


## The Making (Sense) of Traces. Connecting Ginzburg to Digital Sociology

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### Abstract

This article addresses the fundamental methodological challenges posed by trace-based empirical materials, particularly digital footprints, within sociological inquiry. Drawing on Ginzburg's Indiciary Paradigm, the analysis contrasts its retrospective ascent (Manifest-to-Latent) with the prospective logic of the Galilean and Lazarsfeldian models. The article formalizes the core methodological hurdle of zero-agency data: the entire burden of meaning attribution rests upon the researcher. Then, the framework of *ichnology* is applied to sociological inquiry, with reference to that of digital footprints. This framework defines the trace's meaning as the interaction between the trace maker and the depositional context (algorithmic design). We argue that, in the digital realm, the methodological complexity introduced by algorithmic recursivity and user awareness of algorithms renders the pursuit of "genuine" traces counterproductive. Instead, following the lesson of the indicial paradigm means accepting the strategically contaminated trace as a minute, manifest clue of complex and latent socio-psychological objects.

**Keywords:** Indiciary paradigm; Sociological *ichnology*; Algorithmic awareness; Digital footprints; Digital sociology.

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## 1 On the Trail of the Indiciary Paradigm

This paper addresses two related issues: to connect Ginzburg's indiciary paradigm to the current debate on sociological methodology, and, consequently, to propose a framework for the sociological study of digital footprints.

Some terms, in specific contexts and fields of knowledge, have such an intense semantic charge that one can't just use them without clarification. It's often necessary to introduce them and clarify the specific meaning with which they are intended to be used. This is certainly true for the term "paradigm" in the fields of epistemology and sociology of science. Almost by conditioned response, the word "paradigm" evokes Kuhn (1962) and his seminal, highly influential reflections on science, particularly on how scientific knowledge evolves. As Masterman (1970) says, Kuhn uses the term "paradigm" in his 1962 text in a variety of ways that, nevertheless, converge on a common semantic denominator.

That common semantic denominator consists, in a sense, of the idea of a shared stock of resources. For Kuhn, there can be no paradigm without a corresponding scientific community. A paradigm can be understood as what a community shares on various levels and domains: general representative frameworks, theories, concepts, methodological strategies, operational tools, acquired empirical findings, and so forth. By steering, through its normative standards, the training and work styles of a given scientific community, a paradigm preserves and reproduces itself to a breaking point — until the accumulation of anomalous research findings makes it unsustainable, paving the way for what Kuhn calls a scientific revolution.

This necessarily simplified reconstruction of Kuhn's concept of paradigm contains the essential elements needed to ask: in what sense is the indiciary paradigm a paradigm? Ginzburg himself addresses the issue in the first note of *Spie. Radici di un paradigma indiziario*, where he writes: "I use this term [paradigm] in the sense proposed by T.S. Kuhn in *The Structure of Scientific Revolutions*" (Ginzburg, 2023, p. 187). Indeed, the author speaks of the indiciary paradigm as an "epistemological model [...] that quietly emerged within the human sciences [...] largely operating *de facto* even when not explicitly theorised" and goes on to indicate the canonical texts and the scientific communities in which it developed (Ginzburg, 2023, p. 157). He also reconstructs a kind of competition between it and another paradigm, the Galilean one, especially within the human sciences.

Given these foundational claims, the subsequent sections aim to delineate the core methodological and epistemological characteristics of the indiciary paradigm.

### 1.1 Morelli, Sherlock Holmes, and ChatGPT

Toward the end of the 19th century, Giovanni Morelli, under a pseudonym, published a series of essays that art historians consider the core of the so-called "Morellian method". The attribution of an artwork's true authorship was the problem for which Morelli, with his method, proposed an innovative solution that was widely debated by his contemporaries. Ginzburg himself summarizes Morelli's method as follows:

[To distinguish originals from copies] one must not rely, as it's usually done, on the most conspicuous — and therefore most easily imitated — features of paintings: the upward-turned eyes of the characters of the Perugino school, the smile of those of Leonardo, and so on. Instead, one must examine the most negligible particulars, the features least influenced by the stylistic traits of the school to which the painter

belonged: the lobes of the ears, the nails, the shape of the fingers of the hands and feet (Ginzburg, 2023, p. 158).

