Mindcrafting: The semantic characteristics of spontaneous names generated as an aid to cognitive mapping and the navigation of simulated environments

ABSTRACT

Background: This study explores the extent to which names are formed to serve the development of mental maps to enable efficient navigation of unfamiliar terrain, conducted within a simulated landscape.

Purpose: The primary aim of this study was to examine the semantic properties of spontaneous naming systems, and investigate their potential waypointing influence in personal route mapping.

Method: Participants were tasked with the exploration of a closed-environment in MINECRAFT to find a designated goal, and return to the starting point in as short a time as possible, verbalizing their active thought process throughout. All instances of names were recorded.

Results: The 12 participants created 61 names across 13 distinct sites. The environment had not been cultivated to predispose these points to be of interest, allowing a dedicated discussion of the factors that influence or are complemented by name-derived semantics. A strong negative correlation (-0.88) was found between the number of names generated and speed of task completion, which was calculated to be significant.

Conclusion: Name development is shown to play a role in efficient cognitive mapping, with consistent semantic developmental patterns identifiable, formed equally around interpreted poetics of a space and the observable physical form.

BODY

INTRODUCTION:

The field of cognitive mapping has seen a consistently high level of critical attention since it's conceptual introduction by Tolman (1948), but very little has been done that incorporates the use of onomastics – systems of naming – as an identificatory factor that potentially facilitates the underpinning routines of the process. Work by Chadwick, Jolly, Amos, and Hassabis (2015) examining the biological basis of goal-direction representations underlying mental map formation, made use of a simple virtual environment in their experiments, but a notable omission of their work was any investigation into environmental interaction and interpretation. Names are a specialized linguistic branch that serve a practical role in cognitive interpretation of the surrounding world, be it people, place, or object-based, whose function in the development of complex mapping techniques has not seen any critical attention. This investigation is intended to serve as a preliminary step in highlighting the functional role of names in cognitive map formation and encourage the adoption of onomastic consideration in future research in the field. As a preliminary investigation in unifying the two fields, this paper will highlight a number of questions relating to the manners by which humans label their immediate environment to their identificatory benefit. The paper will also exemplify the benefits that easily modifiable videogame-rendered environments can offer in advancing clinical studies of this nature.

Names serve as a major component in providing unique and identifiable markers to the entity they denote, with place-names typically bearing some degree of relation with a recognizable characteristic of the locations, whether this is readily apparent from a perceptible feature of the terrain, or a uniquely formed association for the individual namer. Even highly generic names can functionally render a specific site distinct from its immediate surroundings, and provide a denoted point against which references may be anchored; the most valuable of which – for the remit of this study – is an aid to establishing relational networks that serve as waypoints within the cognitive maps generated for a environment.

The sociolinguistic work of Gelling and Cole (1978), which discussed the origins of place-names as bearing highly functional roles, parallels the hypotheses of this investigation. They proposed that both specific and generic elements were comprised chiefly of cues derived from observable physical characteristics of any topological feature in order to assist travel, with specialized subsets covering minuscule differences in the terrain. Two hill-based generics from Whaley (2006) provide an example of the rich detail found in the historical linguistic component of name studies, where dodd is used to refer to 'a compact, rounded summit' and haugr or how(e) which is 'characteristically compact and free-standing, with relatively steep, roughly round or oval, contours); the modern traveler would not be able to match a name with the form, but to those familiar with original linguistic forms, distinction between the two groups would be readily discernible. Given this relationship between language, form, and function, cognitive mapping techniques may arguably derive from an underlying psychological predilection to labeling immediate environments. What Gelling terms 'signposts to the past', for their historical linguistic functionality, may be adapted to show that names can serve as a literal signpost with generative value assigned within an isolated environmental context to assist interpretation and provide descriptive elements to key anchor points within an area. A related concept has been examined by Skiles and Howarth (2012), discussing the use of symbolic representations of terrain, but their study omitted any mention the hermeneutic psychosocial association held by names, which is the subject of this study.

