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Ten Traps for Non-Representational Theory in Human Geography

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Abstract: Non-Representational Theory (NRT) emphasizes the significance of routine experience in shaping human geography. In doing so, the theory largely eschews traditional approaches that have offered area-based, longitudinal, and synoptic formalisms for geographic inquiry. Instead, NRT prioritizes the roles of individualized and often dynamic lived geographies as they unfold in the moment. To date, NRT has drawn significant inspiration from the synergies that it shares with philosophy, critical geography, and self-referential ethnography. These activities have been tremendous in advancing NRT as a concept, but the theory's strong ties to encounter and experience invariably call for practical exposition. Alas, applications of NRT to concrete examples at scales beyond small case studies often prove challenging, which we argue artificially constrains further development of the theory. In this paper, we examine some of the thorny problems that present in applying NRT in practical terms. Specifically, we identify ten traps that NRT can fall into when moving from theory to actuality. These traps include conundrums of small geographies, circularity in representation, cognitive traps, issues of mustering and grappling with detail, access issues, limitations with empiricism, problems of subjectivity, methodological challenges, thorny issues of translation, and the unwieldy nature of process dynamics. We briefly demonstrate a novel observational instrument that can sidestep some, but not all, of these traps.

Keywords: non-representational theory; human geography; embodiment; GIS

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1. Introduction

"I guess they got a way of reading my mind/I guess I got to adjust" [1].

The emergence of Non-Representational Theory (NRT) in human geography (and the social sciences and humanities more broadly) has been motivated by a longstanding interest in examining how people enact and perform geography in everyday moments of embodied encounter: a *human geography of experience*. This stands in contrast to the traditionally areal viewpoints that human geography is popularly known for [2]. NRT represents a push for human geography, as a field of study, to produce new forms of non-representational understanding and knowledge that can challenge, supplement, and perhaps better source more coarse-view notions that have traditionally predominated in the field. The directionality of inquiry underneath this shift is significant: NRT looks to explain geography from the bottom up.

To date, NRT has drawn heavily from philosophy and from introspective commentary from scholars of human geography and more widely from the philosophy of human experience. But, as NRT is tested in real-world applications, several thorny issues emerge in translating its aims into practice. In this paper, we examine ten such challenges. We explore these ten themes as 'traps' for human geography, as a set of challenges that can halt the advance of NRT scholarship in real grounded situations of encounter and experience. Nonetheless, we reason that these traps can be avoided or at least circumnavigated with some careful approach.

The paper is organized as follows. In Section 2 we review developments in human geography that have provided the foundation for NRT. In Section 3 we discuss the ten traps that we recognize for NRT, with a focus on the difficulties that they may establish when NRT is applied in practical terms. These include the conundrum of small geographies, representation, cognitive traps, detail, access, empiricism, subjectivity, methodology, translation, and the process trap. We briefly explore potential operational pathways around these traps in Section 4 with a worked example of how the traps might be addressed in the computational analysis of everyday scenes. This example follows alongside a broader discussion of further paths that could be established around the traps in Section 5, and then concluding remarks in Section 6.

2. Non-Representational Theory in Human Geography

Many of the concepts that delineate NRT are themselves the product of very active debates in human geography [3–5], and so there is considerable nuance to the concept. Nonetheless, there are perhaps three ways to begin to define NRT and to consider its genealogy within human geography, the social sciences, and the humanities.

2.1. Defining Non-Representational Theory

The first definition comes from a consideration of how NRT differs from other theoretical constructs in human geography. NRT is also often defined by what it is not. NRT marks a departure from classically representational forms of inquiry, which consider space as a (too often static) landscape-like substrate, one that envelops inquiry and explanation inside relatively hard-fastened and containerized conceptualizations of human geography [6]. And so, one initial viewpoint stages NRT as the scholarship that happens beyond the limits of representation as a workable explanation for human geography [7,8]. Castree and MacMillan [8], for example, have argued that NRT is post-representational, while Lorimer [9] (p. 83) regards NRT as "more than representational". At a fundamental level, then, NRT is something that comes after, and that does more than, traditional forms of human geography inquiry.

A second definition is sourced in the subject matter of NRT. Thrift [10,11] originally pitched NRT as a way to study human geography through the viewpoint of lived experiences. This definition of NRT can be traced to a philosophical argument that how one moves through and enacts in the world (the act of "being in" geographies) influences how we develop understanding of the world [12] (p. 107). Vannini [13], in a related characterization, outlined the essential components of NRT as being its focus on an ethnography of corporeality, mobility, performance, sensuality, and vitality (p. 318).

A third way of reading NRT is that it centers the individual as the scaffold for theory-building. In this way, NRT resembles some facets of postmodernism in human geography [14], particularly in considering how individuals relate to landscapes: physical landscapes as well as the representations that they convey through ascribed properties of power and order [15,16]. Using an individualized perspective within NRT, one may arrive at synthesis through consideration of how people themselves produce (their own, maybe even independent) human geography (as well as urban geography, social geography, behavioral geography, and others) in the course of their moment-to-moment interactions. NRT places a special emphasis on how human geography is constituted by experiential encounter—through the myriad individualized interactions that make up our routine and mundane experiences—and how that vista could provide significant explanatory insight for picking apart coarser geographies that have long been understood at holistic geographic scales, but for which significant location- and place-based geographical differentiation presents as a confounding factor (see Storper and Venables [17] for an excellent discussion of a related point in urban studies). Indeed, NRT arose in response, partially, to some of the challenges of big geographies, specifically the means by which big geographies represent people and by which they tend (through representation) to artificially cloister individuality within artificial (often imaginary) spatial structures [18]. These bigger-than-

individual geographies often have little bearing on one's human geography at the scale of the moment. Thus, NRT can be seen as a return to humanism [19,20] and as a response to a perceived trend in human geography that abstracts from the humanity of the individual in geographic context. There was a general sense, ahead of NRT, that by essentially binning people into spatial cohorts, bounded by polygons and connected by numerical attributes, the traditionally popular quantitative trends in human geography [21] were losing touch with everyday geographies of lived experience. In doing so, quantitative human geography also ran the risk of introducing significant methodological biases, which often hid in the backdrop of subsequent geographic inquiry media, particularly in cartography and Geographic Information Systems (GIS) [22,23] as well as in other forms of map-interfaced representation [24–27] and geovisualization [28,29]. This criticism of GIS was raised in the 1990s [30] and reemerged in the 2010s again when issues of volunteered geographic information came to the fore in discussions of how one could develop interfaces at the edges of critical geography and GIS [31].

2.2. Interpreting Non-Representational Theory within Human Geography

NRT has come to formation in human geography from a number of intersecting discussions within geography, but also from related scholarship being considered outside the discipline.

In many ways, NRT is a by-product of discussions of scale in human geography [32–34]. In particular, NRT sits in the midst of a running debate about whether scale imposes artificial representative boundaries on inquiry (and interpretation) in human geography [35]. As we will discuss through the rest of this paper, we interpret some of the traps of NRT as being sourced in this scale concern. More specifically, we reason that NRT represents something of a disjoint from 'big human geography', by which we mean to index area-based studies such as regional science, development geography, or political geography that often consider large assemblies of human geography factors across swaths of space. NRT embraces a parallel thread of 'small human geography' that runs within and alongside its bigger counterparts, e.g., the localized scholarship to examine gentrification [36], pedestrian geography [37], and household decision-making [38], that underpin urban geography [39], transport geography [40], and migration geography [41], respectively. In many ways, NRT could be considered as a theory to reconcile the interstitial intellectual space between 'big' and 'small' geography. This can involve some difficult theoretical scale-jumping that is not always a straightforward feat to accomplish. Long-interfering obstacles of ecological fallacy [42,43], hierarchical ordering [44], fuzziness and indeterminacy [45], modifiable areal unit problems [46], geographical inertia [47], telegeographies [48,49], and fractal geography [50] often interfere in linking the big and the small in human geography. Moreover, as a practical concern, data for human geography are perennially in short supply from either big or small vistas, with the result that while bespoke connections between small geographies and up-scale big geographies can be conceptualized, it can be onerous to draw them into empirical explanatory alignment, even within limited boundary conditions or simplifying assumptions. The difficult efforts to advance complexity-based approaches in geography [51–54] is perhaps an exemplar of the scale challenges in achieving parity between big and small viewpoints and their supporting evidence. (We take up the topic of small geographies specifically in Section 3.1).

NRT also takes on particular relevance within metaphysical dialogs in human geography. This is evident in the relationship between NRT and arguments about the role of structuralism in knowledge-building [55]. Many human geographers have argued that structuralism has sometimes unfairly held sway over discourse in the discipline [55,56]. In some sense, one might consider NRT as sidestepping the structuralist and post-structuralist debate by allying itself with phenomenology. In this paper, we contend that NRT signals a deliberate shift in thinking within human geography, to viewpoints that address the varied means by which things appear to us as experiences [57–60]. In this vein, NRT's human geographic phenomenology follows the theses of Husserl [61] and Heidegger [62] that

advocated for humanistic and experiential approaches to science that would abut more abstract and mathematical methods of inquiry [12] (pp. 104–107). Consider, for example, what this infers for philosophical geography if we contrast phenomenology with ontology [63,64], which is also a popular concept for geography and which has instead taken up concern with the way that things are (See Bower's [65] discussion of the opportunities for non-representation in philosophy of perception and presence, for example) Between phenomenology and ontology, then, we have differing concepts of how things (i.e., observed or supposed human geographies) come to be, and also of how we experience them [66]. Ontology can often lend itself to parsimonious categorization and labelling, which geographic traditions of spatial analysis and cartography are apt to accomplish [67–69]. This can yield to corralling and back to representation. NRT's phenomenology provides opportunities to move beyond the constraining aspects of ontology. However, the phenomenology in NRT is much thornier to realize in practice, and unruly to accomplish at scale [16,50].

NRT is tasked with understanding human geography as an experience, and to do so primarily through what Thrift [10] referred to as "corporeal routines" (p. 8). This notion of geographies of (and as) experience has been advanced along a number of related threads of inquiry in human geography. This includes geographic ethnography [13], emotional geography [3–5,70–72], the mobilities paradigm [73–76], the tourist gaze [77], consumption geographies [60,78–81], body-focused geography [82–84], and rhythmanalysis [85–87]. Collectively, the ideas developed in these conduits have steadily been funneled toward NRT, with the promise that NRT's renewed focus on geographies of lived experience can uncover human geography that may be missed (or under-explored) by representative approaches [88].