As anticipated, Morelli's method provoked controversial reactions, but its application produced significant results that fostered its diffusion in various schools of art history. Ginzburg regards the Morellian method as a typical instance of the *indiciary paradigm* — an epistemological model that attributes cognitive value to details, to the negligible particulars that, more effectively than “conspicuous characteristics”, allow access to authenticity for those who know how to find and interpret them.

The terms “indiciary” and “clue” naturally suggest an easy analogy:

The art expert is comparable to the detective who uncovers the author of a crime by clues imperceptible to most. The examples of Holmes' sagacity in interpreting footprints in the mud, cigarette ashes, and so on are, as it's known, innumerable (Ginzburg, 2023, p. 159).

The way Sherlock Holmes, moving through the uncertainties of a case to be solved, arrives at the solution is typically Morellian: he discovers details or encounters fortuitous particulars that pass unnoticed by most (even by Watson!), and that — sagaciously interpreted — illuminate the scene and unravel the mystery far more effectively than the most conspicuous evidence can.

How would Morelli and Sherlock Holmes distinguish today between a text written by a human author and one produced by ChatGPT? Perhaps they would follow the example of Brian Klaas, a Lecturer in Global Politics at University College London. After grading roughly 80 student essays, Klaas noticed that, although the essays varied in depth, accuracy, and breadth of sources, they shared a striking common feature: no mistakes, no typos, no misplaced commas (Minto, 2025). Rather than inferring his students' mastery of the language, Klaas interpreted this generalized absence of errors as a strong and disheartening clue that the essays had been written by ChatGPT.

Once again, usually negligible particulars, such as grammatical or spelling errors (or rather, in this case, their absence! Absences can also be clues...) have become decisive. The attribution of strategic cognitive value to such small, usually overlooked, details is a constitutive element of the *indiciary paradigm*.

Of course, one might argue that students might intentionally place grammatical errors in the text to simulate the text's human authorship. I will return to this important topic, namely the intentional construction of traces, in the final section of the essay.

## 1.2 The Place of the Indiciary Paradigm

Ginzburg is right to speak of a paradigm: his argument does not merely acknowledge the epistemic value of a particular kind of datum or information (clues, or “indicia”), but instead systematically constructs an overarching epistemological proposal around it. This proposal stands at the same level of generality — and offers an alternative — to the Galilean paradigm, which dominates scientific practice at least within the natural sciences. The specificities of the *indiciary paradigm* become clearer when it is contrasted with the Galilean model.

*Interest in — or indifference toward — individuality.* The references above to Morelli and Sherlock Holmes underscore this point. The *indiciary paradigm* is naturally predisposed to recognize singular cases: to unmask a forged painting and distinguish it from genuine ones;

to identify the perpetrator of a crime among many suspects. By contrast, Galileo's experiments show no particular interest in the individual bodies (spheres, projectiles, etc.) on which they were performed. For Galileo, the world is composed of properties and variables (mass, acceleration, velocity, inclination, and so on); individual objects are merely interchangeable empirical instances used to investigate relations among those properties. Nevertheless, the indicial paradigm's orientation toward individuality does not preclude forms of general or global knowledge. Ginzburg himself offers examples of generalizations derived from *indicia* that lead to "judgments about man and society" (Ginzburg, 2023, p. 185); Peltonen (2001) and Mele (2015) recognize the heuristic function of the indicial paradigm in connecting micro-observations and knowledge at the macro-level.

*From effects to causes.* The indicial paradigm reasons retrospectively — from manifest effects to unobserved causes; the Galilean paradigm proceeds prospectively — observing effects produced by experimental interventions in which possible causes are defined in advance and set into motion. "When causes are not reproducible, one can only infer them from their effects". This is the role Ginzburg (2023, p. 178) attributes to the indicial paradigm, and it is not trivial. The situation described by this sentence unites, with remarkable simplicity, a variety of scientific fields and traditions: geology, astronomy, archaeology, history (and, as the most trenchant critics of experimental designs in social research would note, sociology). These disciplines, for different reasons, cannot adopt the Galilean paradigm in its strict sense — that is, they cannot manipulate potential causal factors to observe their effects. In such cases, causal attribution proceeds via what Ginzburg calls "retrospective prophecies" (*ibidem*), tracing the course of events upstream from what is observed downstream — the *indicia*. The point is not to treat the indicial paradigm as residual to the Galilean one, but to delineate their different domains of applicability.

