AKR Advances on Knowledge Representation Journal

Fundamental choices in Epistemic Foundational Ontology

Gilles Kassel[1]

Abstract. *In this article, we continue our study and definition of a class of ontologies known as "epistemic" by laying the foundations for a foundational ontology called the "Epistemic Foundational Ontology" (EFO). We begin by setting out some basic ontological commitments made to establish EFO and then give details of the main categories that structure the ontology. Lastly, to formalize the core of EFO, we set out a set of axioms in first-order logic.*

1. Introduction

In the present article, we continue our study and definition of a class of ontologies that we recently termed "epistemic" (Kassel, 2023) by laying the foundations for a *foundational* ontology called the "Epistemic Foundational Ontology" (EFO).

An epistemic ontology is used to account for knowledge of the world, rather than to account for the world directly. To establish an epistemic ontology, an ontological framework prioritizes the mind – the ability that our representations give us to refer to the world (*intentionality*) and to form judgments about the world; in short, to endow us with beliefs about the world. In Franz Brentano's school at the turn of the 20th century, Kazimierz Twardowski (1977 [1894], 1999 [1903]) defended a theory of intentionality according to which any conceptual representation brings about an *immanent object* – a thought object endowed with properties (Kassel, 2025). This type of conceptual representation is consistent with contemporary work on *mental files* in the philosophy of mind and language (Murez & Recanati, 2016). The categories of an epistemic ontology correspond to general thought objects, which are organized into an abstraction taxonomy. This choice distinguishes an *epistemic* ontology from the *referential* ontologies

[1] Gilles Kassel is Professor Emeritus at the Jules Verne University of Picardy (Amiens, France) and works in the field of applied ontology. He promotes the definition of epistemic ontologies, the role of which is to account for knowledge of the world rather than to account for the world directly. He is the author of the foundational ontology EFO (Epistemic Foundational Ontology). Email: gilles.kassel@u-picardie.fr. Affiliation: Modelling, Information and Systems (MIS) Laboratory, Jules Verne University of Picardie, Amiens, France. https://philpeople.org/profiles/gilles-kassel

commonly developed in ontological engineering (Borgo *et al.*, 2022), in which categories essentially correspond to universals and physical universals in particular.

In this article, we define EFO as a "foundational" epistemic ontology. This qualifier means that EFO is a upper-level ontology and consists of a system of abstract categories whose structuring principles are ontologically grounded. As mentioned above, the basic ontological principles of this epistemic ontology differ from those usually selected by authors of referential ontologies. However, these principles have a rich but neglected pedigree and are now attracting growing interest in contemporary analytic philosophy[2]. Beyond the basic principles, we are confronted with questions that are still debated in metaphysics, such as the existence of Platonic abstract entities, the mode of existence of fictional entities, the nature of time (presentist *vs*. eternalist), and the dimension of entities (three-dimensional *vs*. four-dimensional). Commitments on these issues must therefore be made in line with the basic principles.

We present our basic ontological commitments in section 2 of the article, which gives us an opportunity to compare them with the commitments adopted by the authors of today's foundational ontologies. In section 3, we then outline our approach to defining EFO and present the main categories that structure the ontology. Lastly, in section 4, we set out a set of first-order logic axioms for EFO's core.

2. Basic ontological commitments

In the philosophical fields of ontology and metaphysics (which we shall refer to henceforth as "metaphysics"), ontologies are traditionally *structured systems of entities that are assumed to exist and are organized into categories and relationships*. In applied ontology, and in order to satisfy the constraint whereby ontologies are components of information systems and enable inferences to be made, emphasis is placed on the computer-readable specification of ontologies. "Computational" ontologies are thus defined as "specifications of a conceptualization," according to the now classic and very general definition by Thomas R. Gruber (1993). In this section, we focus our attention on the notion of *conceptualization*. In applied ontology, the categories of ontologies – properties and relations – correspond to universals instantiated by particular individuals. By promoting the notion of epistemic ontology, however, we break with this orthodoxy by assimilating these categories to general mental objects thought of by a subject. In the rest of this section, we distinguish between the *conceptualization* notions underlying referential and epistemic ontologies (sections 2.1 & 2.2) and then outline some basic commitments that we adopt for the development of epistemic reference ontologies and, particularly, EFO (sections 2.3 & 2.4).

[2] Twardowski's contributions to the philosophy of mind and logic have been studied recently. See (Brandl & Woleński, 1999)(Dubucs & Miśkiewicz, 2009) (van der Schaar, 2015, 2022).

