

Groundwork for the Ontology of Curiosity

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Abstract

Curiosity is increasingly recognized as vital to healthy aging, but the potential for leveraging research on curiosity to promote healthy aging is undermined by definitional inconsistencies and ambiguities in the literature—an issue that ontologies are uniquely well positioned to resolve. This paper proposes an ontological framework for modeling curiosity that addresses major shortcomings in existing definitions. Drawing on the Basic Formal Ontology (BFO), I define curiosity emotion process in terms of an appraisal of search-worthiness and an exploratory action tendency. I also define a related curiosity disposition. My approach enables clear distinctions among subtypes of both kinds of curiosity. The result is a more flexible, rigorous model of the various phenomena described as “curiosity” that aligns with empirical findings

Keywords

Ontology Engineering, Curiosity, Emotion, Basic Formal Ontology, Healthy Aging

1. Introduction

There is mounting evidence that curiosity plays a central role in promoting well-being across the lifespan. While studies of curiosity often focus on child development or educational achievement, curiosity in later life is now recognized as a key to healthy aging [1, 2]. Engagement in curiosity-driven activities such as lifelong learning programs has been shown to enhance emotional vitality and neuroplasticity, helping to counteract the neurological decline associated with aging [3]. Furthermore, curiosity helps to foster adaptive coping strategies amid significant age-related transitions such as retirement, illness, or bereavement [4]. These transitions often erode individuals’ social networks, however, curious individuals are more likely to experience this increasing solitude as generative — as an opportunity for expanded learning and contemplation [5]. In this way, curiosity may not only buffer the emotional toll of alone-time but also deepen its reflective potential.

One of the fundamental challenges to leveraging research on curiosity for the purposes of studying its impact on healthy aging and solitude is the lack of conceptual and terminological consistency in the literature on curiosity. Literature reviews have found over 30 distinct measures of curiosity and 17 different “dimensions” of curiosity that are disparately studied [6, 7]. Sometimes researchers study only one dimension under the guise of “curiosity” and other times “curiosity” refers to a cluster of these dimensions. Moreover, each dimension goes by a variety of names, making it difficult to know when researchers are studying the same construct under different names and when they are studying different constructs but using similar names. Altogether, this creates a fragmented landscape which makes it difficult to compare findings across studies, aggregate data meaningfully, and identify robust patterns to determine the effects curiosity may or may not have on healthy aging.

Addressing this conceptual disarray is a key motivation for developing a formal ontological representation of curiosity. This paper develops a formal representation of curiosity within the Emotion Ontology (MFOEM) —a domain ontology that extends from the Mental Functioning Ontology (MFO) that is designed to support data integration and reasoning across affective science, psychology, and neuroscience. My goal is to offer an ontological model of curiosity for MFOEM that reflects its multidimensional nature with special interest in enabling researchers in solitude and gerotranscendence to leverage these empirical findings.

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2. Background on the Psychology of Curiosity

In the psychological literature, researchers frequently refer to various “dimensions” of curiosity. This terminology is meant to highlight the fact that curiosity is a multifaceted notion and research may be conducted on different aspects. However, unilaterally calling these “dimensions” risks obscuring important ontological distinctions by creating the misleading impression that they are commensurate or structurally uniform—like the dimensions of height and width, which are both spatial metrics of extension and, therefore, comparable in kind. The so-called “dimensions” of curiosity, by contrast, often vary radically in both ontological category and explanatory role.