Notwithstanding some proof-of-concept case study research, NRT has been just that: *theoretical*. In this paper, we examine some of the challenges faced in interfacing NRT with *practical* applications in geography. We admit upfront that our vantage assumes that empiricism should feature in applied NRT (and as we will discuss in Section 3.4, we are not reaching outside the initial ideas of NRT in doing so). As such, many of our contrasts between pragmatism and philosophy or theory-building may come across as unbalanced. We focus on ten (commingled) traps that NRT can fall into when put to work on the ground. These traps include (and largely stem from) an overarching problem of explanation for small geographies, which leads to a circularity in representation, cognitive concerns, thorny problems of detail, access limitations, caveats regarding empiricism, subjectivity biases, methodological constraints, translation challenges, and difficulties with dynamics of process. We approach these ten barriers as 'traps', as potential stumbling blocks for applied NRT, that nonetheless can be sidestepped with some consideration.

3. Ten Geographical Traps for Non-Representational Theory

Issues of how NRT maps to practice is a continual theme in the literature, and understandably so as NRT seeks to deal so resolutely with tangible (and often direct) issues of encounter and experience. This concern with tangibility is rooted in how people perform, enact, and do the varied things that make up their routine lived human geography. In this section of the paper, we focus on the challenges that NRT faces in moving to practical consideration. We identify ten traps for NRT in application. We choose to isolate and prioritize the first trap as being the conundrum of small geographies, from which we consider an additional nine traps as inheritors.

3.1. The Small Geographies Trap

An important thesis of our paper is that NRT has remaining untapped potential to build knowledge of small human geographies. Our starting point is thus a position that NRT bounces around in spaces that present within big geographies, but often sit at scales below their observational reach. This creates a tension, we reason, because the representation traditions from big geography are often at odds with those that are experienced at small geography. For human geography, big patterns and structures are not always easily or

simply summed from their smaller parts [52,89]. Countless non-linearities, uniqueness, and exceptions to rules and norms can conspire to interrupt otherwise parsimonious connections from the small to the big [90], especially in human geography, which is loaded with adaptability [91]. We begin our review of traps with this broad issue of scale and smallness, or more to the point, the matter of detail (which we focus on singularly in Section 3.5). As we will discuss in the remainder of this section, we envisage nine further traps that follow from a general discord between the representative schemes used for knowledge discovery in big and small geographies.

The following assertion is a generalization but will hopefully assist the reader in distinguishing small geographies from 'larger' geographical vistas. Generally put, big geographies have long followed the practice of examining the spatial properties of phenomena, holistically, using inquiry to distinguish patterns and processes that are harmonious or dissonant across distances [92], including physical distances, network distances, cyberspace, and spaces of development geography, among others. Critically, these distances usually invoke some effort to traverse, such that they become meaningfully large, usually burdensome, and measurably costly to move through, over, or past. Geographies of migration [93], international trade [94], and land cover change [95,96] are examples of comparatively grand geographies for which distances far beyond the day-to-day routines of most individual people begin to shape geography. Indeed, significant concepts in geography have been centered on studying regional geographies [97], for which harmonies and dissonances hold constant or even dissimilar across scales that span entire administrative units or large population areas [50,98]. The development of big geographic insights has been fastened by the availability of large data sets: initially census data [99] and later other electronic records [68], as well as remotely-sensed data [100] and recently data feeds from geographically-networked systems [101] or even digital social media [102]. Significant methodological tools have also sprung up to support the analysis of big geographies, notably from capabilities proffered by the quantitative social sciences [21], including locational analysis [103], spatial statistics [104], spatial econometrics [105], and spatial analysis [106]. In each case, the schemes draw inference from distance-based analogies with large variability in their values and cohort sizes: the geographies are big, differences are big, and the 'numbers' are also big.

Increasingly, new forms of small geography data are becoming available. We note, in particular, that citizen science efforts to acquire these data often involve the sorts of non-representational encounters that NRT seeks to understand. This is evident, most popularly, in the incredible amounts of insight that have been built by citizen mappers [107]. However, efforts such as community map-building invariably end up being referenced to highly representational and abstracting schema, namely cartography [108]. Still, the original data that gave rise to open maps are available in many cases, which suggests that they could be usefully explored for many of the issues that concern NRT.

Of course, inquiry into relatively small geographies has long held geographers' interest [109], but the topic has traditionally been difficult to approach with empirical support at high-fidelity across numbers of people-observations that would be robust in supporting generalizable findings. Moreover, analysis, inference, and meaning are sometimes more difficult to settle upon when dealing with small geographies. In particular, classically big notions of distance, separation, distance-decay, and so on, begin to lose potency at small geography, where more intangible properties such as affect, valence, recognition, exposure, duration, meaning, and other individualized attributes take on intermingling significance. Consider, for example, the human geography of crowd behavior on a streetscape [110] or retail high street [111] and the relative maelstrom of individual feelings, thoughts, and decisions that course through even small collections of people in space and time. At small geographies, there are often twinned problems of a relative scarcity of data at fine resolution, and the inexorable slide toward uniqueness at that resolution. These two complications often mean that the significance of distance may fade in crispness of meaning against the relatively fuzzy issues of awareness, perception, cognition, interpretation, and

understanding that are central to enacted geography [112–115]. The typical approach to these barriers has been to study small geographies in case study form, and this tradition is well-developed in behavioral geography in particular [116]. These insights are, however, often difficult to generalize beyond their case study context.

Nonetheless, there have been many notable successes in small human geography. Here, we point out one noteworthy example of the rich understanding of spatial intelligence that underpins navigation and wayfinding [109,117–119]. However, as a general shared headache, scholars of small geographies are often faced with difficulties in how to contextualize, connect, count, and explain processes and phenomena that operate as and in small geographies, which then constrains their ability to theorize. Critically, the laws of requisite variety [120], characteristic timing [63], ecological fallacy [42], and the modifiable areal unit problem [46] conspire to signal to the research community that doing business in small geographies is fraught with challenges. Importantly, a lesson from complexity theory is that help from 'up-scale' (at coarser detail) knowledge is difficult to come by due to messy problems of non-linearity across scale gaps [52,121], with the result that the tension between big and small often remains unresolved, perhaps lost within the opaqueness of the feedback between them.

3.2. The Representation Trap

The consideration of what meaning human geography might take on outside representation is a fundamental tenet of NRT. A straightforward way to approach this consideration is to fault-find representation traditions in geography, as in critical geography [122]. Critical inquiry can assist in clarifying *non*-representational geography. However, building concepts for how geography can be *more than* representational is perhaps more challenging.

Castree and MacMillan [8] (p. 475) made the straightforward—but sort of profound—point that representation is not going to fall out of use in geography. There are perhaps two ways to develop this assertion. The first is that geographers, possibly through the extensive representational modes of scholarship that have shaped the field, are married to the idea of representation and that they have built large scaffolds of the discipline on the concept. The second is that representation could in fact be engrained in the very nature of geography. Regardless of which case—if any—may be resolvable in explanation (or even in proof), it remains commonplace that shaking loose from representation in many geographies that we experience is a difficult task, even more so in geographic scholarship. And so, whether criticizing representation or trying to work above representation, the fact that the concept of representation is everywhere in geographic research and scholarship establishes a foreboding challenge for NRT to tackle. Pushing back against the weight that representation presses upon the field's methodology for inquiry and the organization of its understanding is noble. Certainly, asking questions about which geographies may be non-representative or what scholarship might emerge if we abstract from representation provides very exciting impulses for new ideas and explanations. However, pulling away from the significant gravity of representation in geography can be a lot of work.

The ghost of representation features in the backdrop of both big and small geographic inquiry in NRT: consider, for example, the imposing tradition of boundary narratives [123] in big human geography. However, it is also readily evident that the representation trap also holds for small geographies. Many spaces (in cities, in particular) are governed by geographic rules and regulations that suggest or even dictate how we perceive or behave in spatial and geographic terms [124]. Similarly, there is always at least some latent geographic structuring in our encounters: as waypoints and landmarks that anchor our movement [112,114], as rules and norms for pedestrian crossing [125,126], as caveats on access to prohibited spaces [127], and as social traditions of conduct in celebrated spaces [128], among other examples. Similarly, one could take the view that whenever groups of people collocate in a space, or move through the same space, a set of socio-spatial representations almost inevitably emerges and often takes hold with behavioral consequence. In some instances, these products are directly coded into rules and laws

and norms; in others, they emerge as social doctrine [129]. Additionally, we must often consider that what is coded into spatial form, as in urban design for example [130], can take on (additional) social meaning [131], what Hillier and Hanson [132] referred to as a "social logic" of space and what Büscher and Urry [133] termed to be "grammars" and "orders" of relations (p. 104). The reverse is also true, as evident in recent pushes for new urbanism [134] and transit-oriented design [135], which have shown that social structure can yield tangible spatial structural forms, and this is well-explored in urban geography [136] and urban planning in particular [137].

In a sort of parallel to the observer effect of quantum physics, once observations [138] and measurements [139,140] are cast upon NRT, representation may creep in. We note, in particular, that structure of course flourishes in geographical data science due to the rather heavy hand of existing (representational) systems of cartography, spatial sampling, and geographical analysis. Indeed, we mention that Thrift [10] discussed that new NRT-based theories are possible *because* of the "fine grid of calculation which enables them" (p. 98).

A further consideration is that NRT is possibly unavoidably tethered to structure [56], and this structural inertia in geographies (particularly landscape geographies and built geographies, but also social geographies with political structures, power structures, familial structures, and so on), is something that is engrained in the way that we study geography, and in our experiences of geography. The representational impression of spatial structure is an intrinsic component of how geographers have explained how many large geographies have formed and how they operate over space and time [39,141]. Consider the example of urban geography, where issues of central place hierarchy and urban morphology cling on with significant inertia to structure [142], even when decomposed to sub-components such as geographies of household and individual housing search and choice at local scales [38,143,144]. Structure is also quick to develop among humans in many momentary facets of the mundane, whether in large assemblies such as populations, or in small collections such as dyads and groups, especially when people are on the move [125,145]. Even among children as young as pre-school age, small socio-spatial groups and pairs will draw structure from representation in the environment, even if they need to develop that representation through make-believe play [146,147]. Increasingly, much of the data that we use for geographic research is structured at the point of acquisition, through labelling and location-awareness [148,149], with the result that we may be grappling with representation, even within the 'ingredients' of our scholarship.