AKR Advances on Knowledge Representation Journal

2.1. Mental concepts, rather than universals

In order to clarify the meaning of terms such as "ontology", "conceptualization", and "ontological commitment", Nicola Guarino and Pierdaniele Garietta (1995) suggested equating conceptualization with "an intensional semantic structure which encodes the implicit rules constraining the structure of a piece of reality" (*ibid.*, p. 31). Guarino & Garietta sought to break with Gruber's *extensional* notion of conceptualization (*ibid.*), which equates properties and relations with states of affairs (particular situations in the world). To abstract from particular states of affairs, Guarino & Garietta opt for *intensional* properties and relations by drawing on Richard Montague's semantics, which mobilizes a theory of *possible worlds*. The details of this intensional structure are not important; what is important, however, is that Guarino & Garietta commit to a philosophical theory of concepts – properties and relations – by assimilating them to ideal abstract entities that are distinct from the mental representations held by particular subjects. Barry Smith (2003, 2004) also strongly advocates distancing oneself from mental representations. When criticizing the mental dimension present in Gruber's definition (1995) ("An ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents"), Smith condemns the use of entities that are merely "surrogate-objects" for existing objects in order to promote conceptualizations that directly reflect an objective reality: "it is precisely because good conceptualizations are transparent to reality that they have a reasonable chance of being integrated together in a robust fashion into a single unitary ontological system" (*ibid.*, p. 163).

These criticisms of Gruber's views of conceptualization ultimately led to a widely held position in applied ontology, which consists of assimilating the categories of conceptualization with Aristotelian universals (Borgo *et al.*, 2022). On the terminological level, the terms "conceptual" and "cognitive" are merely borrowed from psychology when they are used (for example) in the expression "cognitive domain of entities". Although the individuals instantiating universals are described as "cognitively relevant objects", they nonetheless remain objects that transcend the human mind.

This universal-centered notion of conceptualization (referred to as the principle of "ontological realism" by the authors of BFO (Otte *et al.*, 2022)) raises many questions (Merrill, 2010). We have two main criticisms of this universal-centered notion. Firstly, it cannot satisfy nominalists of universals – a respectable philosophical position to which the author subscribes. It does not seem reasonable to maintain the existence of an entity present identically in countless particulars. It should be noted in this regard that in the philosophy of biology, there is a strong trend toward anti-essentialism (see Dupré (1993), Sober (2000), Okasha (2002)). Secondly, the principle of "ontological realism" leads one to deny ontological status to fictional entities that "do not really exist". We are not talking here about fictional characters such as Sherlock Holmes (who are considered to be socially existing entities) but about the detective in the flesh. According to psychological

data, we do indeed confer existence on Holmes and Watson, but in a world distinct from the real world (see section 3.2).

The question is therefore whether an alternative to this notion of conceptualization is conceivable. It is precisely such an alternative that we propose as the basis for epistemic ontologies.

The principle of "ontological realism" stems from a strategy pursued by a line of mathematical philosophers – Frege, Husserl, Carnap, Tarski, and Montague – who sought to remove psychology from philosophy. At the turn of the 20th century, the members of the Brentanian school of *descriptive psychology* considered other semantic options. Brentano is acknowledged as the philosopher who brought the question of *intentionality* back to the forefront of contemporary philosophical debate (Albertazzi, 2006). His recently reassessed scientific contribution was to propose a model of indirect reference that combined immanent intentionality with the act of *presentation* or *thought* (*Vorstellen*) and external reference with the act of *judgment* (*Beurteilen*) (Taieb, 2017; van der Schaar, 2023). Between 1891 and 1897, Brentano accorded ontological status to an immanent, intentional object bearing properties (Chrudzimski, 2013). Kazimierz Twardowski – one of Brentano's most faithful disciples – followed in his master's footsteps with a theory of conceptual representations (1977 [1894], 1999 [1903/14])[3].