Some dimensions are characterized by differences in *appraisal* and *affective tone*. For example, Kashdan and colleagues distinguish between dimensions they call “Joyous Exploration” and “Deprivation Sensitivity.” [8] Joyous Exploration is marked by a positively valenced emotional state and an appraisal of the world as rich and inviting; Deprivation Sensitivity, by contrast, tends to be marked by negative affect—such as anxiety or tension—and involves an appraisal of a lack or gap in information that needs closure. Another dimension of curiosity concerns the *breadth* or *scope* of one’s curiosity [7]. This is captured in measures of general curiosity breadth—whether an individual exhibits interest across a wide range of domains or is narrowly focused on a particular subject area. This dimension does not describe the *kind* of curiosity so much as its *distribution* across topics. Still other dimensions concern the *object* of one’s curiosity [7]. For instance, “social curiosity” refers to curiosity directed specifically toward other people—their experiences, thoughts, or behavior [9, 8, 7]. Finally, some dimensions refer not to curiosity itself, but to *prerequisites*. For example, “stress tolerance” is often included as a dimension of curiosity [8, 7]. But stress tolerance is more aptly understood as a background condition that enables or facilitates the expression of curiosity in uncertain or novel contexts, rather than as a constitutive part of curiosity itself. The lack of standardization of terminology in curiosity research presents two related obstacles to cumulative progress. First, the same phenomenon is often referred to by different names, and second, different phenomena are sometimes labeled with the same name. Both hinder the ability to compare studies, integrate data, and build coherent theoretical models.

A prime example of the first problem is the variety of terms used to describe the construct of curiosity that is defined by a desire to resolve an information gap. Depending on the researcher, this may be referred to as “*deprivation sensitivity*,” “*epistemic curiosity*,” or “*knowledge-seeking*,” to name just a few [10, 11, 7]. These terms often describe a common underlying drive—the desire to reduce uncertainty or obtain knowledge—the lack of standardized usage creates artificial distinctions or false equivalences in the research landscape. Another construct that suffers this fate is the construct of curiosity typically associated with infants and non-human animals — the exploration of novel environmental stimulation. This construct is variously called “*perceptual curiosity*,” “*sensation seeking*,” or “*environmental curiosity*,” despite pointing to a similar behavioral disposition toward novel sensory stimuli [12, 13, 7].

This leads directly to the second issue: sometimes different constructs are labeled with the same or a similar term, which may cause conceptual confusion. For instance, “people-oriented curiosity,” “interpersonal curiosity,” and “social curiosity” can refer to curiosity directed at a particular object, namely, other people. [9, 8] An example of this is the curiosity that inspires people to eavesdrop on others’ conversations or ask someone about their lives. However, in other contexts, “*interpersonal curiosity*” refers not to the *object* of curiosity but to the *method* of inquiry—such as asking other individuals questions rather than seeking information independently [14]. Measures based on this latter understanding do not necessarily assess whether someone is curious about people, but rather whether their preferred inquiry strategy involves interpersonal interaction. In order to accurately disambiguate these constructs and represent their different dimensions, we need a perspicuous ontological definition of curiosity. Developing such a definition is what I turn to in the next section.

3. Ontological Definitions of Curiosity

Despite the importance of curiosity research, a search of Ontobee, BioPortal, and OLS revealed only two ontological conceptualizations of ‘curiosity.’ The first comes from the Emotion Ontology (MFOEM) which conceives of curiosity in the following way:

- **curiosity** =def. a positive emotion that is an interest and engagement in an object or situation with a desire to know more.

The second is offered by the Semantic Science Integrated Ontology (SIO) which defines curiosity as follows:

- **curiosity**=def. the strong desire to know or learn something.

Existing formal definitions of curiosity in ontologies such as the Emotion Ontology and the Semantic Science Integrated Ontology (SIO) offer a useful starting point, but they fall short in three key ways. First, they assume that curiosity is always a *positive* emotion — MFOEM explicitly defines curiosity as a “positive” emotion and SIO does so by virtue of **curiosity** being a subclass of **positive emotion** in their ontology. Second, they both define it too narrowly as a desire for *knowledge*, precluding types of curiosity that target other objects. Third, they categorize curiosity exclusively as a *process*, omitting its dispositional forms. Each of these assumptions limits the power of the ontology to represent the various kinds and aspects of curiosity that psychologists study.