*Appearances and accidents matter.* In *Il Saggiatore* (1896), Galileo Galilei develops an important epistemological distinction between primary and secondary qualities. The terms themselves indicate a fundamental claim: primary qualities are privileged over secondary ones; the latter are misleading, deceptive — almost a veil to be torn aside to reach the primary qualities, the proper objects of scientific inquiry. Secondary qualities are subjective perceptions of reality; primary qualities are what remain once these perceptions are removed. Galileo's prose is vivid, and this oft-cited passage makes the point explicit:

[...] and I consider that, if you strip away ears, tongues and noses, there will remain well-formed figures, numbers and motions, but not odors, nor tastes, nor sounds, which when removed from the living animal I do not believe to be anything other than names — just as tickling and titillation are simply names once the armpits and the skin around the nose are taken away (Galilei, 1896, pp. 350–351).

The indicial paradigm inverts this perspective. Smells, impressions, *minutiae*, and apparently insignificant particulars are not a misleading veil obscuring something stable beneath; rather, they are clues — signs — precisely of what matters and of what one seeks to know. They are not a diaphragm to be passed through, but the first step in an upward journey from manifest effects to latent causes. In certain historical contexts, this distinction between the two epistemic modes — indicial and Galilean — has marked the boundary between different scientific practices and disciplines. As Ginzburg recalls, "between the Galilean physicist, professionally deaf to sounds and insensitive to tastes and smells, and his contemporary physician, who risked diagnoses by putting his ear to rattling chests, sniffing excrement and tasting urine, the contrast could not have been greater" (Ginzburg, 2023, p. 169).

*Separation between subject and object.* In the Galilean paradigm, the distinction between stable primary qualities and accidental, provisional secondary qualities connects to another central principle: the separability of subject and object of knowledge. The world is like a great book written in the characters of mathematics and geometry (perhaps Galileo's most famous metaphor, also found in *Il Saggiatore*), and it exists independently of those who read it. All readers can do is learn the language in which it is written. Within this paradigm, experimental design rests on the principle that the experimenter can be fully separated from the events occurring during the experiment — a separation that is a precondition for accountability and reproducibility.

By contrast, Ginzburg (*ibidem*, p. 185) describes the indicial paradigm as a form of knowledge that is substantially mute — not fully formalizable, almost ineffable. While the Galilean paradigm advances by applying concepts, rules, and instruments (all means of knowledge that can be separated from the knowing subject), the indicial paradigm proceeds by intuition; and intuitions, by their nature, are creative acts — a form of knowing in which the clue that triggers the act and the perspicacity of the subject who recognizes and interprets it are inseparable. To clarify this point, Ginzburg recuperates the notion of *frâsa* (borrowed from Arabic physiognomy): the “capacity to move immediately from the known to the unknown on the basis of clues” (*ibidem*, p. 186). It is precisely in this immediacy that the non-separability of subject and object is manifest, whereas the mediation of rules, procedures, and instruments effects their separation in the Galilean paradigm. In this regard, Ginzburg's *frâsa* is quite different from Peirce's abduction: the latter involves an intuitive leap too, but in the frame of a logical inference that introduces new hypotheses (Swedberg, 2014). Thus, Ginzburg's notion of intuition highlights the agent's capacity for creative leaps, whereas Peirce's notion of abduction emphasizes the formal logical pattern of hypothesis formation.

The themes discussed so far do not exhaust the specificities of the indicial paradigm. In the pages that follow, I will introduce additional aspects that are more directly pertinent to social research.

To conclude this section, a brief remark on how I understand Ginzburg's use of the term “paradigm”. It is not in Kuhn's sense of replacement or succession of one paradigm by another; rather, Ginzburg employs the term to enhance and grant dignity to alternative forms of knowledge (the indicial paradigm) alongside mainstream ones (the Galilean paradigm).