Twardowski's theory (whose foundations we adopt) is based on two main theses. Firstly, every representation – including those that do not admit an (external) reference – "brings about" an immanent object. Twardowski thus famously opposed Bolzano's conception of *anobjectual* representations because the latter were non-referential: "The confusion made by the defenders of representations without objects consists in this: they have held the non-existence of an object of representation to be a non-becoming-represented. However, through every representation, an object becomes represented, whether it exists or not, just as every name names an object, regardless of whether it exists or not" (1977 [1894], section 5). Secondly, by focusing on conceptual representation, Twardowski proposed a four-term structure: *act*/*concept* [*object* endowed with properties]/transcendent *object of reference*. This structure can be interpreted as follows. In any act of conceptual representation, a concept conveys as its content an object – let us call it the "thought object" – endowed with properties. The concept thus allows a subject to mentally project into his/her consciousness an object belonging to an arbitrary category – a physical object, for example. According to Twardowski, there are two types of immanent thought objects: *singular* objects (e.g., "Simba", "the Eiffel Tower", and "Paul's pneumonia") and *general* objects (e.g., "a lion", "a building", and "pneumonia"). The former represent particular individuals, while the latter indirectly represent individuals by possessing properties common to a plurality of singular objects. General

[3] Contrary to Brentano's post-1904 "reist" phase, during which he changed his ontology and admitted only real entities (Chrudzimski & Smith, 2004).

objects are organized into a hierarchy of abstraction links. We can therefore consider that each thinking subject mentally possesses an ontology of general thought objects (Kassel, 2025).

In summary, and with regard to our notion of conceptualization, we retain the philosophical notion (mentioned in the Introduction) of a "structured system of entities assumed to exist, organized into categories and relationships", assimilating categories and relationships to general objects of thought that represent the world, rather than universals.

2.2. Concept *vs* conception

By adopting the mental notion of conceptualization, we leave ourselves open to the famous criticisms of Frege and Husserl concerning the variability of mental representations, which were the source of their antipsychologism – particularly with regard to meanings. We abandon the comfortable objectivity of universals and abstract ideal thoughts in favor of subjective, private ideas, although we must deal with the problem of explaining how different subjects can nonetheless "think about the same thing". The explanation lies in the combination of two theses that are now widely accepted in cognitive psychology and the philosophy of language. Firstly, one must distinguish between the *concept* and its content (the *conception*), in order to account for both the endurance of the former and the dynamism of the latter. Secondly, the *similarity* of our conceptions creates *intersubjectivity* and thus makes it possible to account for the conditions of successful communication and knowledge sharing about the same objects.

Twardowski's concept and the contemporary notion of a *mental file* share the property of conveying content, referred to as the "conception" of the concept/file. In the Twardowskian concept, conception corresponds to an object with properties. According to François Recanati (2012), this distinction between concept and conception is important for explaining how a subject can "think about the same thing at different times" and possibly think about it differently. The same *continuant* concept with a fixed reference is used, while the content is likely to change as new information is acquired.

The "sharing" of conceptions must still be explained: in other words, the fact that "several subjects can think of the same thing." The explanation lies in the existence of various psychosocial processes. One of these processes is the baptism of particular entities (people, animals, places, and various objects) by giving them a proper name. This proper name can be passed down from generation to generation through communication—a process already highlighted by Twardowski but formally described by Saul Kripe (1980), who is commonly credited with its invention. Another such process is the use of ostensive speech acts (e.g., "This is yellow", "This is a dog") that enable a subject to acquire the extension of concepts, in a process described by Hilary Putnam (1975). One can also consider the *inculcation* of scientific theories in education. Together with the fact that conventionally constructed terms are integrated into conceptions, all these processes help

to explain the similarity of conceptions among subjects from the same linguistic and cultural community. In his (2016) work, Recanati developed an ideal notion of a *shared mental file* to explain the identity of thoughts and judgments, while acknowledging that only private mental files exist.

We have just acknowledged a shared social construct dimension for concept conceptions (contents) but one observation must be made: even though we acknowledge similarities in the conceptions of our concepts referring to given objects, not all subjects share the same concepts. This raises the following question: which criteria should be used to select concepts (general objects) for establishing a reference ontology that facilitates knowledge sharing (the role assigned to foundational ontologies in applied ontology)? In the rest of this section, we shall examine this question from two complementary angles.

2.3. Manifest and scientific images of the world

The authors of foundational ontologies sought to base the latter's structure on well-established metaphysical principles. However, the plethora of metaphysical theories raises the question of which principles should be chosen. Since Peter F. Strawson's work (1959), it has been common to distinguish between *descriptive* metaphysics and *revisionary* metaphysics. According to Strawson, "descriptive metaphysics is content to describe the actual structure of our thought about the world, revisionary metaphysics is concerned to produce a better structure" (ibid., p. 9). In fact, this distinction raises the question of the weight that should be given to common-sense categories, scientific categories, and those that are strictly metaphysical. According to today's dominant strategy, common sense (i) has a special status, with epistemic and alethic value, and (ii) can be compared with science (which provides knowledge about existing entities) and metaphysics (which provides knowledge about modes of existence) (Guyon, 2023). However, this strategy remains general and ultimately requires one to choose between the available scientific theories and the available metaphysical theories. In this respect, we set ourselves a key objective: to rehabilitate cognitive psychology within metaphysics, which involves selecting metaphysical theories that are consistent with psychological data. A emblematic example (as mentioned above) is to psychologize the entities placed by Frege in his third world of thoughts[4].