The seminal works of Gould and White (1986), Gordon and Jupp (1989), Portugali (1996), and Gillner & Mallot (1998) demonstrate the typical focus of scientific investigation in the area of cognitive mapping: specifically, the assessment of bearing, approximate distancing, influence of disorientation, and perceptual focus – measured across a range of experimental scenarios. Similar work has been carried out with virtual video game environments (Richardson, Powers & Bouquet, 2011; Frey, Hartig, Ketzel, Zinkernagel, Moosbrugger, 1998), and whilst these studies examine waypoint cognition and identification of correct routes, they do not engage with the process of focal loci delineation. Although these investigations offer fundamental insights into the process of environmental interaction, their omission of names as a component in the adaptation and adoption of features into mental models is a consistent and notable shortcoming. Naming may be proposed as an intrinsic component of environmental interpretation, in turn leading to their being a key aspect in cognitive map formation.

Cognitive maps provide a meeting-point between the actual (quantitative), and the perceived (qualitative) in environmental perception and tagging. Names have likewise been presented as a combination of science and art (Ashley, 1989), spanning the real, the fictional, and even the ontological bridge between the two, but with a consistent focus on spatial interpretation. The journals *Names* and *Onoma* highlight the extensive social ramifications of naming practices, covering the historical, the literary, and the psychosocial fields. They have been identified as an integral to the wider field of neogeographical studies: ‘people using and creating their own maps, on their own terms and by combining elements of an existing toolset’ (Turner, 2006: 3). The same definition may be applied to the process of mental map formation, as individuals develop their personal environmental referential frame according to their own interpretative perspective. The lack of dedicated work to the applied formative process of name generation in assisting navigation within an isolated context, or the characteristics that inform the semantic build of such spontaneous elements – effectively the applied processes of proprialisation – is a major omission in the field, that this study is the first step in addressing.

The concept of ‘route perspective’ was proposed by Ferguson and Hegarty (1994: 456) in their analysis of mental map formation from significant points in literary texts, highlighted as being consistently formed from an egocentric perspective – in that such sites were chosen as they bore (a directed) significance to the reader. The principal suggestion of this paper held that the sequential processing of key points in a fictional description of a setting contributes to a logical ordering in the memory of the reader, as they are encountered, rather than the relative placement to one another. Interpretation of the landscape is necessarily guided by the environmental detail provided by the context of the medium, but a higher level of accuracy was found in participants recreating these environments in the order by which they were experienced (building on Levinson, 2003). The conclusions of this research suggest that the traversal of any environment follows a pattern of establishing key anchor points to construct a representative model of the most pertinent aspects of the environment. This paper proposes to investigate the extent to which these representative details are adopted into, and expressed through, onymic form within cognitive maps.

Clarity, concision, and referential uniqueness are three integral factors underpinning both route model formation and functional onymic marking; but as personal models of environment are not typically communicated to external users, the names chosen for focal loci are not required to be readily identifiable to anyone other than the individual denoter. The manners of adoption for third-party comprehension provide ample opportunity for further research in this field, but this investigation is designed to demonstrate the ratio of external (derived from topographic form) to internal (based on personal interpretation) within the parameters of personal navigation.

The experimental task underpinning this research was designed to examine the extent to which individuals identify, tag (name), and later reference particular features, to assist in their navigating a novel and unfamiliar area. This task builds on the work of Frey *et al*. (2007), Mark *et al*. (1999), and Kuhn (2013), but with a targeted focus on the semantic build of the names created and used to assist navigation.

The use of a simulated environment was chosen for ease of access and assessment, in addition to providing a convenient source of unfamiliar territory that could not have been encountered prior to the experiment. Player-environment experience may be directed at every level, with limited internal confounding factors (such as music, wind direction, olfactory cues, etc), with a limited number of consistent in-game visual stimuli (e.g. torch flickering, but even the use of non-fluctuating light sources may direct focal attention) and set soundscapes (e.g. running water), providing the only non-landscape aspects for design consideration.

No analogous research has been conducted in either the field of cognitive linguistics nor, as previously noted, in that of mental map modeling – allowing this investigation to introduce an intermediary concept that unites the two.