3.3. The Cognitive Trap

While representation in geographic spaces and places has a strong influence on how we experience geography, there is an argument to be made that people are already pre-disposed to examining the world through a spatially structured lens. This presents something of a causality dilemma [150], in that existing affinity to structure in our perceptual and cognitive wetware [151] naturally gives way to (and reinforces) interpretations that are themselves representative of those structures and their constructs.

Representation may be functionally essential to how our brains 'do' geography. Work in brain science points to evidence of representational biology in the neurological cells of non-human mammals, with indications that spatial representation is coded into our thoughts at a very basic level. For example, O'Keefe et al. associated the activation of place cells and the firing patterns among them in the hippocampus of animals with the behavioral geography of their movement [152] and animals' marshalling of navigation [117,153]. Although any sense that this could be tied inexorably to geographical perception would be quite a stretch in deductive reasoning, Maguire et al. found in clinical studies that there is a neural explanation and basis for the formation of spatial memory, as evidenced by navigation using topographical memory in the general human population [117,154] and markedly for route-finding among taxi drivers in London, UK [155]. Brun et al. [156] discovered significant cell-specific coding of geographic representation in the brain, showing evidence of place cells, grid cells, and border cells at work in the hippocampal-entorhinal circuit.

Aronov et al. [157] showed that this circuit is associated with a "map-like representation of physical space" (p. 719), responsible for cognition of direction, location, proximity to boundaries, and speed of movement through space and time. Moreover, they [157] contended that even non-spatial phenomena can be encoded spatially in the brain as a sort of shortcut when encoding continuous stimuli in task-related activities (they demonstrated this for sound frequencies). Torrens and Gu [158,159] have shown the proxy effects of this stimulus response in EEG data that is reflective of the fleeting time geographies of pedestrian crossing behavior.

There is therefore perhaps at least some basis for resigning to an opinion that human brains are pre-wired for representation (which is well known generally), and that they are specifically encoded at a cellular level for some significant aspects of spatial and perhaps also geographic representations, especially those that require that our awareness engages in declarative spatial memory [156]. This idea of a natural predilection toward (spatial) representation was actively debated some decades ago during the origins of the geographic information science movement, although the thread of inquiry dropped off quite soon thereafter. For example, Kuipers [160] proposed the "map in the head metaphor" as a way to consider how comprehension of "large-scale space" (p. 202) could be formalized as a mode of information comprehension and recall. However, many cartographers would point out that maps—whether physical, computational, or cognitive in nature—can take on many different meanings given the same structure and representation [22,23]. Indeed, Kuipers [161] himself later questioned whether the structure of the map was adequate relative to varying task loads.

3.4. The Empiricism Trap

There are several points of connection between NRT and the increasing infusion of calculation and digitization into the routine geographies of our encounters [162]. A thread of empiricism has long run through NRT. In his original thesis for NRT, Thrift [10] repeatedly stressed that he regarded human geographies of experience as being interwoven with calculation. In the same vein, Büscher and Urry [133] envisaged NRT as a way to connect observation, theory, and empiricism directly in human geography (p. 99).

Alas, while one could reasonably argue that NRT is an empirical theory, as Thrift [10] points out, "there is no stable 'human' experience" (p. 2). This makes empiricism of experience a difficult concept to pin down in specific terms. Pile [3] (pp. 8, 9) went as far as to index some aspects of NRT (particularly affect) as being "inexpressible: unable to be brought into representation". In a paradoxical turn, empirical groundwork is particularly challenging for NRT to engage in because of representational traditions. In particular, existing headway in NRT has mostly come from conceptual philosophy, drawing particularly from the work of Husserl [61], Heidegger [62], Merleau-Ponty [163], Schutz [164], Dreyfus [165], and Latour [166,167] (see Dourish [12] for an excellent overview). Within that philosophy, there are several indications that there may be a fundamental difficulty in empirically identifying and measuring the phenomena that interest NRT, and in doing so without representation.

Notwithstanding these challenges, several promising efforts to build empirical ground truth for NRT have been advanced. Taking cues from movement and mobility analysis, for example, a number of authors have turned to the notation of choreography as an example of how this might be done. For example, Thrift [71] (p. 67) suggested that Rudolf Laban's notation for dance—Labanotation—could be useful as a tool for cataloging encounters. Others, taking cues from ethnography, have explored how diaries (often deployed as notation of live action experiences of human geography) could provide actionable methodology. These have included, for example, self-narration [168,169], spatial transcripts [170], and photowalks [171]. Although, as we discuss further in Section 3.8, and as Cook and Edensor [172] caution, much of the existing approaches in this vein have been self-referential, with the biases that introspection could easily entail. They are also generally limited to

individual perspectives on localized experiences, which limits their ability to contribute to theories at grander scope.

3.5. The Detail Trap

Much of NRT is intended to be referenced and mapped to the body [82,83,173–175] and to body practices [10] (p. 65). The limiting implications of this are perhaps twofold. On the one hand, a focus on *the* body would constrain NRT to a rather limited set of geographies, centering around individuals, with the associated bias and transferability traps that individuality suggests. On the other hand, a focus on *bodies* potentially opens up NRT to having to account for a quickly untenable and non-parsimonious set of subjects, with significant detail implications. We will address the bias and transferability traps independently in Sections 3.7 and 3.9, but here we first examine the detail trap.

NRT's interest in the corporeal elements of human geography follow the pioneering work of Tuan [19,20,82] in finding room for geographies of tangible, sensory experiences in place-making. NRT's focus on the body can also be interpreted as a reaction to the disembodying influence that geographic representation has previously had upon human geography; this point is advanced well by Büscher and Urry [133], who argued that a focus on human bodies invokes consideration of a range of geographical objects that are often uncommon (perhaps even overlooked) in exploration in human geography.

In many ways, NRT's reach for detail echoes similar arguments from postmodern geography, especially the primacy of uniqueness in shaping explanatory viewpoints on the geography that we encounter mundanely and in the background of routine [14,16]. Pulling these details from the soundtrack of busy everyday scenes can be valuable in building a more intuitive understanding of the rhythms of things that we might take for granted. Alas, detail is often difficult to find and geographic abstractions (sampling, principal components, clusters, agglomeration effects, etc.) are readily at hand for many geographic tasks [176]. Büscher and Urry [133] raised the postmodernist complication of detail in their discussion of NRT: they invoke the work of Latour [166], for example, to describe the huge array of fine-resolution elements of daily life that would be necessary to build a human geographic focus on bodies. Evoking this detail in ways that can address small geography [177] but that also presents explanatory tethers to coarser human geography concepts quickly becomes unwieldly if scholarship of the body is rooted in postmodernism through deconstruction.

The primacy of detail for NRT is an important thread in our argument for this paper, because it implies that the concepts for NRT, almost by necessity, require a huge level of (specificity in) individuality, which additionally needs to be sustained across wide dimensions of variability. Unbridled individuality and variability are a combination that is not often associated with tractability in practical terms [178–180]. If we also consider that NRT concerns itself with the role of the individual body in the broader human–environment interactions that are at play, for example, in urban geography [181], in cultural geography [182], or in social geography [183], then it becomes additionally necessary that NRT levels a relatively high degree of connectivity from the individual, through the variable, to the emergent. These micro-to-macro connections are notoriously difficult to foment in human geography [184–186], particularly where thorny scale and aggregation issues abound [89]. One strong signal from the work of geographers in building complexity theory [121] is that the non-linearities that intervene between scales easily defy descriptive and explanatory tractability.

The use of individual bodies as a topic of study and as a frame of geographical reference within NRT is noble, but it is challenging, specifically on the grounds of resolution. In extant scholarship, there have been successful large-scale efforts to tie individual body geographies to meso-scale human geographic processes and phenomena. Notably, these endeavors have included work by Goffman [187], Stark et al. [127], and Dabbs and Stokes [188], to source geographies of place in local urban settings to body language and social affordances. However, these successes have drawn directly from the very representative types of geography that NRT avoids, using urban geography, architectural design,

and built morphology as a container for behavior [124]. How one might empirically map individuals to phenomena in human geography at the scale of bodies by using existing tools of geographical inquiry is, however, largely missing from the NRT narrative. Tools such as observation of performances and diary-building [168–171] (often while bodies are in motion) have been suggested, but these arguably miss the sorts of (empirical) detail that are discussed in NRT. Consider, for example, the level of behavioral psychology and motion capture that goes into generating short sequences of body language for special effects [189], or the empirical notation necessary for dancers to produce brief sequences of choreography [190,191], and one perhaps has an idea of the level of scientific endeavor required to empirically capture and explain human geography in motion at the level of the body [192] in any given place or space. Techniques from computer science, particularly from computer vision [148,158] and machine sensing [37,193], are beginning to find their way into geographic scholarship in ways that could help with automation and with scale. However, these techniques invariably proceed from foundation models that are highly structured and tightly constrained to representative schemes [194].

A further challenge of detail applies to NRT if we also consider its corporeal alliance with rhythmanalysis [85]. Dynamics in motion is a theme that is intricately woven through NRT, and a topic that dominates in the 'mobilities turn' in human geography and sociology [74,133]. However, it is important to highlight that underneath the mobilities turn, NRT seeks to uncover geographies of the fleeting as well as their connection to the broader dynamics of mobile human geography. This can prove challenging to actuate in practical terms because it suggests that significant detail on human geography be acquired, for events that are often sparse in occurrence, and usually fleeting in access and observation (as we discuss in Sections 3.6 and 3.10). In calling upon themes in choreography and performance, NRT also requires significant temporal detail in human geography. Even in time geography, fine-scale temporal resolutions are often hard to eke out in practical concerns for human geography themes [195]. The preoccupation of NRT with the encounter as a building-block of the theory is a good case in point. Consider, for example, some of the detail claims for NRT: bodies, touch, sensory inputs and sensations, and individual relationships with objects. In concept, these details are presupposed as not only accessible to NRT but also embeddable within (and driving of) grander motifs of dynamic (and for NRT, often mobile) human geography. These presuppositions can slip out of reach in practice. Indeed, coarser-resolution motifs themselves are already relatively poorly understood, including the connection between the materiality of geography and the social science of movement and of motion and locomotion; see Sheller and Urry [73] (p. 212) and Torrens [119,196].

