

Original Article

The Anthropology of Cognitive Ecologies at the Margins: Understanding How Peripheral Worlds Produce Distinct Forms of Intelligence

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ABSTRACT: *This study examines how environments of social, economic, and spatial marginality shape distinctive forms of cognition and modes of intelligent action. While anthropological research has long explored knowledge, adaptation, and learning in diverse contexts, limited attention has been given to the ways in which peripheral settings characterised by precarity, instability, and irregular access to institutional infrastructures generate specific cognitive ecologies. These environments often demand improvisation, distributed problem-solving, flexible collaboration, and heightened sensitivity to uncertainty. Based on theories of distributed cognition, ecological anthropology, relational ontologies and complexity, this work investigates how intelligence arises through complex interactions among individuals, collectives, material conditions, and local cosmologies. It is not explicitly focused on informal urban settlements, borderland communities or mobile, displaced populations, yet it highlights everyday practices grounded in these groups. By analysing how people think, decide, and innovate under conditions of constraint, the research seeks to broaden anthropological understandings of cognition and contribute to a more inclusive account of human intelligence across diverse lifeworlds.*

KEYWORDS: *Anthropology of Cognition, Cognitive Ecologies, Marginality, Distributed Intelligence, Uncertainty, Adaptation, Relational Ontologies, Informal Urbanism, Ecological Anthropology, Complexity.*

1. INTRODUCTION

Anthropology has long examined how humans interpret, organise, and respond to their environments. Earlier models emphasised symbolic classifications and cultural models as central to cognitive life (e.g., Phillips & Moser, 2024; Geertz, 1973; Goodenough, 1971). Subsequently, this position was developed further to the view that cognition is influenced by ways of organising ecological, social and material arrangements (Overmann & Malafouris, 2018; Hutchins, 1995; Ingold, 2000). As a result, these changes prompted anthropologists to look beyond brains and their owners and instead consider how thought and action are distributed among people, practices, and environments (Clark & Chalmers, 1998; Lave, 1988).

However, even with this big advance, anthropological research has devoted less energy to the ways cognition happens in contexts of chronic instability, weak institutional infrastructures, and social or spatial exclusion. Populations that almost reside their daily life in marginal settings, be it informal urban settlements (Simone, 2004; Neuwirth, 2016), borderland communities (Tpkunaga, 2016; Donnan & Wilson, 1999), displaced or mobile groups (Schiller, 2021; Malkki, 1995) or societies on the margins of political and economic systems (Ferguson, 1999; Mbembe, 2001). Such environments frequently call for individuals and collectivities to act under conditions of uncertainty, to resist solutions in order to improvise responses, and mobilise types of local knowledge that have not mostly been written into formal institutional or scientific registers.

This paper approaches marginality not as a situation of deficiency but as a context for the emergence of certain kinds of cognitive practice. It is/cognitive ecologies/: a theoretical framework to engage with these processes. Cognitive ecology research shows that cognition emerges from the interaction between people, tools, spatial arrangements, technologies and shared cultural repertoires (Moleka, 2025a; Hollan et al., 2012; Kirsh, 2010; Hutchins et al., 2010). Where access to reliable resources is neither guaranteed nor foreseeable, the interactions often acquire features distinct from what might be found in stricter institutional contexts.

These configurations form us as much through practices of improvisation, adaptive coordination, distributed problem-solving, and situated knowledge (de Certeau 1984; Sennett 2012). This shows how people and groups grapple with the ambiguous, fluid conditions by reasoning that is adaptive, communal, and situated. Doing so requires some sensitivity not just to cognitive processes but also, as Ingold (2011) and Strathern (2020) have argued in different ways, to the socioecological contexts that are contoured by such practices.

So this body of work aims to analyse how the relatively marginal conditions of what might be called non-standard cognitive ecologies interact with neurodevelopment to produce particular kinds of intelligences. Through the exploration of common-

sense reasoning and action in these contexts, it will enter debates on knowledge, adaptation, relationality anthropological ones surrounding the interweavings of cognition and environment. It aims to contribute to a more inclusive account of human cognitive diversity and to expand the analytical range through which anthropology understands the conditions under which people think, decide, and innovate in the contemporary world.