### 1.3 From the Latent to the Manifest, from the Manifest to the Latent

The very notion of clue points to a crucial epistemological and methodological issue that I have not yet addressed: the distinction between that which is unobservable yet relevant (the Latent) and that which is observable and relevant only due to its relationship with the unobservable (the Manifest). The core cognitive value of a clue resides in its function as a sign: it is not an important piece of information in itself, but rather because it stands for something else. Morelli focused on the depictions of earlobes in paintings, utilizing these seemingly trivial features solely as diagnostic signs to ascertain the genuine authorship of a work of art.

The distinction between manifest and latent, coupled with the idea that the manifest may serve as a passageway to the latent, is a crucial challenge in social research. Frequently, the most critical characteristics for sociological understanding are not immediately accessible to the researcher. Social cohesion, trust, anomie — to name a few constitutive sociological phenomena — are not directly accessible, whereas other sociologically relevant features, such as the distribution of incomes in a community or its average age, may in principle be directly observable. The

only way sociologists can conduct empirical studies on cohesion, trust, and anomie is through the mediation of more immediately observable aspects, which can, at the same time, be interpreted as signs of levels and forms of cohesion, trust, and anomie.

Within social research, a formalized framework has emerged to manage the study of the latent through the manifest. In methodological texts, this framework is widely attributed to Paul Lazarsfeld and is often referred to as the Lazarsfeldian paradigm. This is not the place for a detailed exposition of it; for that, the reader should consult the main reference literature (Lazarsfeld, 1955; 1958). Nevertheless, highlighting some of its basic elements can be useful for grasping the sense of the other paradigm we are discussing here — the indicial paradigm — which can be understood as an alternative way to configure the relation between latent and manifest.

In quantitative social research, particularly — though not exclusively — within survey methodology, the Lazarsfeldian paradigm is central. For this reason, its association with the Galilean paradigm, which, as we saw earlier, develops around the experiment as a research design, may not seem obvious. Yet the two paradigms share a main feature which, as often happens with fundamental issues, can remain implicit or taken for granted. For both Galileo and Lazarsfeld, the starting point of scientific inquiry requires conceiving the world not primarily in terms of objects, but in terms of characteristics or properties and the relations between them. In this way, the Galilean and Lazarsfeldian paradigms shape their indifference to individuality. Individual referents are *bearers* of characteristics, and what happens to them depends exclusively on these characteristics and their relations/intersections. Singularity has no agency of its own.

The term *imagery* is crucial in Lazarsfeld's discourse; it refers to an act of conceptualization by which the researcher identifies the initial properties with respect to which sub-dimensions and indicators are then specified and defined. Most of the steps within the Lazarsfeldian paradigm are conceptual and necessarily precede empirical contact, meaning they occur before the data collection phase. It logically follows that the meaning assigned to the data collected is substantially designed *a priori*, before their actual retrieval. Within the Lazarsfeldian framework, the data collected do not carry meaning in themselves; rather, they are signs of what truly matters, namely the properties defined upstream in the imagery process, which are not directly observable. The meaning of any single indicator is therefore not absolute, but relative to the entire theoretical schema of concepts, dimensions, and indicators within which it is embedded.

Also, in the framework of the indicial paradigm, any piece of information has no meaning apart from the act of sense-making that recognizes it as a sign of something. In that framework, not only can trivial details become clues, but also the failure of an expected event to materialize, or non-occurrences, can serve as evidence, forcing a retrospective inference. As Ramírez Cortés (2020) shrewdly observes, speaking of the relationship between psychoanalysis and the indicial paradigm, this approach implies the shift from a *clinic of listening* to a *clinic of reading*. Listening is primarily the reception of a narrative; reading implies the simultaneous construction of signifier and signified.

Yet, the two processes of sense attribution sketched by the indicial paradigm and by the Lazarsfeldian one could not be more different. In the latter, the meaning of the data is strongly articulated upstream of contact with reality and guides the construction/elicitation of empirical material. In the indicial paradigm, by contrast, it is the contact with concrete instances (often accidental and unplanned) that activates the attribution of meaning — that is, the link between the manifest (clue) and the latent. We might say that the Lazarsfeldian paradigm is

a theoretically guided descent from the latent to the manifest, whereas the indicial paradigm ascends from the manifest to the latent, just as, in comparison and contrast with the Galilean paradigm, we noted that it proceeds from effects back to causes.