In part, more traditional forms of geographical inquiry eschewed the sorts of detail we discussed above, either because it was elusive or because it was parsimonious for geographers to abstract from a more complicated and high-resolution world. In both cases, the law of requisite variety [120] can quickly come into play. Again, this was noticed by Thrift [10], who described that NRT requires "continuous calculation at each and every point along each and every line of movement" (p. 89). He went on to discuss how these calculations take place "in the background of any encounter" (p. 90), through a phenomenon that he termed "qualculation", after Cochoy's use of the term in the sociology of marketing [197,198]. How to actually perform this qualculation, we would argue, remains to be developed, which presents significant opportunities for geography, and for human geography in particular, because empirical approaches will by necessity need to embrace the humanistic properties, qualities, and signals that are fundamental to identifying and rationalizing experiences. Any foundation model that could be built—through sampling, artificial intelligence (AI), agent-based modeling, querying infrastructure, data-driven heuristics, etc.—to buttress qualculation methods or products would need to steep itself in the humanity of experience, and to do so perhaps even before or ahead of any representational metamorphosis.

3.6. The Access Trap

The detail challenge for NRT begets an associated access difficulty. NRT, with its association to relatively high-resolution and high-fidelity descriptors of things that are routinely difficult to capture in everyday life, implies access to its target phenomena at the scale of the individual encounter. However, many of the phenomena that are central to NRT are out of reach of quantitative inquiry, and even of qualitative inquiry, at scales above a few encounters. One way of reading NRT is that it requires that access to human geography at the spatial scale of the body and that the temporal scale of the encounter be not only available but also be sustained 'up to' larger scales, all the while preserving attention to individuality. In general terms, this resembles surveillance, which raises additional concerns [199,200]. It also implies sampling across scales (in lieu of access), which invokes secondary complications of (micro-) ecological fallacy and the modifiable areal unit problem [43].

To date, NRT has tackled the access challenge in relatively limited form. Traditional access approaches have mainly focused on human observation and interpretation, usually by ethnography [201], by story-telling [202], using photography and photo-journaling [203], and particularly through (often single-perspective and individually introspective) diaries [204]. We do mention that the walking interview technique introduced by Evans and Jones [205], as a variant of their GIS-based spatial transcript method [170], represents an interesting approach to reducing this individual focus. This has produced tremendous insight, but extant approaches are almost intrinsically limited to small case studies, which are narrowly finite in their transferability and generalizability to geographical context at different sites and among different populations. Several aspects of ethnography could potentially be automated such that case study work could be extended to large swaths of observation, while still preserving individuality [206], but the current schemes for accomplishing this are sourced in data science [34], computing [192], and machine sensing [207]; as we already mentioned, and these are almost foundationally rooted in very restraining representation schemes at their inception.

Pile [3] introduced a very germane argument for (partially) dismissing NRT on counts of limitations in access. Pile's thesis is, essentially, that one cannot suitably hope to gain access to what is going on in people's heads. This problem has been debated in the NRT literature specifically in relation to affect, i.e., the outward display of emotion and feeling that is routinely exchanged or interpreted in human encounters [3–5,65,70–72,181,208]. Affect is one of the main mechanisms by which non-representational theorists propose to frame emotional geography in encounters, what Thrift [71] refers to as an "outer lining" (p. 60). In discussing the relevance of affect to NRT, for example, Pile [3] (p. 9) echoes commentary by McCormack [209] (p. 496) in raising a concern that affect is an unmanageable "object of study" because it cannot be observed or understood [3]. Although advances in computer vision (see our own Figure 1) can possibly negate Pile's thesis regarding the potency and depth of observation, at the core of Pile's argument is that the experiences that produce affect are beyond observation as a unit or locus of appreciation [3] (p. 11).

Nevertheless, some significant work in behavioral geography [116] is available to address these access concerns, including experimental work to reconcile brain science, spatial behavior, and spatial phenomena that they are shaped by and that they produce [159,210,211]. Building parity of exchange in ideas between NRT and behavioral geography and spatial components of perception [212], action [118], and cognition [213] in psychology requires some empirical synergy. We discussed the empiricism challenge in Section 3.4, a reminder that several of the ten traps that we propose for the reader's consideration are themselves conjoined, which creates further complications for NRT in practical applications.

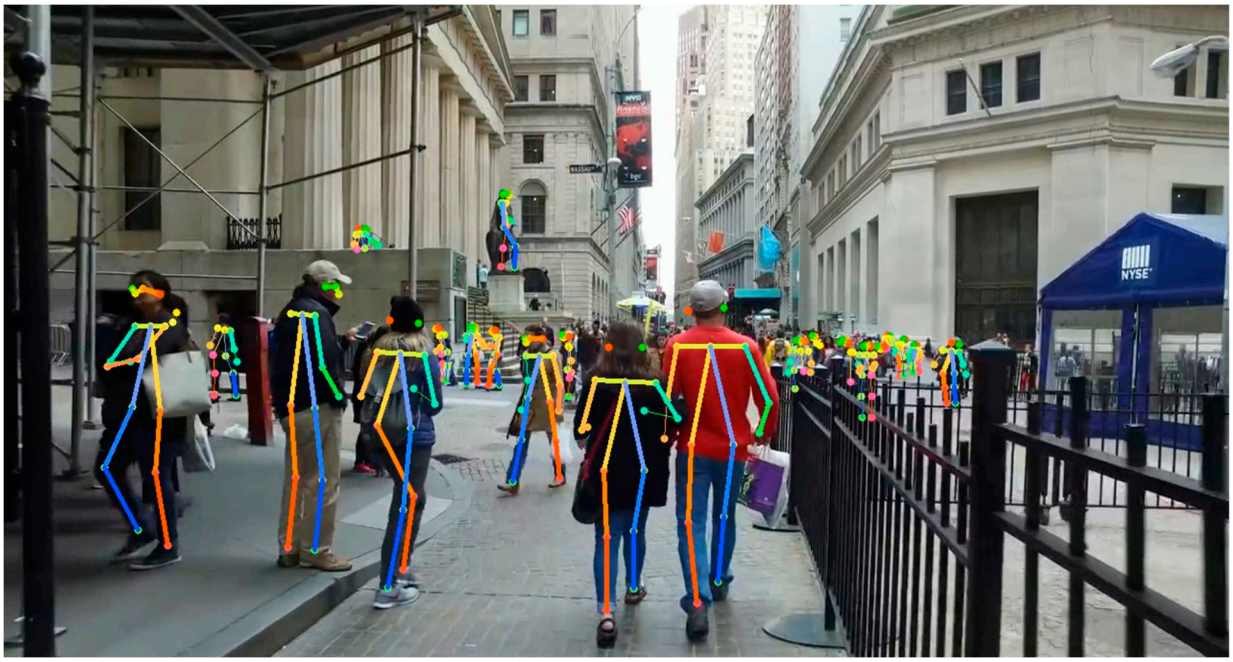


Figure 1. Using computer vision to automate collection of detailed time geographies of human encounters within hyper-localized leitmotifs of place.

3.7. The Subjectivity Trap

Human geography must almost necessarily deal in large volumes of subjectivity associated with the vagaries of human motivation and action, which renders definition—particularly at hyper-local scale—opaque and tractably difficult to conjure. NRT, perhaps because of its roots in interpreting philosophical lessons for human geography and its early inroads in critical geography, has chosen to tackle subjective topics early in the theory's development, possibly before its defining components have come into resolute focus. As a consequence, NRT is vulnerable to being faulted as a vague and elusive concept, with some concern that the theory is lacking in conceptual foundation [3] (p. 5). The aim of this paper is to examine the challenges of exposing NRT to practice. Thus, it is problematic that the usual chain of discovery and understanding that would normally proceed from theory through conceptualization to application is openly discussed in the NRT literature as faltering at the second step in this sequence.

There are varied motivations behind the remonstration of subjectivity, but a significant reason centers around NRT's focus on self-reflection. An easy complaint for a theory that is introspective is to fault it as idiosyncratic. There are also concerns that NRT's emphasis in focusing upon the individual opens the theory to bias. These biases come in many forms. Some stem from factors in psychology [214] and sociology [215] that are intertwined with encounters and experiences and that have significant bearing on NRT. Other biases are geographical, for example through geographical implications of gender biases [216], ethnocentric biases [217], place location knowledge biases [218], and sex biases [219], as well as well-documented reflections and shadows of these biases and others in geographic information products [220,221], including the diaries and spatial transcripts that are popular tools in NRT research. Skeggs [222] discussed this at length in explaining numerous pitfalls of relying on scholarship produced from the personalized and self-reflections of geographers, who may have their own ability, sex, power, and class biases. Indeed, she ultimately hazards against adopting universalisms from their subjective narratives.

3.8. The Methodology Trap

Perhaps because of its origins in theory, there is somewhat of a grab bag of methods that are usually brought to bear in docking NRT to the real world. There is nothing particularly amiss in this observation, but it could be argued that the preexisting mixture of methods that NRT relies upon leaves the theory flat footed in its ability to support repeatability (and therefore refinement), in extension to new cases or experiments, and in generalizability. If we consider that NRT deliberately eschews representation, it is understandable that NRT started as a theory first and reached for methods later. By comparison, more well-traversed theories in human geography have had time to co-develop with supporting methods; remote sensing and land use science [223], censusing and population geography [224], geographic positioning systems and transport geography [101,225], and social and digital media and allied cybergeographies [226,227] are some examples.

To date, there has been a heavy emphasis on the narrative interpretation of NRT through the work of several philosophers, particularly Husserl's [61] and Merleau-Ponty's [163] phenomenology, Brentano's [228] intentionality, and Heidegger's [62] ideas about experience. Many facets of these philosophies are difficult to actualize on the ground in ways that might produce data or measures (and this is obviously not the point of their philosophy anyway). Simpson [86] (p. 424), in particular, has been quite outspoken about the difficulties of putting NRT ideas into empirical service, especially in support of rhythmanalysis. Indeed, Simpson [86] (p. 424) made the blunt and pertinent observation that the task of how to go about engaging in empirical and applied NRT analysis on the ground is often overlooked in extant discussions, and he discusses the limitations of several philosophical theorizations in this regard, especially in the work of Lefebvre [85].