3.1. Problems for the Extant Ontological Accounts of Curiosity

The first problem with the extant accounts is that curiosity is not always *positively* valenced. While curiosity can be a positive emotion — e.g., as it is in the case of *Joyous Exploration* — this is only one facet of a multifaceted construct. Some of the most commonly studied forms of curiosity, such as *Deprivation Sensitivity*, are in fact marked by negative or ambivalent emotional tones. As Kashdan et al. note, *Deprivation Sensitivity* has “a distinct emotional tone, with anxiety and tension being more prominent than joy—pondering abstract or complex ideas, trying to solve problems, and seeking to reduce gaps in needed information.” [8] This kind of curiosity is accompanied by stress, frustration, or even neurotic over-checking and compulsive inquiry (e.g., “I know I locked the door, but I still need to check again”). Such forms of curiosity are integral to understanding how individuals cope with uncertainty and incomplete information, especially in high-stakes or emotionally charged contexts. Definitionally determining that curiosity is *positive* precludes modeling this kind of curiosity.

The second problem is that curiosity is not always a desire for *knowledge*. Although paradigmatic examples of curiosity may involve a desire for knowledge, there are other the kinds of motivations and cognitive targets that curiosity may take. For instance, *Perceptual Curiosity*, drives organisms—including infants and non-human animals—to explore novel stimuli without any explicit representation of knowledge acquisition [15, 16]. This kind of curiosity motivates engagement with the new and unfamiliar, but the engagement aims for novel stimulation rather than forming justified, true beliefs which would amount to knowledge. In other cases, curiosity is not satisfied by mere knowledge, but reaches *beyond* knowledge towards something like *certainty*. Deprivation Sensitivity, for example, often involves agents who continue seeking information even after they report “knowing” the answer. What they appear to seek is not merely knowledge, but something closer to *certainty*. In short, curiosity spans a range of cognitive goals—from low-level perceptual engagement to higher-order epistemic states—and formal definitions that limit it to a desire for *knowledge* are not able to represent the full range of epistemic targets curiosity takes.

Finally, the third problem is that, while both conceptions are right to point out that curiosity is spoken of as a process, it is problematic to suggest that this is the *only* sense of ‘curiosity’ that is discussed in the literature. Curiosity also functions as a disposition. The process sense of *curiosity* refers to a momentary episode of interest or inquiry, but *dispositional curiosity* (a stable propensity to explore,

ask questions, or seek novelty across contexts) is another important sense. Instruments like the 5DCR and the Curiosity and Exploration Inventory (CEI-II) are specifically designed to capture dispositional tendencies toward different types of curiosity [17, 18]. A strictly process-based definition of curiosity cannot represent enduring personality structures. To accurately model curiosity in its full psychological and developmental range, an ontology must accommodate both transient emotional processes and more stable behavioral dispositions.

The next section begins by developing a definition for the *process* sense of curiosity that addresses the first two problems discussed. This will provide a runway for defining a *dispositional* sense of curiosity, solving the third problem.

3.2. A Solution: Curiosity Emotion Process

In MFOEM, curiosity is modeled as a subclass of **emotion process** so, it inherits the suite of mental processes essential for representing **emotion processes** which is defined as [18]:

- **emotion process**=def. An affective process that is a synchronized aggregate of constituent mental processes — including an appraisal process, physiological process involved in emotion, and subjective affective feeling — which is valenced, realizes some intentional modality, and gives rise to an action tendency

This is a fitting ontological parent, as it lends curiosity many mental processes that are necessary for representing many dimensions that psychologists are interested in regarding curiosity. Without delving into precise ontological formalizations, allow me to illustrate the mechanics of each component of **emotion process** by considering a type of another emotion process—joy. The **appraisal process** refers to the mental process of representing some object or event as emotionally salient (e.g., representing a flower or life itself as beautiful). The **physiological process** refers to the bodily changes constitutive of that emotion (e.g., a dopamine surge). The **subjective affective feeling** reflects the first-person experience (e.g., the felt sense of joyful delight). The process is **valenced**, meaning it has an affective tone— it is not mere neutral noticing, but a distinctly positive experience. Furthermore, it **realizes an intentional modality**, which is simply consciousness’s fundamental capacity to ‘represent’ something at all (e.g., a flower or life itself). Finally, it gives rise to **an action tendency**, which is simply a disposition to act in certain ways, e.g., a disposition to smile or to greet a neighbor. Each specific emotion processes will differ in how these components are specified.