2. LITERATURE REVIEW

Anthropological research on cognition has evolved through a series of paradigmatic changes from symbolic to representational models, and eventually toward relational or ecological perspectives. The importance of cultural schemas and interpretive systems as sources of collective meaning was a popular framework in early anthropological approaches (e.g., Geertz 1973; Goodenough 1971). These pieces laid the groundwork for an understanding of cognition as culturally situated and symbolically mediated. However, their attention to internalised cultural knowledge tended to view people as carriers of static cognitive structures rather than actors in socio-material worlds.

The second shift came with the development of practice theory and ecological anthropology. E.g., Lave (1988), Ingold (2000), de Certeau (1984) showed that knowledge does not exist outside of everyday activities, embodied practice and local improvisation. In contrast, cognition is enacted in doing, relational skill and concrete engagement with particular places. These perspectives allowed one to describe knowledge as a product of action rather than being merely symbolically represented.

Another notable development is the concept of distributed cognition, which posits that thought arises not just inside people, but within and between large networks of people, objects, mundane and extraordinary (Hutchins, 1995; Kirsh, 2010). They illustrate the ways cognitive tasks are distributed over groups, mediated by symbols, infrastructures and social coordination. Although widely applied in studies of navigation, education, and technological work, relatively few studies have explored how distributed cognition functions in contexts of chronic instability or limited resources.

Parallel contributions from science and technology studies and relational anthropology have deepened interest in the mutual constitution of persons, environments, and knowledge. With the separation of mind and environment being deemed detrimental in some models, Strathern (2020) and Ingold (2011) take it further by expressing relationality as a condition where humans exist. Similarly, scholars like Haraway (1991) and Stengers (2010) articulate the need to pay attention to heterogeneous assemblages that not only act for humans, but also allow humans to deliberate and sense the world.

Digital media and marginality endures. Works on informal urbanism (Simone, 2004), borderlands (Donnan & Wilson, 1999), displacement (Malkki, 1995) and postcolonial conditions (Mbembe, 2001; Ferguson, 1999) describe settings characterised by improvisation, precarity and shifting social relationships. This work demonstrates that marginal contexts breed unique rationalities and collective organisation but avoids discussing these processes as cognitive ecologies.

Overall, existing scholarship forms an important basis yet begs key questions on the role of cognition in peripheral, unstable, or resource-scarce environments. This study sets out to overcome this by merging ecological (distributed, relational) approaches to cognition with ethnographic studies of marginality individual informational or structural deprivation, uncertainty a loss of predictability in everyday life, and locally developed adaptive practices.

3. THEORETICAL FRAMEWORK

The study combines ecological, distributed and relational theories of cognition with anthropological understandings of marginality and adaptive practice.

3.1. COGNITIVE ECOLOGIES

Cognitive ecologies refer to the interactions between individuals, environments, artefacts, and social structures from which cognition emerges (Hutchins, 2010; Hollan, 2012). Rather than viewing cognition as an internal mental property, ecological models emphasise the dynamic interplay of material, spatial, and relational elements. This perspective is particularly suited to marginal environments where stability is limited and adaptive responses depend on shifting resource configurations.

3.2. DISTRIBUTED COGNITION

Distributed cognition provides a second theoretical pillar. It investigates the intergroup spread of cognitive processes, made possible by tools through mediation, and embedded into social coordination (Hutchins, 1995; Kirsh, 2010). In situations where people are exposed to loss or resource deprivation, distributed systems tend to emerge organically in order to mitigate risk, synthesise solutions and bolster collective resilience. In this sense, this framework serves to highlight how informal networks and knowledge in common help-or hinder-day-to-day reasoning across marginal settings.

3.3. RELATIONAL AND ONTOLOGICAL APPROACHES

A dimension of this for anthropology is relational anthropology, which provides another perspective to analyse cognition in contexts where personhood, sociality and environment are inter-related (Ingold, 2011; Strathern, 2020). These perspectives

foreground the co-constitution of human beings and their environment, counteracting views that cognition is separate from the circumstances in which it arises. In many marginal contexts, relationships with kin, neighbours, nonhuman entities, and spiritual forces also shape how people interpret events and make decisions, extending the cognitive domain beyond strictly material interactions.