This investigation is built around four primary hypotheses: 1) That naming is a component of cognitive map development. 2) That topographical distinction at the micro level (within immediate surrounding) will be chosen as focal loci and be assigned a unique name rather than wider frames of reference. 3) The names chosen will possess close semantic links with the site, bearing reference to the loci feature (topographic generics) and distinct discernible characteristics (specific elements) in equal measure. 4) The personal and temporary nature of the task (and cognitive map formation) will result in a selection of name semantics derived entirely from interpretations of perceived qualities of the location or that describe a notable experience at the site.

DESIGN:

Participants were tasked with navigating a pre-designed subterranean virtual environment within the videogame software *MINECRAFT: XBOX ONE EDITION* to find a specific resource that had been planted within a set area; the software was run through the named console and a standard controller. This title procedurally generates a landscape, through the use of biomes (distinct areas that are self-contained environments, such as swampland, savannah, taiga, arctic woodland, jungle, stone beach, etc), each randomly composed of various geographical features and flora. The topographical structure is unique for every chunk of landscape created as a player explores the world. All in-game assets are rendered through uniformly sized and patterned blocks (each representing a five ft^3 area), providing a standardized appearance of low-level sprite detail; slight foliage color variation (spanning three different shades) is the only aesthetic variable. World generation is conducted through the random construction of standalone ‘chunks’ beneath the open landscape, riddled with caves, tunnels, abandoned mines or strongholds, and mineral ores that provide the required components to construct increasingly stronger in-game items.

The low-fi graphic design is a purposeful design consideration for the software, which provides an ideal platform for psychological experimentation (following on from the conclusions of Frey et al., 2007). As background stimuli detail is kept artificially low throughout the software, this was deemed an attribute that may encourage an increased focus on the topographic structure and material shifts would be readily apparent. The generated worlds do not contain any superfluous background animations, overarching music and sound effects can be disabled, and the entire experience for the participants may be precisely tailored to experimental parameters, whilst providing a immersive simulated environment that is not so far removed from reality as to be an abstracted representation. Previous research using the software has commented on the popularity of the software as an educational resource as a stark contrast to its relative underuse as a research asset (Nebel, Schneider, Schledjewski and Rey, 2016); the ease of shaping environments at any scale, without requiring any coding experience, makes MINECRAFT an unparalleled experimental tool for work in fields related to this study.

The console version was chosen for the native adapted control scheme that did not require custom keyboard mapping, and corresponded with onscreen guides.

The specific resource had been planted at the bottom-most point of the cultivated map – a patch of six Diamond blocks elevated from the ground and highlighted by distinctly colored light-emitting markers. All participants were informed that the lower the levels they explored, the more likely they would find their target, and the metric under assessment was the time taken to find the resource and return to the surface. The true purpose of the experiment was revealed after the task had been completed.

The cultivated map was comprised of a closed-loop subterranean route that contained a combination of abandoned mines, tunnels, cave systems, and manually excavated connection points, that contained a total 36 dead ends, and 72 side trails that intersected cave areas of varying size. The map was a closed maze system, containing a single shared entrance and exit point to the surface (the starting point and target), designed so that common solution strategies (e.g. the ‘left-hand solution’) would not work. The terrain was non-fantastic: i.e. features and environment type blended into one another in a natural manner, all routes were reachable without modifying the environment, maneuverability was entirely traditional forms of movement (such as jumping across chasms or waterways on a series of stepping stones), and there was no danger presented throughout the exploration. The 'peaceful mode' of the game was engaged in order to remove any form of threat from the experience.

Participants were instructed not to physically alter the environment, even through the placement of a single light source. These were already placed throughout the complex, randomly distributed on surface direction – with the sole exception of a series purposefully planted to illuminate the premise target. There were no identifiable or consistent markers to indicate a specific route, correct or erroneous, through any aspect of the labyrinthine environment.

Participants were instructed to verbalize their thought processes upon both the initial exploration phase and – most importantly – on the return journey to the surface, as they explored the environment. The results were collected as the task was carried out, with all pertinent terms (onyms and adjective-derived descriptions) uttered during the course of the experiments recorded; the latter descriptions were discarded from the dataset after it had been compiled. After confirming that the participants understood this process, there was no further interruption or assistance from the investigator, who was seated 1 meter away from the participant outside of immediate view, to mitigate potential unconscious cues. The potential for a negative observer effects due to the presence of the researcher must be acknowledged, but all participants confirmed their comfort and none noted it as an issue during debrief. As they were recruited from a social group dedicated to tabletop gaming, involving roleplay and energized discussion ‘in character’, the potential for group bias regarding comfort and ability to verbalize actions and thoughts in the presence of the researcher is possible, but the limitations of this study prevented wider recruitment. Additional work conducted in this field with a wider population could be easily adapted to address these potential issues.