## 2 Footprints: Digital or Not

### 2.1 The Fascination of the Unnoticed

As we have seen, the methodological approach defined by the indicial paradigm posits one essential insight: attention must be paid to residues, trivial aspects, secondary elements, and by-products. In what might at first glance be dismissed as mere scrap material, one can grasp signs that open the way to knowledge. This focus on the marginal and the often-overlooked — validating the importance of accidental and minute evidence — is fundamental to the scientific value attributed to traces, or trace-like empirical material.

In many fields of study, empirical research is naturally founded upon traces. Archaeology, palaeontology, and, more generally, the sciences that study the past, often the remote past, have little choice but to do so. The temporal distance that separates them from their object of study structurally compels them to search for and interpret traces of phenomena or behaviors which, through them, resist, at least in part, the oblivion of time (Lucas, 2012).

On the other hand, many scientific disciplines concerned with contemporary life, such as sociology, also systematically resort to traces as a possible and strategic empirical material (Heiskala, 2021). This discourse inevitably raises the topic of digital footprints, which is energizing the current methodological debate. The widespread proliferation of digital media has ushered in an era where massive volumes of data are generated unobtrusively, opening a new frontier for communication researchers seeking non-reactive data sources. In principle, the resulting digital footprints can create corpora that are exponentially larger than those obtained through traditional elicitation or human transcription. The vast amount of this information that enters the global network constitutes big data that can be utilized across a wide spectrum of the humanities and social sciences, including sociology, law, economics, and psychology. This methodological shift prompted my colleagues and me, Francesca Comunello and Lorenzo Sabetta, to organize an international conference in 2021 entitled *What People Leave Behind: Traces, Footprints and their Significance for Social Sciences*, where scholars from various disciplinary fields discussed the renewed interest of the social sciences in trace-like empirical material (Comunello et al., 2022).

I will return to digital footprints in depth later; here, it is important to stress that traces, as a specific type of empirical material, have been of interest to sociologists since before the Internet. This enduring methodological interest is encompassed within the methodological framework known as “Unobtrusive Measures” (Webb et al., 1966), which defines methodologies that do not involve direct elicitation of data from research subjects but rather find indirect ways to obtain information.

In this regard, one of the most famous and significant cases is the Garbage Project, through which, in 1973, William Rathje and his staff collected, catalogued, and sociologically analyzed the household waste of residents in the city of Tucson, Arizona (Rathje & Murphy, 1992). The intention was to study family consumption behaviors and lifestyles by combining analyses of domestic waste with interviews with the same families. The success of this experience led to the replication of the Garbage Project in other cities across the United States.

Why study people's consumption styles by rummaging through the trash rather than limiting research to interviews? The answer to this question is partly suggested by one of the main findings of the Garbage Project: the systematic inconsistency between the quantity of alcohol consumption declared by families and what could be inferred from the composition of their domestic waste.

We are led to believe that, in such cases, the actual consumption of alcohol is much more likely represented by the quantitative estimate of the waste than by the declarations of the interviewees. It is, in fact, improbable that families accumulated the bottles consumed by other families in their bins, whereas it is more probable that they downplayed their alcohol habits in response to the interviewer's questions. Waste materials are by-products — side effects to which no attention is paid, evidence that is resistant to post-hoc rationalization. In contrast, through the declarations provided during an interview, people often present their self-image, which, in many cases, they wish to control, thereby introducing self-censorship mechanisms and social desirability bias. To this point, Erving Goffman (1959) distinguishes between impressions "given" and impressions "given off". Impressions given are the deliberate signals or information a person intentionally conveys to others (typically via explicit verbal statements or controlled behaviors), whereas impressions given off are the inadvertent, often nonverbal cues that observers pick up from the person's behavior. In the Goffmanian metaphor of theatre, the former are the managed and planned aspects of one's performance, while the latter are the unplanned signals (tone, body language, context, and so forth) that audiences infer. The core difference is that people can control what they give, but not what they give off, highlighting that self-presentation involves both intentional façade and incidental information.