3.4. UNCERTAINTY AND IMPROVISATION

Theoretical work on uncertainty highlights how individuals develop strategies for acting in situations where information is incomplete or rapidly changing (Whyte, 2009; Cooper & Pratten, 2015). Combined with de Certeau's (1984) analysis of tactical improvisation and Sennett's (2012) work on cooperative practices, this perspective emphasises flexibility, creativity, and situational adaptation as forms of reasoning in their own right. These concepts are central for analysing cognitive ecologies in environments of precarity.

3.5. INTEGRATING MARGINALITY AND COGNITION

Finally, studies of marginality (Ferguson, 1999; Mbembe, 2001; Simone, 2004) provide insights into the social and political conditions that shape the environments under examination. Integration of these views with cognitive anthropological perspectives helps to address some less amenable areas where knowledge and intelligent action cultivate in otherwise hard-to-casual frameworks, informally structured or ambiguously separated social fields.

All of these frameworks work together to support an ecological and distributed, relational analysis of cognition that is sensitive to the dynamics specific to marginal environments. They also give us the conceptual tools for exploring the ways in which forms of intelligence emerge through regularised practice amid uncertainty, constraint, and the necessity to respond to others.

4. RESEARCH QUESTIONS

The specific cognitive practice and cognition-making process taking place in spaces defined by marginality, instability of resource consolidation and uneven degree or means to institutional assets access is reviewed in this study. This investigation is thus guided by the following research questions:

1. What strategies do people and groups in precarious situations pursue to create and mobilise their cognitive environments faced with uncertainty, instability, and unsteady resources?
2. In these contexts, how are problem-solving, decision-making and learning diffused through social networks, technology and the material environment (Hutchins, 1995; Kirsh, 2010)?
3. How is it that the day-to-day practices of improvisation, coordination and local knowledge
4. cognitive strategies (de Certeau, 1984; Lave, 1988) production function?}
5. What do relational ontologies and socio-spatial constellations enable and preclude in terms of forms of intelligence that emerge from marginal environments (Ingold, 2011; Strathern, 2020)?
6. What do the findings suggest for anthropological theory regarding cognition, adaptation, and knowledge ecology?

5. METHODOLOGY

It has a qualitative & ethnographic methodology, drawing from cognitive anthropology, ecological anthropology, and urban, marginality studies. The methodology is designed to capture both the everyday practices of cognition and the socioecological conditions within which these practices unfold.

5.1. RESEARCH DESIGN

A multi-sited ethnographic approach (Marcus, 1995) will be used to compare cognitive ecologies across different marginal environments. These may include:

- Informal urban settlements;
- Borderland or transit spaces;
- Communities experiencing chronic infrastructural instability;
- Mobile or displaced populations.

This design allows for detecting patterns which are both site-neutral as well as sensitised to local specificities.

5.2. DATA COLLECTION METHODS

5.2.1. PARTICIPANT OBSERVATION

Long-term immersion will allow direct observation of everyday reasoning, cooperation, problem-solving, and improvisation (Spradley, 1980). Special attention will be given to:

- Interactions with material environments;
- Group decision-making processes;
- Practices of adaptation to uncertainty.

5.2.2. SEMI-STRUCTURED INTERVIEWS

Interviews with residents, local leaders, informal workers, and knowledge holders will provide insight into:

- Perceptions of risk and stability;
- Narratives of expertise;
- Collective knowledge-sharing practices.

5.2.3. COGNITIVE TASK MAPPING

Inspired by cognitive anthropology (D'Andrade, 1995; Shore, 1996), this method will document how individuals and groups organise tasks, coordinate information, and make decisions under constraints.

5.2.4. THICK MAPPING AND SPATIAL ANALYSIS

Spatial ethnographic tools (Zeiderman, 2016) will be used to analyse how environments pathways, boundaries, infrastructures, material flows shape cognitive practices.

5.2.5. ARCHIVAL AND DOCUMENTARY RESEARCH

Where relevant, policy documents, historical archives, and local media sources will contextualise the social and political conditions of marginality.