Participants were told to keep their focus on the screen unless any discomfort was experienced, of which there were no occurrences. The monitor was placed against a blank wall, with no other objects or decoration within immediate view. Once each trial had finished, the participant was informed of the true focus of the investigation, which did not reveal any unarticulated naming systems to have been in operation, as each confirmed full and true adherence to the verbalization component of the task. Nor were any other potentially confounding strategies declared during the debrief phases.

There was no reward impetus given for completion of the task (quickly or otherwise), other than believing they were contributing to a survey in determining effective elements underpinning interesting game level design. This was a plausible output, related to the research but sufficiently separated to avoid potentially influencing responses.

PARTICIPANTS:

Due to the limited nature of this investigation only 12 participants were invited to take part. They were all recruited personally through the University of Glasgow Gaming Society (GUGS), and were a representatively chosen combination of students and former-students, with primary academic disciplines divided evenly between Arts, Social Sciences, and Engineering. The researcher had been a member of the group for several years, but had no level of prior acquaintanceship with any of the participants (with the group having over a hundred members, all forming smaller groups that gamed together over a period), to minimize any potential bias that could be introduced from this pool of candidates. Group officials introduced the study, and provided the contact information for both researcher and their affiliated departments of linguistics and psychology. All were under 26 years of age, had experience with a variety of videogames, including MINECRAFT, and were familiar with the particular layout of the Xbox 360 controller (the model being a popular accessory for PC gaming). Physical or personally-identified sex was not a determining factor, nor recorded as part of the data, but the group comprised the following ratio (physical basis): *m*-8, *f*-4.

No alternative control schemes were offered (or available for the platform), but this is unlikely to have had any impact on either task or data generation (Peterson, Wells, Furness & Hunt, 1998). None of the participants were briefed as to the true intent of the study prior to its undertaking, and signed permission was granted by each. All were debriefed after their involvement, and agreed not to disclose any details until the study had been completed.

RESULTS:

A total of sixty-one items that could be considered proper nouns were provided across the twelve runs, which clustered around fifteen specific areas encountered by participants. Eight of these names comprised a definitive form (having been assigned a prefix of 'the'), and the participants who used these forms were spread evenly across the three academic backgrounds (arts: 3, sciences: 2, engineering: 3).

Graph 1: Average navigation time measured against number of names formed.

The quickest run-through (descent to find the diamond patch and return to the surface dwelling) was 7:22 – making use of seven distinct onyms) from an engineering background, and the slowest took 16:50 (with three names) possessing an arts background. The average time taken was 11:56, assisted by five created names.

A Pearson product-moment correlation coefficient was computed to assess the relationship between trial time (in seconds) and number of names generated, which showed a strong significant negative correlation between the two variables [$r=-0.88$, $n=12$, $p= 0.001$].

Neither the number of erroneous paths chosen during the return navigation, nor the time taken to identify and self-correct, were recorded.

DISCUSSION:

The data, despite its limitations, supports all four hypotheses made for this preliminary investigation in combining cognitive fields:

1) Names consistently featured across participants, providing an observable assistance to applied navigational recall of a subterranean environmental-centric mental map.

2) The thirteen sites consistently chosen by the participants were distinct (described in the Appendix) which supports the suggestion that sites of interest are not arbitrary or based on panoramic interpretation but a focused attention to detail that provides immediate distinction.

3) The names were balanced in their reference between the topographic generic and the specific of the distinctive element.

4) Personal semantic interpretation is evident across the names ascribed to each of the focal sites, derived from both perceived characteristics and notable participant experience during the course of the trial.