Returning to the concept of trace-like material, waste is a trace precisely because it is given off and has meaning only for those who detect and interpret it, not for those who produce it (Gibbs, 1999; Sabetta, 2020). This asymmetry is the essence of the strategic value of traces. Therefore, we could say that a researcher who studies traces feels to be in a privileged position similar to someone who observes a person who does not know they are being observed, because what is being observed is, from the viewpoint of the observed, unimportant or even unnoticed (Brekhus, 1998).

Explained in this way, the concept of the trace allows us to further specify the indicial paradigm, introducing a theme that has not yet been discussed. It is true, as we have seen, that clues often hide in the folds of daily life, consisting of accidental, marginal, and insignificant facts; but what confers them a particular informative value is the fact of being insignificant to the person who produces them, at the time they are involuntarily produced.

Following this reasoning, the heuristic force of clues and traces lies entirely in a nexus deeply inscribed in our culture: that between casualty/ephemerality and authenticity/truth (Grenz & Robinson, 2022, p. 60). Everything that, like a trace, is unplanned, or even unconscious, can inherently be considered genuine, non-artefactual. Because it is not produced with intention, a trace does not have the limitations that often characterize one of the most used empirical materials in social research: responses to interviews, whose cognitive value depends on how collaborative the interviewees are, their willingness to be sincere, the meaning they attribute to the question, and so on. Responses to questionnaires are communicative acts and, as such, are conscious and intentional. Pushing the terms a little, we could say that a trace constitutes an unintentional communicative act (Comunello et al., 2024).

The above-mentioned connection between psychoanalysis and the indicial paradigm also applies to this point. Just as Giovanni Morelli believes that an artist's identity should be sought in the parts of the painting where his effort to comply with canons is supposedly less intense

(that is, where he feels free from a plan), similarly, for a psychoanalyst, dreams are interesting material because in them the Ego stops paying attention and controlling thought (Ramírez Cortés, 2020). Furthermore, the Morellian method is applicable not only to paintings: even official documents — which, as such, are the fruit of precise communicative intentions — can be read and studied “against the intentions of those who assembled them” (Comunello et al., 2024, p. 625), that is, in search of traces of meanings that have, so to speak, escaped the control of intentions. The persistent methodological focus on the residual and the unintentional thus spans a wide spectrum, linking archaeology, history, psychoanalysis, and contemporary digital footprints.

## 2.2 Making Sense of What Doesn't Have One

The importance and difficulty of attributing meaning to those phenomena that intrinsically lack it is a typical everyday life experience. By lowering the level of discourse, thereby transitioning from existential questions to problems of research methodology, the same issue can be applied to the type of empirical material previously designated as “*trace-like material*”.

More broadly, the process of meaning attribution, in the various forms and modalities it may assume, constitutes a relevant methodological dimension for distinguishing between different categories of empirical material. Analysing texts — whether political discourses, official documents, newspaper articles, novels, or autobiographies, and so forth — implies, particularly within hermeneutic analysis, a systematic — even if not narrow — attention to the author’s agency; that is, to the active construction of meanings by the subject within the text they have produced (Montesperelli, 1998; Cardano, 2011, pp. 170–175). Conversely, responses to a questionnaire can be viewed as the result of a double and joint attribution of sense: that which guides the researcher in defining the question and the response alternatives, and that through which the interviewee selects one of the provided responses. A significant portion of the problems encountered in managing structured interviews stems from the potential conflicts between these two attributions of meaning (Pitrone, 2009, pp. 88–93).

In case of trace-like materials, the activity of meaning attribution rests entirely with the researcher because, strictly speaking, a trace can only be defined as something produced unintentionally and inadvertently. Indeed, if, as has been said before, even a non-event can be treated as a trace of something, it can be argued that a trace is not merely something to which meaning is attributed, but is, in itself, an attribution of meaning.