Taking cues from NRT's interests in 'being in' (immersed, enacted, present, embodied in) human geography phenomena and their contexts, several methods for practical and observational NRT analysis have drawn from the methodological traditions of ethnography, particularly in the efforts of NRT to forge practical knowledge for geographies of encounter. This has included the varied methods of journalling encounters, especially where journals can support touchpoints as interactions and transactions of a geographic nature. A productive spin on the ethnographic analysis of NRT has emerged around the technique of co-present immersion [133] (p. 218). This has included methods such as shadowing people as they go about their everyday activities [229,230]. Co-presence ethnography can be tremendously helpful in developing high-detail and high-fidelity insight. Indeed, techniques for assessing affect and valance among small social groups rely on similar approaches, often with socio-spatial context as a central consideration [147]. However, ethnographic work is often necessarily labor intensive, requiring trained human observers embedded in fieldwork for many hours of effort. This may limit the reach of the technique to relatively small case studies, which could then artificially constrain the transferability of NRT to different places and times.

3.9. The Translation Trap

Because NRT delves into details of individual encounters and the feelings that they evoke in human geography, it becomes challenging to translate some of its insight into laws and principles that could underpin a classically scientific approach to human geography [92,231,232]. It is of course an option to retreat to the assertion that NRT is not a science and that it does not aim to be one [233], but rather that NRT sits in closer alignment to the humanities [20], where its translation across texts and other media (the 'literary turn' [234–236] in human geography) is more aptly registered. NRT is not necessarily interested in or responsible for adhering to the norms of classic scientific pipelines, especially those of the relatively hard sciences. Nonetheless, the oftentimes difficulty that NRT faces in translating from one case study to another presents a significant trap for the theory. If one additionally considers the challenge of translating NRT from one geographic locality to another—when that geography is hyper-local, as is often the case in NRT applications—this becomes a valid consideration for NRT, even as a social science or

in the arts, letters, and the humanities. It is also worth acknowledging that NRT draws from concepts in many other fields, which raises the issue of how well it can interface as a theory with allied pursuits beyond (or adjacent to) geography, say, for example, through the notion of spatially-integrated social science [237,238].

Aspects of the translation challenge proceed from the foundational ties that NRT has to philosophy, particularly NRT's couplings to debates about the nature of things, and to the philosophy of perception as a mental phenomenon. While translation across these dimensions is relatively straightforward between different philosophies, or spanning varied arguments within philosophical corners, NRT's ties to philosophy—especially in conceptual terms—can make the theory difficult to shift across geographic sub-fields, which often draw upon their own (incommensurate) philosophies, and may do so without formality or shared concepts that could form the basis for translation [14]. When compounded with the often unique nature of applied NRT across grounded geographical case studies, translation becomes an even more arduous task.

The barriers that NRT faces in translation across tangible geographic locations, places, and sites is one that human geography generally encounters, either as boundary problem [123] or vernacular concerns [239]. Most human geography involves cross-location and cross-place comparisons, as a necessary step in examining whether theories remain valid when applied to new geographic context, and what similarities, differences, dissonances, and anomalies might present when the theory is extended to new locations, places, populations, and times. NRT perhaps takes this to an extreme, because of its focus on the geography of the hyper-detailed and the hyper-fleeting. Nonetheless, there are examples in human geography that approach the same level of insight, often at or near individual specificity. For example, NRT has been considered for its relevance to urban planning [181], transport (travel) geography [240], and tourism geography [203,241–244]. NRT could perhaps learn from these adjacent fields, but formality in conceptual foundations may be necessary for parity of exchange. Consider, for example, that laws and rules abound as rather hard and non-negotiable representative barriers in urban design and planning [148,245,246], as do highly representational codes [247,248]. Similarly, a variety of laws—traffic laws, physical laws of motion, economic laws—are available to tangibly bound much of transport geography [249]. Again, this is illustrative of a basic but inexorable trap: escaping geographic representation by looking to other fields can often just draw that geography into representation in other forms.

3.10. The Process Trap

Theoretical arguments by Büscher, Law, and Urry [133,250] showcase that NRT can fill knowledge gaps in existing human geography by explicitly tackling phenomena that are fleeting [133] (p. 102). By 'fleeting', we mean to characterize geographies that appear and reappear in ways that might be overlooked by representations that freeze time to favor space [251]. Sheller and Urry [73] usefully raised a concern that process is something of a blind spot to representational geography. Implied, then, is that NRT could have a significant explanatory advantage over representational geography. Consider, as an example, human geography's traditional focus on infrastructure, which Sheller and Urry [73] point out moors human geography to things that are fixed in space and time (p. 210).

In contrast with its relatively static counterparts within human geography, NRT often interprets human geography as a process that is continually coming into being [252] (p. 3) (if not coming into formation). In doing so, NRT is able to forswear the representative traditions of other theories that tend to freeze—by capture, by codification, by observation—properties of the human geography they study [8] (p. 475). This centrality of process to NRT is taken up by Thrift [71] (p. 59), for example, in his tangential inquiries into the geographies of feeling and affect and the difficulties that time and process dynamics pose for categorization.

However, without elucidating the pathways and processes by which NRT takes hold in spatial behavior, or through which it forms within human geography phenomena, pro-

cess claims for the theory may risk coming across as speculative. Addressing process and dynamics in geography generally [253–255] and NRT specifically is not easily accomplished. Accounting for process dynamics at the level of encounters, particularly, is difficult under NRT, especially when one considers the potential intricacies needed to distinguish encounters within broader and up-scale motifs of human geographic phenomena.

NRT has adopted two promising lines of inquiry to handle dynamics. First, significant theoretical frames for handling dynamism in NRT have come from philosophies of rhythmanalysis [85] and (usually observational) case studies of performance as rhythmanalysis [86]. A second significant practical headway in understanding process in NRT has come from mobilities research in geography. We might also consider a third: in many ways, this discussion of process dynamics opens conduits between NRT and time geography. This synergy is evident, for example, in the work of Sheller and Urry [73] and their discussion of the role of tempo (p. 215), which accounts for process dynamics (which can also be considered as structured), but also questions the influence of time in the psychology of human geography. Examination of the nature of tempo provides an opportunity for both NRT and time geography. NRT, in embracing things that are continually on the move, could draw from the formalities of time geography. Concurrently, time geography, which has long been faulted for being abstract and coarse in its representation of behavioral geography [195,206,251,256,257], could draw insight and explanation from NRT's focus on individuality. For example, Hägerstrand [258] famously reminded scholars of time geography that at the tip of each space–time path (and super-positioned atop that formality) there was a person; time geography was always supposed to deal with the individual and with their human condition [251,256,259], and this leads to a plea among time geographers for more attention to people in the topic's expositions [195].

Vannini [13] (p. 322) made an interesting observation regarding NRT that is relevant to process dynamics: the slow pace of many human geography experiences (he uses walking as an example), permits new forms of ethnography at high-resolution scales of space and time, which could lead to new insight about the processes that drive and animate human geography. A focus on mobility (and things on the move) in human geography, building from the well-developed philosophy of rhythmanalysis and practical theories such as time geography, provides a pathway for NRT to embrace process dynamics. Alas, *how* NRT could actionably do this often falls by the wayside in the theoretical discussion. It is worth noting that, perhaps paradoxically, there is significant lingering attention afforded to landscape symbolism [260] in human geography generally, and indeed in NRT specifically [7,75,172]. Again, there is perhaps an argument to be made that in endeavoring to be non-representational in geography, NRT actually falls back onto temporally representational formalisms. Indeed, in referencing Rifkin [261] (p. 191–193), Sheller and Urry [73] (p. 212) made the salient point that structure and process are almost inextricably bound together in most phenomenology and that dynamics also hold significant influence on how we develop knowledge about geography.

4. A Worked Example: An Empirical Field Observatory for Human Geographies of Encounter

We would be remiss to forward ten traps for NRT without demonstrating some hopeful paths for their resolution in practice. Here, we briefly outline a preliminary observational framework for examining human geographies of encounter in applied settings in ways that aim to circumnavigate the ten traps (as shown in one form in Figure 1). We stress that this is work in progress, and thus its purpose in this paper is to point to research vehicles that match to some of the narrative arguments around the NRT traps we presented in Section 3. More details of the research instrument are provided in Torrens [34,148].

Our goal for the observational vehicle is to build a methodology for live, real-world NRT research that can sidestep as many of the ten NRT traps as possible. We developed the instrument around the concept of a leitmotif. Leitmotifs are originally considered in music, where they are used to score an often short in duration burst of music that is used to

invoke the essence or spirit of a place, event, or character [262]. In anthropology, leitmotifs have been used to describe the intertwining of movement, psychology, and culture (see Astrov's [263] work on connections between the leitmotif and movement in Navajo folklore, for example). Albrecht and Wöllner [264] described the use of leitmotifs in film music as a medium for embodying the audience: by establishing direct and compelling connections between the feelings and the sense of movement that music streams can convey. Hallnäs and Redström [265] discussed the use of leitmotifs in computer–human interaction as a means to fold the notion of presence into design, by leveraging leitmotifs as a form of expression for artifacts, e.g., the leitmotif as an expression of a thing's functionality. Interestingly, Hallnäs and Redström [265] tied leitmotif expression specifically to "time structures" and to "space structures" (p. 106).

Here, we repurpose the idea of the leitmotif to conceptualize small rivulets of fleeting space–time encounter that we might ascribe to people, roles, places, and events in very hyper-local instances of human geography context. This involves the development and deployment of data-collection schemes that may be situated unobtrusively in natural contexts of encounter in everyday life. These methods should be capable of accounting for immersion in that geography at the scale of the individual, with reach to small ambient geographies in fleeting windows of time. The apparatus should be capable of collecting data on scenes in ways that would naturally be appreciated in the routine of momentary human geography.

To achieve this, we recruited user-participants to wear small body-mounted high-definition (HD, 4K resolution) cameras with high-resolution geographic positioning (GPS) (Figure 2) and asked them to record scenes from their everyday walks around New York City. This study was approved by our Institutional Review Board (IRB) under a human subjects research plan. In total, 33 participants recorded 194.41 h of footage (~5.9 h per person) for an intermittent period that stretched over 18 months, in varying urban and suburban locations, at different times of day and night, and across seasons. Video data were recorded at 60 fps, yielding ~1.27 million frames of real, encountered human geography (Figure 3). We then ran these data through machine-learning schemes to extract (1) individual people, (2) individual artifacts, (3) people's body language poses, (4) people's gaze direction, and (5) a pseudo mesh volume of their three-dimensional body geography (Figure 4). Because the GPS signal was interleaved with the video feed on-device when the data were recorded, each of these pieces of information (and any subsequent data products) can be indexed to very high resolutions of space (sub-meter) and to time (0.017 s). In addition, we asked participants to wear a smart watch with inertial measurement (accelerometer, cadence, heading relative to true north) and GPS, the data for which are also indexed to the same space–time geography (Figure 2).