That a small selection of distinct locations appeared across all the participants (see Appendix for description and onymic range) supports the initial of common environmental delineation at the micro level – as the term suggests, focal loci do appear to be sites where perception can be focused. All the features held at least one reference to personal interpretation of the topography to external associational objects – as opposed to being assigned a name based entirely on the physical characteristics, providing sufficient data to qualify the tertiary hypothesis. Given the purposeful textural consistency and lack of detail, interpretative development was expected in the temporary naming schemes that would enhance the individuality of the focal sites through the addition of semantic characteristics. The even use of semantic exaggeration (e.g. referring to a single patch of dirt as a ‘farm’), amelioration (e.g. identifying patterns in ore clusters), and of basing names on personal association with presumed characteristics (e.g. *Creepy Point*) supports the fourth hypothesis.

The limited scope of this trial precludes the definitive claim that the use of names is a direct causal variable to faster navigation times or higher accuracy of spatial cognitive mapping; but the data demonstrates that this is a viable area for further work in itself, and worthy of greater consideration in related research.

The use of the definitive form in seventeen names is indicative of the importance of perceived distinctiveness in using such sites as loci points for navigation. There were very few onymic references to Cartesian direction (restricted to *Upper Pond* and *Lower Pond*; with *Iron Heights* and *Copper Drop* both referring to the perceived physical property of a single loci site as opposed to a navigable direction. This may suggest that the name forms preferred for use in mapping tasks favor distinction over relational reference. It was anticipated that innocuous features could serve as functional markers when taken as an isolated unit outside of the immediate surroundings, and this was seen in the use of otherwise common features within the environment as focal loci within the task.

The attribution of names to a large waterfall encountered by the majority of participants was of particular interest, as it was expected that the physical property would be the dominant means of identification (which would provide a simple form of reference), but it was instead a series of related aspects that provided the semantic association. This might be explained through the participants expecting to encounter other instances of this feature, and instead of adopting a naming system that could confuse similar topography focus was made on uniquely identifiable aspects (such as the size of the pool at the bottom (*Wee Pool* – 'wee' being a colloquial Scottish term for 'small' - and *The Puddle*), the presence of grass (*Strangler Drop*, *Reed Bay*), the means of traversing around the feature (*Sheer Steps*, *The Climbing Wall*), or on one occasion the presence of collectable bones and weapons that resulted from an errant generation process during the loading of the program leading to the assignation of *Sacrifice Lake*. These items did not despawn during the course of the experiment, and so provided the unique identifying element that allowed the participant to create an associative property for that location.

Two names, *Leg-Breaker* and *Dead Drop*, were formed from a notable instance happening on one site, accentuated through an appropriate sound, when the participant fell from a ledge whilst trying to ascertain a safe route down. Under normal gameplay settings a fall of this distance would kill the player's avatar, but within the remit of this task – where there was no penalty – the notable incident created an episodic connection with the site, that was semantically defined through a personal interpretation of an associational cue.

One site of curious semantic development was the largest cluster of mushrooms within the environment that was given two names associated with purposeful cultivation: *Cave Farm* and *Fungi Field*, the latter providing one of only four examples of alliteration within the data. The use of *Cabbage Patch* to denote a different site comprising two lines of dirt follows this concept. Another loci which saw particular creative semantic interpretation was a stone block surrounded by grass, in a chamber containing several other stones (of various heights) and a number of scattered tufts – but no others surrounded as this feature was. As seen with *Reed Bay*, the grass was transposed by way of semantic affiliation into a form related to its appearance with *Weedy Stone* and *The Overgrowth*. One name assigned the site was notably creative in its interpretation, derived from this same sense: *Natures Altar*. This name is a strong example of the entries formed entirely from semantic cues that demonstrate the use of these associational forms for temporary personal navigation that does not require anchoring to actual topographic form.

The inclusion of different types of ore in *MINECRAFT* – intended as a primary resource explored for within the core game and dispersed randomly, like all other aspects of the environment – presents alternative (non-structural topographic) aspects for consideration. These features are embedded within the environment rendering their role within the terrain (within the parameters of this task) as ornamental, in that they are observable but do not require player action to move around. The semantic assignation of patterns identified in their layout provides valuable evidence for the role of personally perceived associative values in environmental labeling, and their prominence in the data set demonstrates an equal importance to physical features.