Meaning attribution is a complex, creative, and non-receptive cognitive process in which the identity, history, and prior experiences of the individual engaged in sense-making play a crucial role (Bruner, 1991). However, not only the subject and their background matter, but also the context of what the meaning is being assigned to. Attributing meaning may, in fact, entail a specific cognitive operation: contextualization.

In certain cases, this operation may seem relatively simple: the meaning that a researcher attributes to the responses of interviewees to a specific questionnaire item depends on their context — namely, the other response alternatives provided by the question that the interviewee did not select. The intention here is not to diminish the complexity of the cognitive processes activated during a standardized interview (Gobo, 2003), but simply to note that the minimal frame of reference through which meaning is attributed to responses, in the case of structured questionnaires, is both explicit and known, both to the researcher when collecting, analysing and interpreting the data and to the interviewee when providing the information.

Obviously, traces also require contextualization. Indeed, “contextualization” is invoked in the very definition of ichnology, a branch of paleontology and biology that can be defined as “the science of traces” (from the Greek *ichnos*, meaning trace). Ichnology is defined not as the study of a particular empirical referent (such as footprints or fossils) but rather the study of an interaction: that between organisms and their substrates (Seilacher, 2007). Within the ichnological framework, a specific trace must always be considered the resultant effect of a given behavior by a *trace maker* (that which the researcher wishes to infer from the trace) and the *tracked surface* (or depositional context), that is, the surface upon which the trace is left (Bennett & Reynolds, 2021). This implies that, in principle, a specific behavior of a trace maker can leave diverse traces across different depositional contexts, and conversely, the same physical trace found in two different depositional contexts might be produced by two different behaviors.

The methodological awareness implicit in this distinction can be extended to what we can call “sociological ichnology”, that is, the analysis of traces as by-products of the interaction between specific actions and the sociological spaces in which they occur. Within this framework, the meaning of a trace depends entirely on its context, and in most cases involving sociological traces, this context remains silent (or “mute”) to the researcher. As said before, the response to a questionnaire item is always defined as a realized alternative within a known set of potential alternatives (which also includes the unselected responses). But what is, or was, the context of possible alternatives to a trace that was actually left? Making these mute contexts speak is a crucial methodological operation central to ichnology, including its sociological application.

### 2.3 From Footprints to Digital Footprints: Things Get Intricate

The methodological awareness that the meaning of a trace depends on its context, particularly the features of the *mute* context, could be extended to the digital realm. Consequently, the interpretation, or even prior to that, the initial recognition of a digital footprint should necessitate a deep and precise understanding of the spatial environment in which it is impressed (Bennato, 2021, p. 216). Transferring ichnological terminology to the digital sphere, we could say that the depositional context of a digital trace is determined by platforms, whose agency is incorporated into the design of their algorithms (Airoidi, 2022). The opening or sharing of a link, the duration of video fruition, and a like or a dislike assigned to a post are relative and inherently contextual actions. That is, they depend, at least in part, on algorithms, which are “engines of order” regulating content visibility and presentation through filtering and recommendation processes (Rieder, 2020) and, consequently, constructing the depositional context of digital traces.

However, with regard to digital traces, this kind of methodological awareness appears insufficient. As to the relationship between traces and the depositional context, moving from classical to digital ichnology means moving from *dependency* to *interdependence*. The operational structure of major platforms is characterized by a dynamic in which traces generated by users are not simply inert by-products of action. Instead, they are immediately reutilized as input to further train the algorithmic machinery (Pronzato, 2024, p. 22). This immediate reuse is explicitly designed to favor and optimize prolonged engagement with the platform itself.

Algorithms create a recursive process of interdependence in which traces and the depositional context mutually influence each other: the space in which users act (and leave traces) at time  $t$  also depends on the traces they left at time  $t-x$ . The most significant implication of this structural recursiveness is that researchers should consider digital traces not as events, but as

moments or states of a process.

The process of interdependence described above is not strictly confined to the knowledge of researchers or industry professionals. A large portion of platform users possess some degree of conceptual understanding regarding how their traces are utilized to train and shape algorithms. Although these perceptions may be imprecise or exaggerated, they nonetheless orient and shape user behaviors.