For particular localized urban places (crossings, transit stations, retail outlets, municipal buildings, historical sites), we additionally collected observational data to describe the urban and human geography in paired context (Figure 5). This involved collecting hand-coded observations, for which we looked at people's action, activity, affect, and valence (while also noting their demographics) using the Inter-personnel Process Code (IPC). We also used automated ranging data to catalog distances and timing (sub-centimeter distances at a temporal resolution of 0.01 s) using Light Detection And Ranging (LiDAR) (Figure 6). For the coded scenes, we recorded ~1200 site observations over a period of a year, again in varying urban environments and situations around New York City.

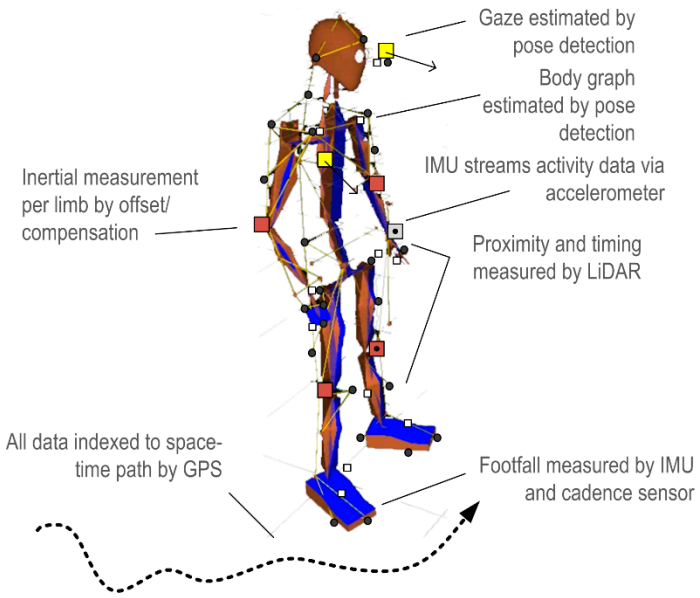
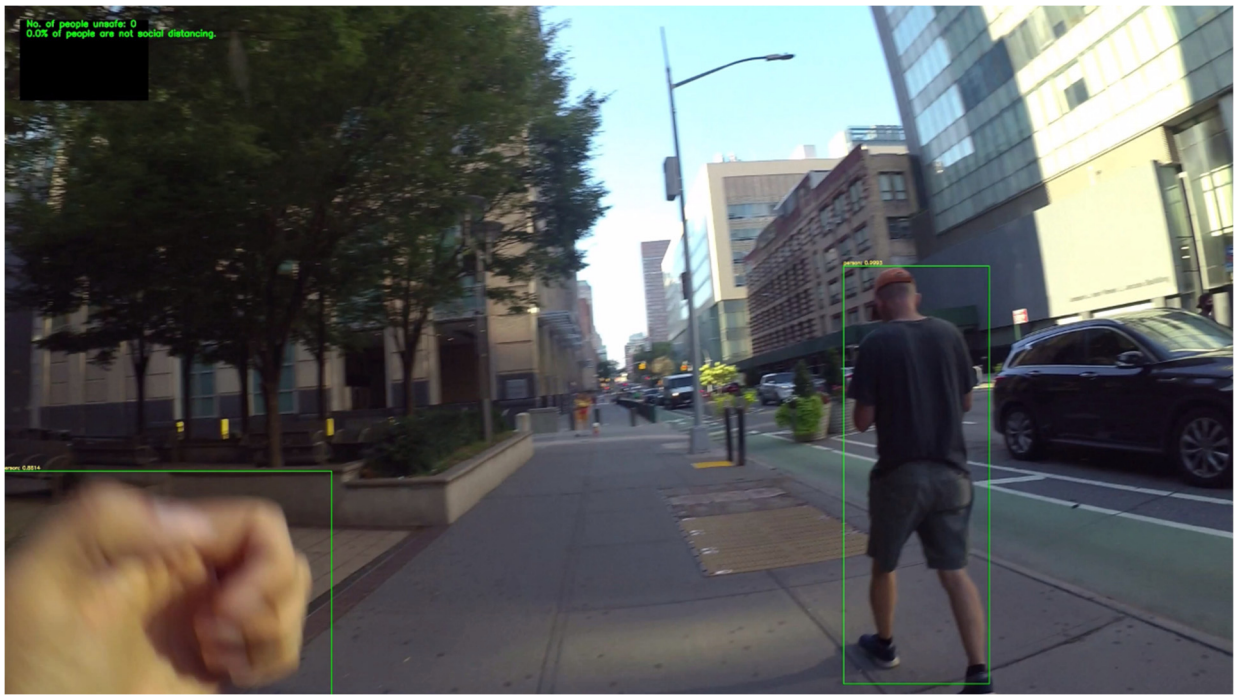


Figure 2. Recruited participants were invited to wear a chest-mounted camera with GPS and IMU and a smart watch with GPS and IMU. For some urban scenes, we also collected LiDAR and coded observation data.

Video footage from a chest-mounted camera.

Figure 3. *Cont.*



Machine learning of bounding boxes for people in the scene, and frame-distance between boxes.

Machine learning to resolve likely people, vehicle, object, and artifact types in the scene (with confidence interval).

Figure 3. *Cont.*

Machine-learned three-dimensional body meshes for identified people in the video scene.

Figure 3. Recorded encountered geographies from first-person video during routine walking. (Machine-learned segmentation into objects and people is shown, as well as in-frame distance calculations.)

Machine-learned partial affinity fields from first-person video.

Figure 4. *Cont.*

By searching the value-space of the partial affinity fields, we can build poses and gaze detection from the video scene.

Figure 4. Machine-learned poses (body language) and gazes from first-person video of a hyper-local human geography encounter. In this case, the scene is taken from an Online video, which shows the transferability of the approach.