The named entities did not flow readily from one into another, but were instead scattered across the terrain. This could provide the basis for additional study into the relative distance between these loci that appear to serve as a form of triangulation – which would build directly on the work of Gordon and Jupp (1989). The purposeful design of the experimental area included the formation of a number of passageways that ran counter to the expected route (i.e. a passage might head up for a number of blocks before a rapid descent), but none of these reversed-cambered paths were named.

Feature 6 (a winding S-shaped passage) was assigned four names based on its unusual path, suggesting the degree of interaction as a potential factor for non-observationally based loci.

The high ratio of water-based features given a name was or particular interest, with two potential psychological explanations. The first possibility could be an innate human connection with the medium that directs a perceptual bias (tangentially examined by Herzog, 1985), even in a simulated environment. An alternative explanation could be the default in-game animation effects where water blocks constantly shimmer, even standing bodies in poor lighting conditions, and in an otherwise static environment this could prove sufficiently noteworthy to draw focus, attention, and correspondingly predispose such sites as focal loci. Water was not present in every cavern, but modifying the environment to standardize its presence with a disjointed series of waterways (sufficiently broken up so as not to provide a navigable path) would mitigate this potential factor in future environmental design.

The use of *MINECRAFT* as an experimental medium presented an ideal environmental distillation for this study – consistency and lack of specific detailing to denote individual blocks within the same material, limiting semantic denotation to perceived and inferential values alone. A further strength of the easily modifiable software is the ability to alter the block skins through different ‘themes’ (sets of alternative meshes, color schemes, and designs), which would allow work on the potential impact these superficial aspects have in providing semantic cues to participants. Although the game presents a fantastic setting, there were no elements within the confines of the task area that would it as such, in order to avoid any bias from reality-breaking observations that might influence engagement. All of the participants held prior experience with videogames, which may have contributed to a heightened level of comfort at navigating and interacting with the virtual environment not representative of the general population for the specific task. Although this is not beieved to have had any impact on the specialized components of cognitive processing – the focus of this proof-of-concept experimental investigation – a broader population chosen on this basis would assist in demonstrating any bias such familiarity could have introduced to the task.

A broader experimental group with variable levels of experience with virtual environments would allow for more detailed assessment of focal loci, in addition to allowing a detailed semantic assessment across groups not familiar to fantastic description. Recent commercial developments in mass-market virtual reality (VR) gaming to provide a fully-immersive experience could also be of use through an increased immersion within the virtual world (Fominykh *et al.*, 2014), potentially providing a higher level of environmental engagement and closer reading of surroundings.

Immediate adaptation of the task to explore the functional and formational semantics of temporary naming may be made through two slight alterations: changing the focus of the task in order to have participants direct another through the labyrinth, in order to assess how their chosen names or descriptions are adapted towards more generic forms, or whether levels of explanation are offered. The work of Garrod *et al*. (2007) investigates a parallel concept of graphical systems for symbolic representation that is directly comparable to the conceptual arguments raised by this experimental task. Following the work of Nebel, Schneider, Schledjewski and Rey (2016), additional modification of this experimental design could replace the set task with a goal-free environmental exploration component using the open-ended surface layer. Such work would facilitate an assessment of the extent to which the significant difference they note in cognitive load translated to efficient processing and modeling of mental maps.

Participants were not recorded, but transcriptions would benefit further work on conscious navigatory thought-processes. Such records could reveal additional linguistic characteristics concerning site exploration and focus of attention underpinning the development of a spatial reference framework as focal loci are discovered and selected for onymic attribution. Furthermore, ERP monitoring and eye tracking data could be incorporated to measure relationships between environment scanning, identification of suitable loci, and later recognition/utilization of these points, further building on the findings of Zeidman and Maguire (2016). Such work would also tie the semantic development into the work of Proverio *et al*. (2001) who identified a significant distinction in the neurological response of places referenced through a proper name, which they proposed as being due to the location names used in their trials being integrated within episodic memory. The personal assignation of names seen throughout the task set by this investigation would allow a more detailed examination of the extent to which following cognitive maps shifts between proper and common spatial node activation geocentrically relative to the focal loci.