I propose that we specify **the curiosity emotion process** in the following way:

- **curiosity emotion process**=def. An emotion process that is a synchronized aggregate of constituent mental processes — including an **appraisal of search-worthiness**, physiological process, and subjective affective feeling — which is valenced, realizes some intentional modality, and gives rise to **exploratory action tendencies**.

This definition specifies two components of the **emotion process** definition, namely, the **appraisal process** and **action tendency** components. First, the **appraisal** involved in curiosity is specified as an **appraisal of search-worthiness** which I define as:

- **appraisal of search-worthiness**=def. an appraisal that represents something as worthy of exploring for the sake of gaining new information.

This sort of appraisal is a hallmark of curiosity that pervades all dimensions and types of curiosity. Importantly, this type of appraisal does not necessarily require robust, cognitive judgments or metacognitive representation. Even infants and non-human animals can engage in this kind of primitive evaluative representation. For example, an infant’s attention to a novel visual stimulus can reflect an implicit appraisal that the stimulus is “worth looking at” without necessarily requiring a reflective

desire for “knowledge,” as both the extant MFOEM and SIO definitions of curiosity problematically require.

Second, the **action tendency** component is specified as an **exploratory action tendency**. This refers to a dispositional orientation to act in ways that are directed toward gaining new information. Defining this component in terms of *information-seeking* further fortifies the solution to the second problem discussed, which arises when curiosity is too narrowly identified with the pursuit of knowledge. What is sought through curiosity may fall short of knowledge (as in perceptual curiosity) or exceed it (as in compulsive information-seeking after knowledge is attained). Additionally, the proposed definition preserves a healthy degree of flexibility. Almost any behavior that aims to reduce uncertainty or reveal new experiential content can fall under the umbrella of **exploratory action tendency**. For instance, if I’m curious about what it feels like to skydive, this might generate a tendency to watch skydiving videos, talk to a friend who’s gone skydiving, or even sign up to jump myself—each of which counts as the realization of my exploratory action tendency insofar as those tendencies emerge as a result of some **curiosity emotion process**.

3.3. Strategic Underspecification of Curiosity Emotion Process

Notably, the proposed definition of **curiosity emotion process** intentionally underspecifies several components, namely its valence, physiological process, and subjective affective feeling. The benefit of this modeling decision is to allow for increased flexibility in modeling the multifarious dimensions of curiosity. The definition refrains from assigning a fixed **valence** to curiosity because, as we’ve seen, empirical research shows that curiosity can manifest with varying affective tones. Some forms of curiosity are associated with highly pleasurable emotional states (e.g., *Joyous Exploration*), which involves excitement, playfulness, and positive engagement. Other forms are marked by discomfort or unease (e.g., *Deprivation Sensitivity*) where curiosity arises from the felt absence of some crucial piece of information and is accompanied by tension, dissatisfaction, or even anxiety. Still other instances, such as *morbid curiosity*, combine both attraction and aversion: individuals are drawn toward stimuli that simultaneously provoke fear or disgust.[19] Because no single valence type adequately characterizes all instances of curiosity, a general ontological account must leave this component open for more specific subclasses to determine.

Likewise, the **physiological process** of curiosity is not monolithic. Different forms of curiosity activate different systems and hormonal responses depending on the nature of the stimulus and the organism’s state. For instance, exploratory curiosity related to novelty-seeking has been linked to dopaminergic activation in reward-related circuits [15], whereas deprivation-driven curiosity may co-occur with heightened cortisol levels or physiological stress responses more typical of anxiety [9, 15]. Sensation-seeking curiosity, on the other hand, may involve physiological markers associated with thrill or risk-taking, such as elevated heart rate and norepinephrine release [9, 15]. By omitting a specific physiological profile from the general definition, we leave room for this variation and avoid prematurely excluding some kinds of curiosity.