5.3. DATA ANALYSIS

A combination of grounded theory coding (Charmaz, 2006) and thematic Analysis will be applied to the data. Analytical emphasis will be placed on:

- Identifying recurring cognitive strategies;
- Mapping distributed networks of reasoning;
- Understanding how socioecological conditions influence cognitive processes;
- Integrating relational and ecological interpretations of cognition.

Cross-site comparison will allow for the identification of shared patterns and local-specific adaptations.

5.4. ETHICAL CONSIDERATIONS

The study follows standard anthropological ethical guidelines, including:

- Informed consent;
- Protection of anonymity;
- Sensitivity to vulnerability and power dynamics;
- Attention to the ethical implications of representing marginalised populations (malkki, 1995; scheper-hughes, 1995).

6. FINDINGS

The findings presented here draw on multi-sited ethnographic work in informal urban settlements, borderland transit zones, and neighbourhoods affected by irregular infrastructures. Across these settings, participants navigated conditions characterised by uncertainty, fluctuating resource availability, and shifting social relations. Three core patterns describe how cognitive ecologies operate in marginal environments: (1) improvisational reasoning, (2) distributed coordination, and (3) socio-material attunement. These patterns are illustrated with ethnographic examples and analysed in light of ecological and distributed theories of cognition (Hutchins, 1995; Ingold, 2011; Kirsh, 2010).

6.1. IMPROVISATIONAL REASONING IN UNPREDICTABLE CONDITIONS

A common feature across all sites was the reliance on improvisation as a cognitive practice. Participants routinely encountered situations in which information was incomplete, infrastructures were unreliable, or events changed rapidly. Improvisation was not treated as a last resort but as a primary mode of reasoning.

6.1.1. VIGNETTE 1: WATER ACCESS IN AN INFORMAL SETTLEMENT

In an informal neighbourhood, residents organised water access around a shared borehole that functioned inconsistently. Small groups met every morning not only for water but also to compare notes about pressure levels, what equipment was in need of repair, and the results of recent groundwater quality tests. Instead of following fixed routines, residents adapted daily strategies to the behaviour of the pump, recent rain and expected crowding.

The case of improvisation emerged from an ongoing estimation of changing parameters, many of which changed erratically. During rapid decisions, participants showed the capacity to integrate sensory cues, social information and changes in the environment. Improvisation, in this sense, formed part of an ongoing ecological engagement rather than a deviation from stable cognitive routines (de Certeau, 1984).

6.2. DISTRIBUTED COORDINATION THROUGH FLEXIBLE SOCIAL NETWORKS

Across sites, individuals rarely acted alone in reasoning through challenges. Instead, decision-making and problem-solving were frequently shared across loosely organised networks. These networks were not formal structures but informal associations activated as needed.

6.2.1. VIGNETTE 2: INFORMAL, CROSS-BORDER TRANSPORT IN A TRANSIT ZONE

Transport operators used motorcycles to navigate unpredictable flows of travellers, variable fuel costs, and the irregular enforcement of border regulations at a transit point on the border. No operator on their own had complete visibility into the state of events. Rather, information was shared in a permanent flow: one operator monitored the number of customs officers at each crossing, another found out about points with congestion, others brought up data on informal rates for currency conversion.

Collectively, these people created a distributed cognitive system to share information, cross-check with each other and act together. The decision-making came from the network, not any individual actor. This kind of coordination is consistent with theories of distributed cognition (Hutchins, 1995), showing that reasoning can be extended across social relations and material environments.

6.3. SOCIO-MATERIAL ATTUNEMENT: THINKING WITH ENVIRONMENTS

Participants also engaged in forms of reasoning that involved close attunement to material and spatial conditions. This attunement required sensitivity to environmental signals sounds, textures, movements as well as to infrastructural rhythms.

6.3.1. VIGNETTE 3: A HISTORY OF ELECTRIC UNCERTAINTY IN A SMALL CITY

In a neighbourhood repeatedly crippled by power cuts, people had started discerning increasingly precise cues that the lights might come back on: the whirl of local transformers, the incursion of workers wrenching wires from poles or abnormalities in the radiance of bulbs flickering down parallel lanes. This meant observing things like how, when, and for how long you cooked or charged your devices or even ran a small business.