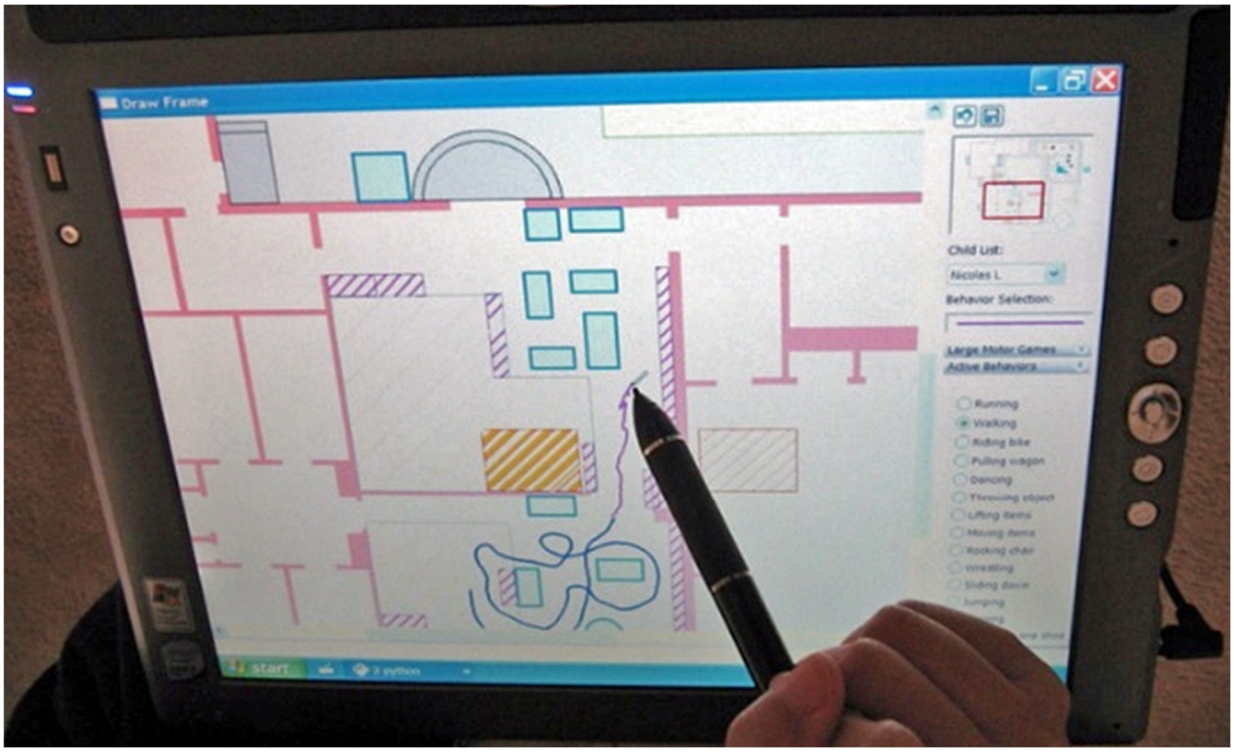


Figure 5. *Cont.*

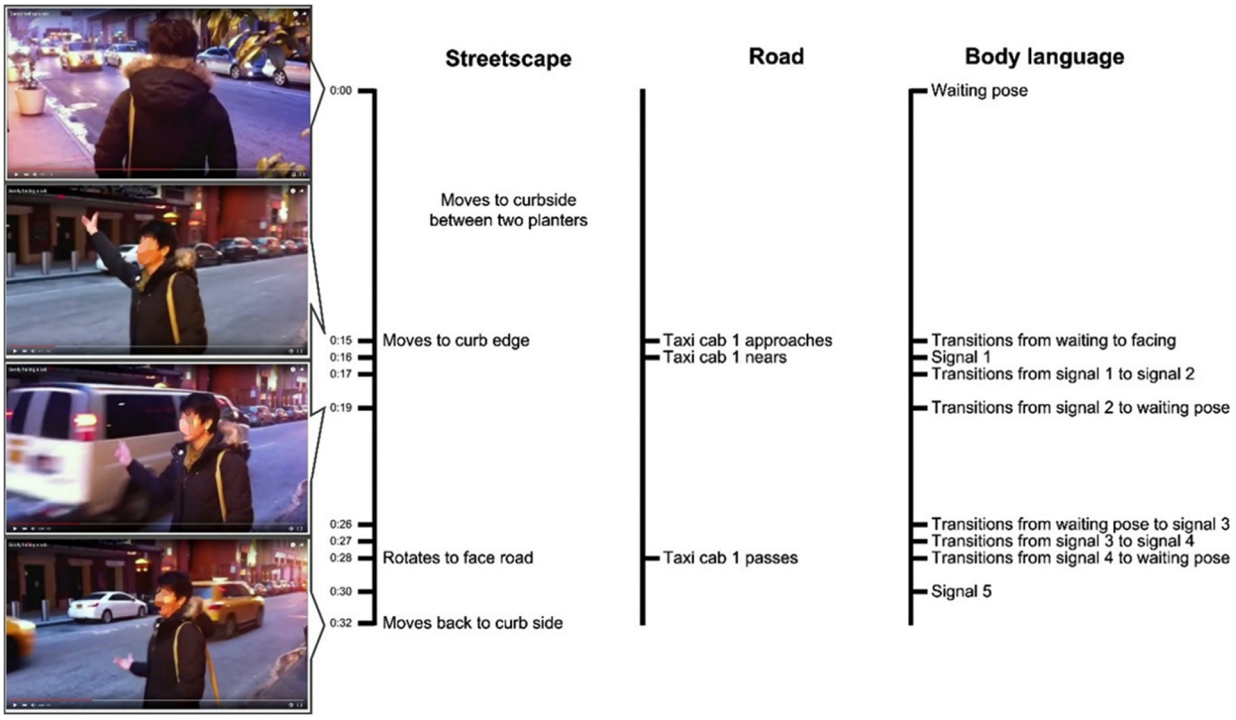


Figure 5. (**Top**) Coded observation of affect and valence using IPC. (**Bottom**) Resulting coded action-states and state transitions (on Online video).

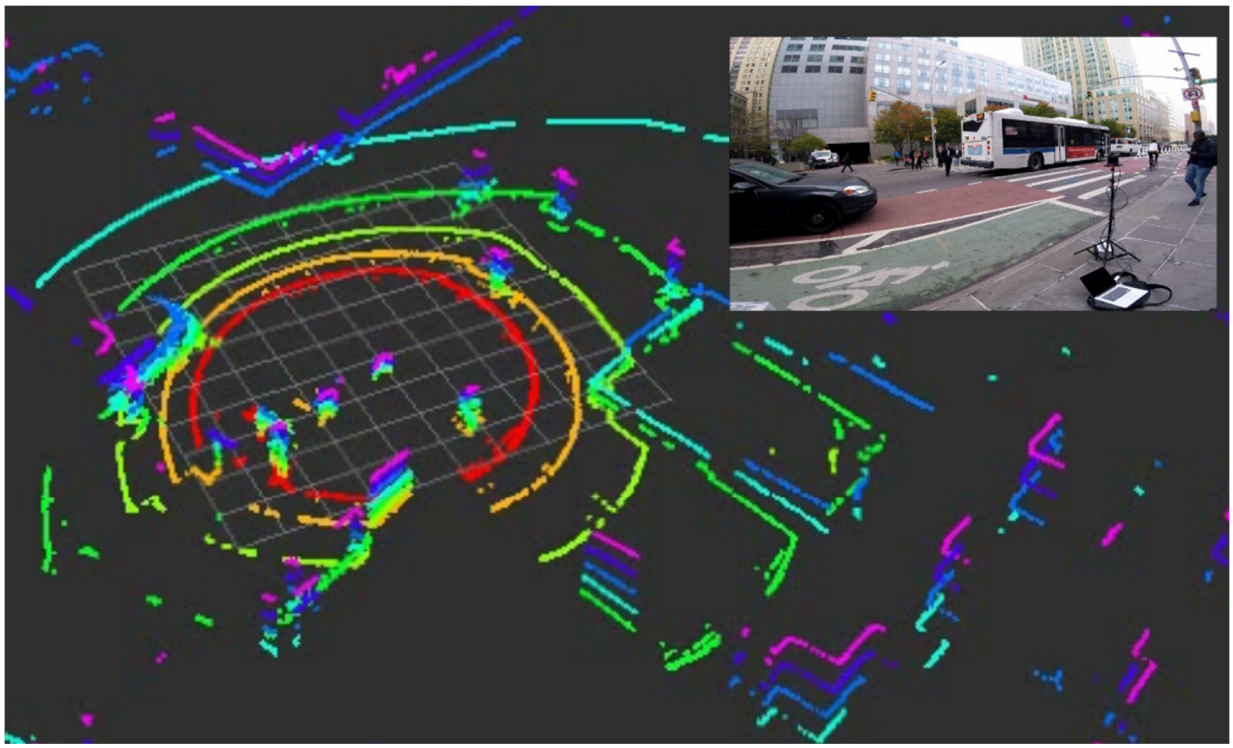


Figure 6. *Cont.*

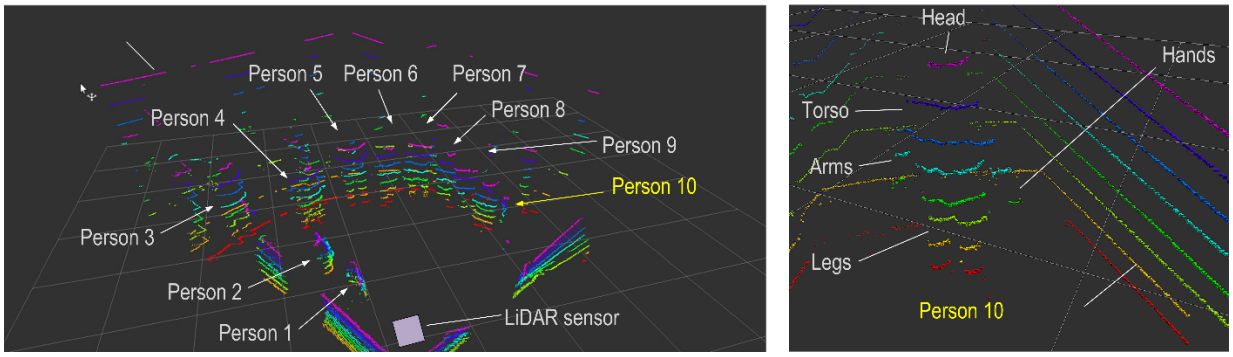


Figure 6. LiDAR-based observations of a hyper-local encounter scene. The yellow color for "Person 10" is to index it to the inset at right.

Taken together, the first-person video and telematics, as well as the qualitative/machine coded observation, yields a huge volume of empirical data on encounters (Table 1). We were also able to apply the coded observation schemes to Online video (Figure 5 at bottom). These data, we consider, may help to alleviate several of the ten traps that we discussed in Section 2 (Table 2).

Table 1. Connections between observables, human geography behaviors, analysis, and supporting data.

Observable	*Underlying Behavior*	*Supporting Analysis*	*Available Empirical Data*							
			C	**F**	**I**	**L**	**M**	**O**	**P**	**V**
Pose	Action	Action classifier			■		■	■	■	■
	Intention				■		■	■	■	■
	Attention	Gaze direction					■		■	■
Locomotion	Ambulation	• Activity recognizer • Effort recognizer • Localization to space–time path	■	■	■		■	■	■	■
	Footfall			■	■	■	■	■	■	■
	Cadence			■	■			■	■	■
	Kinematics		■	■	■		■	■	■	■
	Proxemics	Trajectory clustering	■			■		■	■	■
Heading	Maneuvering	Time geography				■	■	■	■	■
	Wayfinding	Map-matching				■		■	■	■
Personal space	Buffering	• Segmentation • Egocentric distance • Allocentric distance	■			■	■	■	■	■
Object use	Task action	Action classifier	■				■	■	■	■
Valence	Affect	Affect classifier	■	■	■			■	■	■
Physicality	Interaction	Segmentation	■	■	■		■	■	■	■

C = coded observation; **F** = force and valence; **I** = Inertial measurement; **L** = LiDAR; **M** = motion capture; **O** = object recognition; **P** = pose detection; **V** = body-mounted video.

Table 2. Mapping the observational instrument to the ten traps.

Trap	*Observation (See* **Section 3***)*	*Discussion*
Small geographies	C, I, L, M, O, P, V	The immersive nature of the observations, and their ability to register sensed, coded, and measured properties against high-resolution spatial and temporal increments, allow for very small geographies to be studied.
Circularity in representation	O, V	This trap is not wholly or satisfactorily avoided. Object recognition from video necessarily relies (exclusively, heavily, and in often biased ways) on representation and categorization relative to pre-baked labels.

Table 2. *Cont.*

Trap	***Observation* (*See* Section 3)**	***Discussion***
Cognitive	C, P, V	Some signs of recognition or attention could be tied to pose detection from video. Where understood, cognitive factors can also be hand-coded by IPC.
Detail	C, F, I, L, M, O, P, V	The observation scheme produces large volumes of detail on the human geography of encounter. Moreover, these details can be cross-indexed (via space- and time-based stamps certainly, but also across different empirical categories, as shown in the shaded areas of Table 1).
Access	C, F, I, L, M, O, P, V	By essentially embedding with individuals in the natural milieu of their momentary activities, the observational scheme presents rather unprecedented access to human geography in applied settings.
Empiricism	C, F, I, L, M, O, P, V	The observational scheme is highly empirical, using qualitative categories, recognizers, and measurements.
Subjectivity	V	Although all of the data in the observational scheme are open to subjective interpretation, records of live video mean that that the scenes can be revisited through many different lenses as ground truth.
Methodology	C, F, I, L, M, O, P, V	The applied observation introduces a wide range of methods for studying NRT in pragmatic terms, using novel mixtures of coded ethnography (IPC), machine learning, geomatics (GPS, LiDAR), and signal processing (IMUs).
Translation	C, F, I, L, M, O, P, V	Each of the observation instruments and methods can be ported to new locations. Indeed, we applied our study widely across different locations in New York City. We also showed that the scheme can work on any video, including those taken from Online sources (Figure 5).
Process dynamics	C, I, L, M, P. V	Several of the observations can be time-stamped, so that process dynamics can be localized to snapshot instances of time (and space). Moreover, a number of the methods support streams of time to be studies, particularly via inertial measurement, LiDAR, and video.

5. Discussion

An obvious question that one might raise is, "What are some potential pathways that could be navigated around these ten traps?"