Similarly, the **subjective affective feeling** of curiosity varies widely. Some instances of curiosity are accompanied by a sense of wonder or intrigue, others by a nagging itch or a cognitive tension that must be resolved. These differences reflect important experiential diversity across types of curiosity. This definition appropriately avoids stipulating a particular subjective affective character, allowing more specific subclasses to refine this dimension as needed.

Taken together, the specification of appraisals of search worthiness and exploratory action tendencies combined with the underspecifications ensure the general definition of **curiosity emotion process** can function as an inclusive umbrella category. It provides a stable yet adaptable ontological foundation upon which more granular subtypes of curiosity can be built by explicitly refining particular components of the process. *Perceptual Curiosity*, which has gone by several different names, for instance, can be defined as a curiosity emotion process with a specific **exploratory action tendency** and **physiological process**. The exploratory action tendency involved in perceptual curiosity is a drive to seek out not just any information, but *novel orstimulating* sensory information. As mentioned, the physiological

profile is often linked to reward-learning circuits in the brain, especially those implicated in novelty detection and arousal. Hence, we might develop a definition as follows:

- **perceptual curiosity**=def. a curiosity emotion process that has as an occurrent part some a novel stimuli **exploratory action tendency** and some **reward learning physiological process**.

Now consider *Deprivation Sensitivity*, which also has gone by several different names. These terms can be seen as logically connected (if not identical) insofar as they all involve a specification of the kind of **appraisal process**—one that includes not only the categorical **appraisal of search-worthiness**, but also an **appraisal of lack of information**, which motivates closing the information gap. Additionally, they all share a specific **subjective affective feeling** component in involving anxiety, frustration, or restlessness.

- **deprivation sensitivity**=def. a curiosity emotion process that has as an occurrent part some **appraisal of lack of information process** and some **anxious affective feeling**.

This kind of modular specification strategy will be helpful in disambiguating the various senses of “*interpersonal curiosity*.” As mentioned, this sometimes refers to curiosity with a *particular object* — namely, people. To represent this construct within the ontology, we can specify the **realizes some intentional modality** component of the definition. Recall, this component captures the idea that all emotion processes are *about* something—they have intentional content. In this interpersonal subtype, the intentional content is defined in terms of people or social agents.

- **interpersonal object curiosity**=def. a curiosity emotion process that **realizes an intentional modality** with some **social object** content.

This allows us to easily distinguish the object-oriented sense from the **method-oriented sense** of “interpersonal curiosity,” i.e., the sense in which curiosity unfolds through social exchange, such as asking questions, or initiating conversation. What distinguishes the subtype is not what the curiosity is *about* , but how it is *pursued*. To represent this variant, we can specify the **exploratory action tendency** component of the emotion process: it involves a tendency to engage others directly as part of information-seeking. In this way, the ontology can clearly differentiate between object-oriented and method-oriented variants of the same nominal label.

- **interpersonal method curiosity**=def. A curiosity emotion process that has as occurrent part some **social exploratory action tendency**.

By identifying and formalizing the components of the curiosity emotion process, we can clarify the extent to which researchers who rely on different operationalizations of “curiosity” are studying the same or different phenomena and understand the extent to which these phenomena are related.

4. Curiosity Beyond the Emotion Processes: Curiosity Disposition

Having developed a definition of **curiosity emotion process** that can adequately represent the various processual senses of “curiosity” we are now poised to tackle the third problem mentioned previously: curiosity is not only a *process* . For example, when we say that Sue is curious about sea creatures, we do not necessarily mean that she is experiencing a specific episode of curiosity in the moment, but rather that she tends to have those episodes in relevant contexts—a tendency that may persist even during periods of inactivity or emotional neutrality.