In this, cognition extended into the material landscape, dependent upon modalities of sensory survey and kinetic intimacy. Such reasoning supports ecological views of cognition, which emphasise the interdependence of thought and environment (Ingold, 2011).

6.4. ADAPTATION THROUGH TEMPORAL FLEXIBILITY

Across sites, temporal flexibility emerged as another cognitive pattern. Reorganising daily routines to accommodate uncertainty: Participants adapted their activities in response to the changing availability of transportation, electricity, water, or security. This temporal adaptation functioned as a cognitive skill, requiring anticipation, forecasting, and the capacity to shift plans repeatedly throughout the day. It also depended on collective coordination; individuals often informed neighbours, relatives, or co-workers about sudden changes, reinforcing distributed systems of temporal knowledge.

6.5. INTEGRATION OF LOCAL KNOWLEDGE AND EMERGENT EXPERTISE

Finally, findings indicate that marginal environments foster forms of expertise that are rarely formalised but widely recognised locally. Such expertise involves long-term experiential knowledge of how infrastructures behave, how institutions intervene, and how environments respond to disturbance.

These forms of knowledge are emergent and cumulative and often collectively based. They question beliefs that expertise is largely located in more institutional or specialist locations and instead demonstrate how marginal sites produce their own epistemic modalities, grounded in experience and ongoing adaptation.

6.6. SUMMARY OF FINDINGS

Across all field sites, cognitive ecologies in marginal environments were defined by:

- Improvisational reasoning in response to uncertain conditions.
- Distributed coordination using flexible social networks.
- Socio-material attunement, where environmental cues become integrated into daily decision-making.
- Temporally flexible nature capable of adapting quickly to infrastructural instability.
- Locally generated know-how built on a collective memory of experience.

These patterns collectively show that marginal cognition arises from ecological, relational, and distributed processes as co-expressive forms of situated individual behaviour as opposed to more entrenched models in which some stability, linearity, or individual autonomy is the norm for cognitive engagement.

7. DISCUSSION

The findings suggest that cognitive processes in marginal environments are shaped by the interplay of uncertainty, socio-material conditions, and collective forms of action. This section situates these findings within anthropological debates and demonstrates how they refine, extend, or challenge existing theoretical frameworks.

7.1. RETHINKING COGNITION BEYOND STABLE CONTEXTS

The anthropological works in cognition presupposed a reasonably stable environment, where rituals, infrastructures and institutions can be expected to be entrenched (Lave, 1988; Hutchins, 1995). Our results suggest that this assumption is not appropriate in contexts characterised by infrastructural volatility, the ebb and flow of resources and governance, where service providers have limited entitlements to public authority.

Improvisational reasoning, which has been documented across our field sites, speaks directly to this suspicion that cognition works with rigid schemas or culture-bound routines (Geertz 1973). Rather than representing a static and pregraphic pattern of reasoning, as in the arguable classical tradition (Peirce, 1931), reasoning is therefore temporally emergent and systemic [or reconstructive/non-representational], more compatible with ecological/enactive approaches to cognition that foreground situated engagement with environments (Ingold, 2011).

7.2. DISTRIBUTED COGNITION IN INFORMAL NETWORKS

Distributed cognition theory (Hutchins, 1995; Kirsh, 2010) has typically been applied to well-organised settings such as navigation teams, technical workplaces, or educational contexts. The findings extend this framework by demonstrating that distributed systems also emerge spontaneously in informal, resource-limited, and unpredictable environments.

Knowledge and decision-making spread through networks in informal settlements, since there was no formal leadership structure with institutions of authority. These observations highlight that distributed cognition can arise wherever social actors coordinate under pressure, suggesting that marginality is conducive rather than detrimental to distributed cognitive systems.

7.3. THE ECOLOGY OF CONSTRAINTS

The concept of cognitive ecology traditionally emphasises the affordances and opportunities provided by environments (Hollan, 2012). The present findings highlight an ecology of constraints in which reasoning depends on recognising, navigating, and anticipating environmental limitations.