This dynamic is captured by the concept of algorithmic awareness and has generated a robust field of inquiry (Felaco, 2022; 2024), centering on how individuals perceive, understand, and interact with these governing computational systems. Algorithmic awareness also poses a methodological issue, relevant to the discussion I am developing in these pages. If digital traces are no longer passively or unwittingly left — as is assumed in classical ichnology — but are instead generated consciously and strategically with the explicit aim of deceiving, manipulating, or conditioning the algorithms, their empirical meaning undergoes a radical transformation. When a trace is consciously deployed for strategic purposes, it seems to cease to be a genuine trace in the strict inferential sense proposed by Ginzburg's paradigm.

### 3 Some Concluding, but not Conclusive, Remarks

Algorithmic awareness does not uniformly translate into corresponding behaviors. Representation and knowledge (what the user believes) often remain independent of action (what the user does). Many empirical studies focus on identifying and circumscribing the specific factual instances of user-algorithm interactions where enacted awareness — awareness translated into strategic behavior — is most powerfully activated (Bonini & Trerè, 2024; Xie et al., 2022). Such studies could be useful for drawing a methodological distinction between genuine digital traces and intentional behaviors designed explicitly to influence the system.

But the challenge of identifying purely genuine traces, uncontaminated by the influence of user awareness, appears self-limiting and methodologically counterproductive. Exploring digital platforms with the objective of demarcating presumably ever-shrinking zones of pristine data does not seem a particularly fruitful research endeavour.

Therefore, digital footprints analysis should not be confined to online dynamics presumed to be unconditioned by enacted algorithmic awareness. It is no longer just a matter of recognizing authenticity among fakes, nor of breaking through a complex image-control strategy to uncover truthfulness. Instead, it must accept that traces, even the intentionally generated ones, can serve as the minute and manifest clues to an increasingly complex latent reality. An intentional digital footprint, such as the strategic deployment of a hashtag to game visibility metrics, can be read as a symptom of the users' strategic negotiation of platform power and their internalized conceptual models (Eslami et al., 2016).

Furthermore, digital footprints should be read as clues to complex, latent socio-psychological objects, where users' values, attitudes, and preferences intertwine with their platform theories and hidden algorithmic rules.

It means capitalizing on some theoretical and conceptual advances that have been placed at the intersection between research methodology and the social studies of science and technology. In this regard, Marres's (2017) contribution to digital sociology is relevant. The author proposes a research framework to overcome the background/foreground distinction, where platforms should be in the background and human actions in the foreground; and to conceptualize and empirically study non-human agency, moving beyond the conception of platforms as "environments". Taking the issue of interdependence seriously, we should ask *what* leaves a

digital trace: whether it is a human action in a digital environment, or the interaction between human and non-human agencies.

What are the main methodological implications of this reconceptualization of digital footprints?

First, to move beyond the static collection of data (Bennato, 2021). The interdependence between platform and user, or more precisely, the co-agency between human and non-human actions, is better captured by analyzing a process, namely the sequence of user behaviors and algorithmic feedback, rather than point data. Second, this analysis must be situational, based on a deep understanding of the specific characteristics of the platform where digital footprints are left. Third, accepting, indeed exploiting, the possibility that traces may be left intentionally means embedding them in research strategies aimed at identifying the attributions and negotiations of meaning that constrain and shape online interactions as they occur. Rather than treating digital traces as empirical material acquired in large quantities for desk analyses, they can be better understood and valued within more immersive research approaches, such as digital ethnography or cognitive walkthrough. In its most recent evolutions, the latter is rapidly becoming an established methodological strategy in both the fields of digital studies and science and technology studies (STS) (Light et al., 2018; Cavagnuolo et al., 2022).

This perspective seems to put distance from the simple, genuine, clear, and traditional concept of trace-like material, but it proposes a more direct way to capitalize on the epistemological strengths of the indiciary paradigm. It is not intended as a prescriptive procedure or a set of explicit, transmissible techniques; rather, it fundamentally constitutes a posture of attention to detail, to the marginal, to what is in the background or hidden, and which can give cognitive elements that are different and more effective compared to what is in the foreground. A posture that accepts the challenge of complexity and does not seek comfort zones where analysis and interpretation are simplified.

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