In the framework of Basic Formal Ontology (BFO), of which the Emotion Ontology is a distal extension, **dispositions** are defined as **realizable entities**—that is, as powers or tendencies that exist by virtue of the physical makeup of their bearers, and which may or may not ever be fully realized.[20]With this ontological apparatus in place, we can define a **curiosity disposition** as follows:

- **curiosity disposition** =def. an emotion disposition that, if realized, is realized in some curiosity emotion process.

This allows us to account for dispositional talk without conflating it with occurrent emotional episodes. Like all dispositions, a curiosity disposition is *realizable*—it may be manifested in specific episodes, such as Sue’s curiosity disposition being realized when she begins asking detailed questions about sea creatures at an aquarium. It is *modal*—it describes what the bearer *can* or *would likely* do under specific conditions, e.g., if you take Sue to the aquarium, she will likely ask a million questions. It is *materially grounded*—it is instantiated in the physical and neurobiological features of the bearer, such as the dopaminergic reward pathways in Sue’s brain. And it is *graded in strength*—e.g., Sue may have a very strong curious disposition when it comes to marine biology, but she may have only a weak curious disposition when it comes to celebrity gossip.

With this formal account of **curiosity disposition**, we have addressed the third problem stated above. Just like with emotion processes, we can specify different types of curiosity dispositions by linking them to the corresponding subtypes of curiosity emotion processes. For example, a **perceptual curiosity disposition** would be defined as a disposition that, when realized, gives rise to **perceptual curiosity emotion processes**—such as those studied in nonhuman animals and human infants. This framework preserves flexibility while offering ontological rigor and conceptual clarity across use cases.

5. Conclusion

In this paper, I have argued that existing ontological definitions of “curiosity”—such as those found in the Emotion Ontology and the Semantic Science Integrated Ontology (SIO)—are inadequate on several grounds. They tend to over-specify curiosity as a *positive* emotion, as necessarily aimed at *knowledge*, and as a *process* only. In contrast, I have proposed a BFO-conformant definition of **curiosity emotion process** that addresses each of these shortcomings. By formally specifying the emotion process in terms of search-worthiness appraisals and exploratory action tendencies—while leaving valence, affect, and physiology underspecified—I offer a general model that accommodates diverse subtypes. This likewise paved the way for create **curiosity disposition** in order to represent the dispositional sense of curiosity. I summarize the novel terms and definitions in Table 1.

Table 1
Curiosity Terms and Definitions

Term	Definition
curiosity emotion process	an emotion process that has as an occurrent part some appraisal of search-worthiness and gives rise to exploratory action tendencies
appraisal of search-worthiness	an appraisal that represents something as worthy of exploring for the sake of gaining new information
perceptual curiosity	a curiosity emotion process that has as an occurrent part some novel stimuli exploratory action tendency and some reward learning physiological process
deprivation sensitivity	a curiosity emotion process that has as an occurrent part some appraisal of lack of information process and some anxious affective feeling
interpersonal object curiosity	a curiosity emotion process that realizes an intentional modality with some social object content
interpersonal method curiosity	a curiosity emotion process that involves some social exploratory action tendency
curiosity disposition	an emotion disposition that, if realized, is realized in some curiosity emotion process

I expect this development of the Emotion Ontology (MFOEM) will be especially helpful for researchers working at the intersection of psychology and healthy aging. These definitions were devised with

specific psychological constructs in mind, however, further subtyping of curiosity should be developed in consultation with domain experts. Domain expert evaluation would also strengthen the reasoning for adopting definitions beyond the philosophical reasoning I have provided here. As this modeling effort matures, my hope is that the groundwork offered here provides a solid foundation for better research on curiosity in service of aging research and public health.

Declaration on Generative AI

The author(s) used GPT-5 for grammar refinement and reference formatting only. All substantive content was authored and reviewed by the human research team. The author maintains sole responsibility for the work produced here.

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