For instance, residents used sensory cues as a way to check for the availability of electricity or water. Such attunement practices resonate with ecological anthropology (Ingold, 2000; see also Deleuze and Guattari, 1987), yet extend it by demonstrating how cognitive engagement is predominantly directed towards the management of scarcity rather than abundance.

It not only reconceptualises the environment as a source of opportunity but also as an arena for cognitive strategy.

7.4. RELATIONAL DIMENSIONS OF REASONING

- Relational anthropology stresses the co-constitution of persons and environments (Strathern, 2020). Results demonstrate that reasoning in marginal environments is relational in several key ways:
- Socially relational: Relationships are the name of the game, not institutions.
- This has two main components:• Materially relational cognition is situated within infrastructures, tools and spatial configurations.
- Temporally relational: Adaptation involves synchronising activities with shifting temporal rhythms.

These findings support relational theories while adding empirical detail on how relations become cognitive resources.

7.5. EXPERTISE AS EMERGENT AND SITUATED

Conventional models often frame expertise as specialised knowledge produced in formal institutions. The research uncovers types of local knowledge based on enduring experience with unpredictable systems: predictions about when the power will go out and how to understand signals that regulators might take action.

This lends credibility to claims that expertise is socially situated, embodied and distributed (Shore, 1996) and emphasises how marginal spaces create their own epistemic traditions.

7.6. IMPLICATIONS FOR ANTHROPOLOGY

These results shed light on a number of ongoing debates:

1. Cognition is not universal or individual
2. Rather, the landscape is determined by environmental uncertainty and social solidarity.

3. Through these informal systems, we are able to generate complex cognitive practices.
4. These tools are not just coping mechanisms, but structured ways of thinking.
5. Marginality also breeds certain types of intelligence.
6. Other modalities of intelligence are missing in traditional cognitive models.
7. Anthropology requires BIGGER MODELS of ECOLOGICAL and DISTRIBUTED COGNITION.
8. Especially those models that also take into account uncertainty, constraint and improvisation.

8. CONCLUSION, LIMITATIONS, AND PERSPECTIVES

The article looked at cognitive ecologies under the conditions of instability, limited infrastructure and rapidly changing social contexts. Reasoning that emerges in marginal environments through practices of improvisation, coordination, attention, and temporal flexibility is embodied. Such patterns point to cognition as something that is not just an individualistic mental activity but a relational and ecologically embedded practice conditioned by everyday encounters with uncertainty. In foregrounding these forms of reasoning, the article adds complexity to recent discussions in unclear and ecological anthropology and takes a broader context-oriented approach than many models that maintain existences or institutional regulation.

Several limitations qualify the findings. Having a specific socioecological context, the insights from the study are not generalisable to all forms of marginality. Fieldwork, necessarily constrained in time, does not lend itself to capturing long-run change in either infrastructures or social networks. Informal coordination systems that are only partially visible create gaps in our ability to observe the way we actually work. The participants drawn on in this study are sometimes unable to articulate embodied and tacit forms of expertise, which affects the full development of the data. The researcher's position also affects access and interpretation. Finally, the focus on selected urban margins restricts comparative scope, and the absence of quantitative triangulation limits broader population-level inference.

To summarise, these limitations offer multiple pathways for future work. Heedful as it is of the contours of infrastructure and political cycles, what longitudinal studies can unravel are the ways in which cognitive ecologies change. It might enable the identification of commonalities and divergences through comparative work across urban, rural and cross-border environments. Further consideration of digital mediation may elucidate how mobile technologies are in force mediators and participants in distributed cognition scenarios under conditions of precariousness. The generational lenses may gain insights into strategies forged among the new generations as they strive to identify clarity out of uncertainty. It might even provide a deeper understanding of how infrastructures, animals and environmental signals conjoin in reasoning when the nonhuman and material perspectives are incorporated. This may improve how adaptive cognition is modelled, and interdisciplinary collaboration with cognitive science and complexity theory should be encouraged here. Finally, methodological innovation is needed to document better tacit knowledge, sensory attunement, and improvisational practices that are central to reasoning in unstable environments.

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