To illustrate these principles, let us analyze the perceptible qualities of material objects; for brevity, we shall limit the latter to colors. As a starting point, consider the benchmark interdisciplinary analysis of colors (drawing on psychology, physiology, chemistry, and physics) conducted by Alex Byrne and David R. Hilbert (2003). Byrne & Hilbert distinguished between a mental, phenomenal percept that can be expressed as a quality (with a magnitude) inherent in the colored object and a physical *disposition*: "the

[4] In this regard, we follow Michael Dummett's (1991) criticism, which describes this third world as "ontological mythology."

AKR Advances on Knowledge Representation Journal

proportion of incident light that the object is *disposed* to reflect at each wavelength of the visible spectrum" (*ibid.*, p. 9). One advantage of proposing a physical disposition is that it explains the *constancy* of color: under standard lighting conditions, the object appears to us to have the same color. However, this proposal conflicts with a conception that has gradually gained acceptance in metaphysics concerning the *reality* of dispositions. According to (Mumford, 1998; Mellor, 2000; Kistler, 2020), the distinction between dispositional and categorical properties is a matter of linguistic and conceptual levels: a disposition refers to a *power* or *categorical basis* that causes a *manifestation* under certain conditions. The terms "power", "categorical basis", and "manifestation" refer to roles played by real entities; what, then, is their nature? Again considering the example of colors and according to Robert Pasnau's (2009) analysis, a physical color (as a characteristic affecting a colored object) can be identified with a multitude of microprocesses in which light is absorbed and re-emitted at the surface of the object. The term "process" refers to an activity affecting atoms near the surface of the object (hence the qualifier "micro"), namely the reconfiguration of electron orbital distributions by absorbed light energy.[5] According to the conception of dispositions that we have just outlined, we are thus dealing with a processual *manifestation* whose *categorical basis* – namely the structure of surface atoms – precisely explains the *constancy* of the phenomenal color. Since the manifestation is conditioned by the occurrence of a light flux illuminating the object, the properties of attributing a specific color (e.g., "being red") are dispositional.

How should we interpret the results of these analyses? Our conceptualist notion of conceptualization prompts us to set aside the rhetoric of "mental side, physical side", suggesting the existence of entities on each side, and to highlight two thought objects corresponding to two mental conceptions of the same physical reality. Like the two famous tables (one ordinary and the other physical) of the physicist Arthur S. Eddington (1929), we are dealing with two colors: one based on common sense – namely a quality inherent to the object – and the other informed by physics – namely a multitude of microprocesses occurring at the surface of the object. These are manifest and scientific images of the same world, which we assimilate to two meanings of a property sur as "being red". Each with an alethic value: the subject perceiving a colored object is justified in believing that he sees a color *in* the object, and science is indeed capable of providing an explanation for this perceptual experience. In some cases, the manifest image is further removed from the scientific image: I see the sun rising, and science explains this apparent (not real) movement by the Earth's rotation around the Sun and on its own axis. In any case, with regard to metaphysical commitments, it is more appropriate to speak of "complementarity" rather than "revision."

[5] As described in Kurt Nassau's authoritative work (2001) *The Physics and Chemistry of Color*.

2.4. Multiplicative *vs*. reductionist approaches to material reality

To continue outlining our basic commitments, we address the question of the nature of material objects (particularly mesoscopic objects: tables, chairs, and other everyday objects) and how we think about them. In metaphysics, Peter van Inwagen (1990) famously advanced a reductionist thesis that refuted the existence of these ordinary objects, while Kit Fine (1982) just as famously advanced a multiplicative thesis defending the existence of *qua-objects* – literally physical objects "amalgamated" with an intensional description. An example of a "qua-object" is a statue of Goliath identified as a block of bronze having the shape of Goliath. According to Fine (*ibid.*, p. 100), the statue and the block of bronze have different properties (the statue has an intensional feature that the block of bronze does not) and are distinct material objects. This multiplicative strategy was adopted in the applied ontology community by Laure Vieu *et al.* (2008), in order to distinguish between a material artifact and the physical object that constitutes it and to which a function has been assigned (e.g., a paperweight and a pebble) or a role and the object fulfilling the role (e.g., an individual passenger on an Air France flight). Fine (1999) subsequently theorized and expanded this concept of the "qua-object" with the notions of *rigid* and *variable embodiments* to account for the structure of complex objects composed of other objects. In our choice of an ontological theory, we preferred to apply our principle of descriptive metaphysics backed up by science, rather than an *a priori* criterion of number of entities (such as the principle of parsimony).

