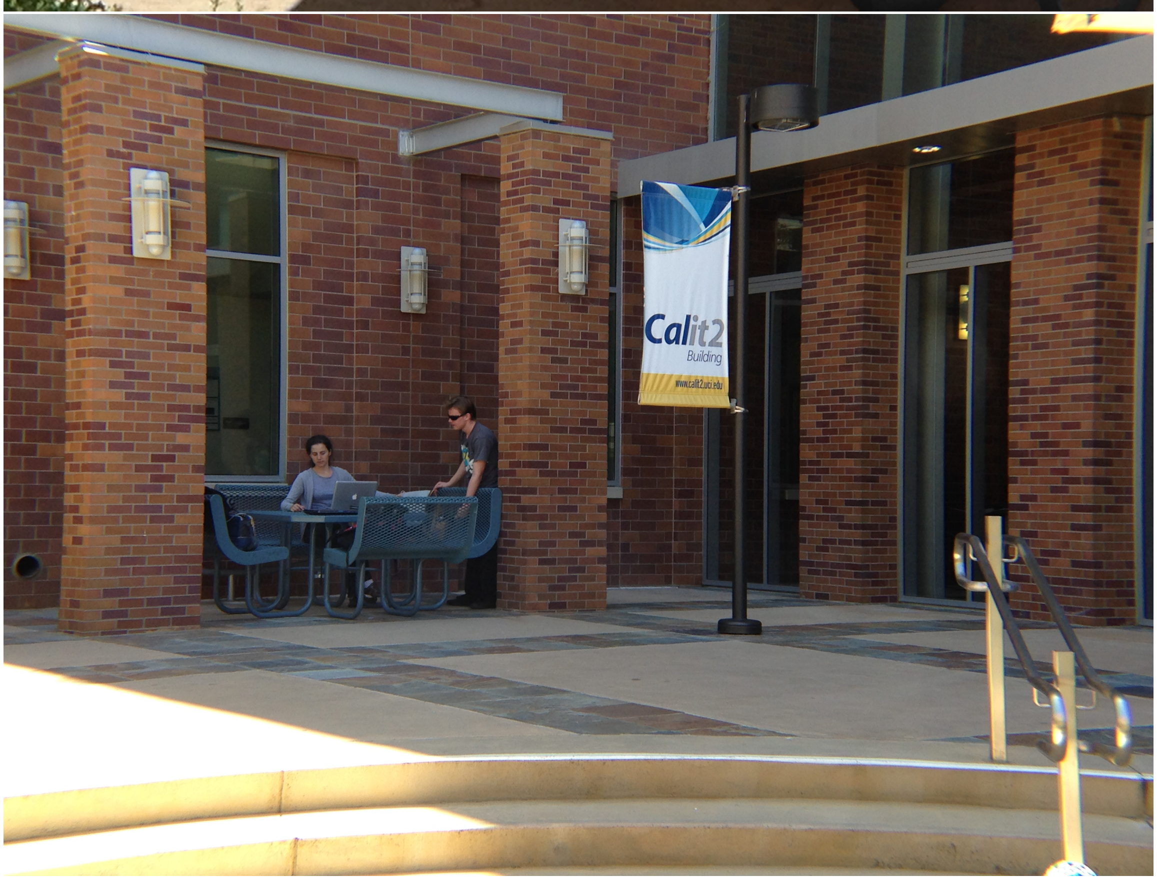
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