One approach may be to examine how scholars are addressing the limitations of representation in other allied disciplines. NRT is part of a broader movement within the social sciences and the humanities. NRT has synergies with (but is different to) the relation space idea of Social Network Analysis (SRN) [266] and Actor-Network Theory [267], which concentrate on the social structures yielded from human relationships. NRT might usefully adopt some of the methods from network approaches. Schemes for explaining social encounters using graph theory and related sociometrics, for example, are adept at representing social geographies (as geometries) without representation, chiefly by forgoing absolute (coordinate) spaces for relativistic spaces that can be assembled without formal prescriptions. The advantages of relativism in place of absolute representations are plentiful, for it allows (for example) for the withholding of a range of representative formalities: without the vast emptiness of coordinate planes, without the universality of fixed distances, without absolute demarcations of positive and negative valence, without strict process formalities of calculus or linear algebra, without presupposed logics of topology and its bounding influence, etc.

NRT focuses on people's experiential encounters with their surroundings, but the theory also has ample room to include social surroundings and how those encounters govern geography in the rhythms and motifs of daily life as stable practices [10]. The advantages of a social viewpoint include (1) connecting observers to objects in ways that transcend difficulties in distance-based representations [8] (p. 472) [268]; (2) eschewing static codi-

fication in favor of dynamic perspectives that can address fleeting geographies [250] and connections between space, time, and processes that can be missed in analysis with fixed categories [71] (p. 59); (3) embracing multiplicative perspectives that can describe how geography takes on different shapes in different places [133] (p. 102) [16]; and (4) moving geography away from some of the biased vistas that representation often invokes. Together, this establishes new threads of connection between theory, observation, and engagement, especially in helping to explain how encounters might reveal the grammars of geographic relationships [133] (p. 99, 104). This approach of considering NRT as grammars has some affinity with extant work in urban design and architecture. This includes work to advance Gibson's [115] ideas about environmental cognition, particularly its relevance to concepts of affordance and classification [269]. The descendants of these concepts are perhaps most well-articulated in the idea that space has a social logic [132,270]. (Grammars also have some touchpoints with literary geography [234], the large stock of insight that is available from early toponym research [271,272], as well as new approaches from AI that are centered on large language models [273].) However, even a grammar approach returns heavily (and inextricably in a circular fashion) back to classification. This is evident, for example, in the social logic of space approach from urban design, particularly its adherence to quantification around the axial line [274], and its reliance upon an assumption that the spatial substrate (in this case architecture and urban geography) is fixed, unmoving, and largely steadfast.

One way of reading NRT (we argue) is that it centers immersion as the scaffold for theory-building. Using an immersive perspective, one may arrive at synthesis through consideration of how people themselves produce (their own) human geography (as well as various 'up-scales' such as urban geography, social geography, behavioral geography, etc.) in the course of their moment-to-moment interactions. By immersion, we mean the faculties and circumstances by which people draw information through active and passive encounters with the geography that surrounds them, as well as the means by which they reason upon that information to develop a picture of themselves as situated in that geography. Within NRT, one might usefully consider immersion as a process that unfolds dynamically and with significant tempo, in fleeting moments underneath broader rhythms and motifs of encounter in everyday routines. In this way, immersion explains what Vannini [13] referred to as entanglement in human geography (p. 320), i.e., the messy and organic interplay that emerges in human geography relationships in the engaged experiences of encounter, rather than the representation and symbolism that those encounters could be (often arbitrarily) coded to. Within the early debate about NRT, Hinchliffe [7] proffered an argument that NRT could be usefully framed as "inhabitation" (p. 215). Sheller and Urry [73] also explicitly raised the possibility of immersion in discussing (briefly) that mobile geography could advance aspects of NRT through "copresent immersion" (p. 218) as a form of mobile ethnography. In many ways, immersion could be a useful glue to bind NRT to broader terms in human geography. For example, a viewpoint on NRT from the vantage of immersion could reinforce other longstanding theoretical arguments from human geography, particularly Tuan's [19,20] ideas about egocentric and allocentric relationships as forming through humanistic interpretations between people and place.

There is also perhaps significant potential to revisit the classic approaches of behavioral geography for paths around NRT's ten traps. In some ways, NRT could serve as a natural extension of cognitive maps and mental mapping research [32,109], but newly slanted toward uncovering small geographies of encounter as dynamic inputs to such maps [69,206,218]. This could potentially provide theoretical support for new ideas about the role of action maps [126] and behavioral regions [69] in a sequence of behavioral geography processes that lead from perception to cognition and action. By specifically tying immersion to information-acquisition and decision-making, it could be fruitful to tilt human geography toward empirical solutions to the ten traps we outlined, specifically aiming for explications that could be achieved with geographic information science, if and when prudent to do so.

It is also likely that significant new practical insight for NRT could be derived from continuing investigation into mobilities geography. The benefits of NRT have thus far privileged the value of tethering human geography to phenomena of movement and dynamics [75,275], both of which are purposeful in (1) matching theory to the fast-moving flux of human life and in (2) allying geography to other pan-social-science concepts (particularly the 'new mobilities paradigm' [73] and complexity theory [276]). These paired benefits have significant potential to render human geography more generalizable relative to adjacent fields of study (in psychology and social psychology, in particular) and more relatable to everyday practice. We see a third benefit of NRT in this vein: (3) in supporting fast-forming hypotheses that are required to match pace with the fast-moving troves of data that now swamp research on geographical phenomena [277], particularly those that become available as by-products of the Internet of Things (IoT) and the Wireless Edge (Wi-Edge) [31,34,148]. Streaming data present a relatively unrealized potential for NRT to bring human geography to parity with emerging developments in location-aware computing and engineering [37], during a period in which there is growing concern about the role that surveillance and algorithmic decision-making play in determining who has access to encounters, and where [149,162].

Finally, we posit that NRT might usefully look to work in computer science for ways to traverse the ten traps, particularly via the innovations that are increasingly available from developments in behaviorally-focused AI [206]. Some significant work in human-centered computing and affective computing [278] has developed around a thesis that our understanding of the world as we encounter it proceeds, not through the traditional pipeline of perception → meaning → action, but rather that routine actions already exist, *as meaning*, in the world. These meanings may have built-up through our experience with encounters [12] (pp. 107–108), particularly through mechanisms such as embodiment [59,177,279]. The idea that cognition is physically grounded (through situated cognition [280]) is an important component in explaining embodiment [12,279] (p. 186). This, then, suggests a very different process dynamic at play underneath the blanket of human geography with implications, for example, for how we approach models of spatial behavior or even concept-based theories. One might also consider Schutz's [164] work on inter-subjectivity, which poses the conundrum of considering how we develop shared (social) meaning when our experiences are singular [12] (p. 110–111). Schutz's [164] solution was to regard how people resolve intersubjectivity "routinely . . . in the course of their action and interaction" [12] (p. 111), framed within the milieu of causes, goals, motivations, and requirements [12] (p. 112). Similarly, in AI researchers are realizing that "explicit representations and models of the world simply get in the way" [281] (p. 97). As a component of AI, cognition has traditionally been approached through the sense–model–plan–act (SMPA) framework [282], which has some limitations when faced with dynamic environments. This is leading to research into alternative forms of building cognitive processes, including 'enactive AI' [283] based on autonomy and adaptivity. Indeed, much of this computing-based work has strong analogies to the performance-based foundations from which NRT originally came into being. It would seem, therefore, that NRT could help to ground a new 'artificial turn' in geography to both theory and to practice.

6. Conclusions

Non-Representational Theory (NRT) has thus far in its development largely intended to facilitate an important investigative departure for theory-building and conceptualization within human geography: a shift in thinking, away from traditionally representational forms of inquiry that consider space as a substrate that is relatively hard-fastened and containerized [6]. Alternatively, NRT charts a different path for scholarship in human geography by examining the ways in which human geography shapes our moment-by-moment existence in the world (the so-termed act of 'being-in') [12] (p. 107). Further, NRT occupies itself with uncovering how that shaping influences development of our (individual and shared) geographic understanding. Much of the existing scholarship that underpins NRT

has been conceptual and even philosophical. Nevertheless, by concerning itself with tangible encounters in quotidian contexts, NRT is intricately bound to pragmatic applications.

In this paper, we have reviewed the concept of NRT with particular attention to its trajectories for use in applied human geography. We regard this scrutiny as important at the current stage of development of the theory, as NRT is moving beyond its roots in philosophy and enjoying more practical consideration. Pragmatic engagement of NRT with the realities of geographic life is where the theory encounters some friction with operational concerns and with tangible research contexts. Several opportunities for connections between geographic NRT and allied theories in social science, the humanities, and even in computer science are also likely to take hold with most ease in practical applications, and so issues of how NRT is practiced in tangible contexts takes on currency. All the while, we are acutely aware that there is still much to be gained from considering NRT purely as a conceptual vehicle, or even in remaining purely within philosophical bounds.

Although there are likely others to be brought into consideration, we have argued for ten traps of non-representation that create possible frailties in practical applications of NRT. We postulate that an initial umbrella regard for conundrums of small geography serves as an impetus for nine additional traps. We have also shown an observational survey instrument that can collect data specifically for small geographies of encounter by relying on wearable location-aware technology and first-person video to build embodied vistas on everyday scenes. In part, NRT's emphasis on small geographies of the fine and of the fleeting can position the theory at odds with many traditional synoptic approaches to human geography. Even when human geography has been holistic in its view (in transport geography, in social geography, in urban geography, for example), it has usually traced its explanation through a top-down (macro-to-micro) passageway through the scale chain of inquiry and explanation. NRT, alternatively, involves vistas that are often micro-to-micro in explanatory direction, which is to say that the concerns of NRT may not even (necessarily or needfully) reach beyond the confines of the small. The initial trap of small geography, we contend, sets the stage for nine related traps: circularity in representation, cognitive traps, challenges in dealing with detail, issues in access to the atoms of NRT such as individuals and encounters, the difficulty of empiricism for many humanistic themes in NRT, all too often intrinsic dilemmas of subjectivity, methodological hurdles, complications in translation, and the pervasive slipperiness of process dynamics. Tackling these traps, as a next frontier of NRT, could be a very worthy pursuit for geography. Indeed, there is much to be accomplished in considering how NRT can glissade and sashay at the traps that it encounters. After all, if geographies of dancing and performance can find common ground with the science of computing, these are surely topics worth pursuing as we look to ground our growing understanding of everyday encounters to its foundations in geography.

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