CONCLUSION:

This investigation was designed to examine the semantic characteristics personal naming strategies formed for mental map models, as well as test the viability of environmental-focused software as a experimental toolset in the field, and the evidence gathered supports both hypotheses and methodology. Despite the limited nature of the participatory group, the functional identificatory semantics were consistent, and a correlation was observed in the use of names resulting in more efficient navigational task completion. The dataset is not sufficiently broad to claim onymic generation as an essential component of cognitive mapping, but it provides evidence for the further exploration of the role of naming in the field. This study is demonstrative of the amalgamated natures of artistic, linguistic, and psychological components that underpin applied proprialisation, as well as exploring the motivation behind semantic identification beyond appellative form.

Despite the widely varied research conducted in related areas of both cognitive mapping and semantic form ationof environmental names, none has hitherto specifically examined the role of procedural naming in providing an applied bridging point between these two fields. This paper has demonstrated that names do serve a functional role for cognitive navigational assistance through holding meaningful semantic content that accentuates perceived qualities of noteworthy sites within spatial networks.

APPENDIX:

As noted under the Results section, the onyms recorded in the descriptive utterances were attributable to thirteen unique topographic features. The full list of names recorded, along with a brief description of their applied area, is provided below:

Feature 1: Two parallel lines of bare dirt in an otherwise stone-lined cavern.

Names: *Dirt Grove*, *Cabbage Patch*, *The Graves*.

Feature 2: A cluster of 9 wild mushrooms along one wall of a stone-lined cavern.
Names: *Shroom Haven, The Growths*, *Cave Farm*, *Damp Patch*, *Fungi Field*, *The Patch*.

Feature 3: Large waterfall with easily identifiable steps of blocks arranged down both sides to allow a safe ascent or descent.
Names: *The Plunge*, *Well Spring*, *Sheer Steps*, *Wide Falls*, *Wee Pool*, *The Puddle*, *Sacrifice Lake*, *Dead Drop*, *Leg Breaker*, *The Climbing Wall*, *Upper Pond*.

Feature 4: Smaller waterfall with a shallow pool lined with reeds at its base, bearing no readily apparent navigable path.
Names: *Streamy Fall, Weed Lake*, *Strangler Drop*, *Reed Bay*, *Lower Pond*.

Feature 5: A short passage filled with a series of large spider webs.
Names: *Dead Shaft*, *Web Central*, *Spider Nest*, *Spider Tunnel*, *Hell-Way*, *Creepy Point*, *The Crawly Space*, *Shady Passage*.

Feature 6: A winding passage (S-shaped).

Names: *The Nick-Knot*, *Kink Corner*, *Double-Corner, The Twist*.

Feature 7: Two separate standalone chests found in adjoining passageways, one directly under a torch, one next to a small pool of water.

Names: *Bright Box, X*, *Dark Chest*, *Damp Chest*, *The Sodden Box*.

Feature 8: A single stone block surrounded by grass blocks, in a cavern with multiple exits containing several such blocks scattered across the floor.

Names: *Lone Patch*, *The Tufts*, *Weedy Stone*, *Natures Altar*, *The Overgrowth*.

Feature 9: Long vertical patch of iron ore embedded within the wall of a tall stone cavern.

Names: *Copper Drop*, *Iron Heights*.

Feature 10: A fragmented patch of coal ore embedded within the floor of a small otherwise non-descript cavern.

Names: *Patches*, *The Chess-board*, *The Kitchen Tiles*.

Feature 11: A patch of emerald ore within the corner of a small cavern, roughly circular in shape.

Names: *Cat's Eye*, *Green Point*, *The Bullseye*.

Feature 12: A small cavern spotted with occasional blocks of gold ore.

Names: *Golden Hall*, *The Riches*.

Feature 13: A passageway that circled around on itself, with no vertical shift.

Names: *Hadron*, *Helter Skelter*, *The Loop*, *The Doughnut*.

Table 1: Semantic premise for onymic form.

The data demonstrates a high level of semantic extrapolation, whereby the focal loci are personalised through associational attributions (the semantic content) that sets them apart from visually similar (if not identical) features found at other sites within the cultivated environment. All of the names generated possess descriptive qualities of the physical form, but vary significantly in the level of personal interpretative semantics brought into the navigation scheme by the participant (i.e. the divergence from an entirely physical description of the topography).

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This research was approved by the ethics committee of the author's former institution (at the time of the experiment being conducted).

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