Elisabeth S. Spelke's (1990) work on the psychology of perception and development gives these everyday objects a mental reality: we conceive of them as solid, connected masses of matter that move as a whole. Jean Petitot and Smith (1996) argued that the physical sciences are capable of justifying the existence of these objects and that these objects are part of the domain of the material sciences. In fact, manifest and scientific images of these objects coexist, with the manifest object being more homogeneous (containing less empty space) than the physical object.

In seeking to account for the intrinsic nature of material objects, Fine calls on metaphysics to deepen the objects' scientific image. According to his theory of *embodiment*, a complex material object is a whole composed of material objects and an intensional or conceptual entity that accounts for the components' arrangement as a whole. For example, a ham sandwich is a whole composed of two slices of bread s_1 and s_2, a slice of ham h, and the relation *being between*: $<s_1, h, s_2,$ *being between*$>$ (1999, pp. 65-68).

In our view, this theory has a significant flaw. On the metaphysical level, it amounts to introducing inhomogeneous objects (composed of material and intensional or conceptual entities) that are usually considered (by virtue of their inhomogeneity) to be ontological chimeras. We can make the same observation about the statue of Goliath, whose identity criterion incorporates the concept of the mythical character Goliath – a

AKR Advances on Knowledge Representation Journal

non-material component. However, there is a specifically material way of accounting for complex objects[6]. Firstly, the weight of the top slice of bread in a sandwich held horizontally is sufficient to ensure its integrity. To prevent movements that could compromise this integrity, fat (e.g. butter) can be added to improve the adhesion of the bread slices and ham. Lastly, if this is not enough, a piece of paper can be added to wrap the sandwich to make it easier to transport. In short, various physical *connections* ensure the integrity of the whole, with or without the presence of additional material.

The notion of physical *connection* allows us both to keep ordinary objects in the realm of material science (without needing to mobilize intensional or conceptual concepts) and to avoid their multiplication as material objects. Descriptions of these objects, such as attributing the shape of Goliath to a block of bronze or a price on the art market, are part of our knowledge about these objects. Multiplicity is on the mental (conceptual) side, not the material side. To continue our analysis of the intrinsic nature of material objects, we would have to look at the relationship of *constitution* and the nature of its *relata*, which is commonly referred to when accounting for the relationship between objects and the matter of which they are composed. For reasons of space, we shall not undertake this task here; instead, we shall provide an overview of EFO.

3. An overview of EFO

The ontological commitments presented in section 2 lead us to consider that every thinking human being psychically possesses an epistemic ontology consisting of a set of general thought objects organized into a hierarchy of abstraction links. In this section, we seek to lay the foundations of a *foundational reference* epistemic ontology. To this end, we adopt a two-pronged approach.

Firstly, and considering that an epistemic ontology is by definition that of a particular subject, we select a specific subject. In fact, we select a subject whose ontological commitments correspond to those presented in section 2. The author of the present article considers himself to be such a subject.

Secondly, and in accordance with our general strategy (in which ontological theories remain in competition), we choose to favor common sense and give priority to theories (particularly those from cognitive psychology) based on scientific data. In line with these objectives, we prefer *presentism* to *eternalism* as a theory of time and we reject *four-dimensionalism* (particularly as applied to physical objects). Furthermore, we defend the realism of *fictional worlds*. The resulting ontology is based on a set of principles that are clearly identified and defended in the literature, which is a prerequisite for serving as a *reference* ontology in knowledge engineering.

[6] Details are provided in (Kassel, forthcoming). In this reference, we draw on an ontology of *connections* (and particularly physical *connections*) proposed by French metaphysician Frédéric Nef (2017).

AKR Advances on Knowledge Representation Journal

EFO comprises around thirty categories corresponding to general thought objects and organized according to generality links (Figure 1). In the rest of this section, we informally characterize these various categories.

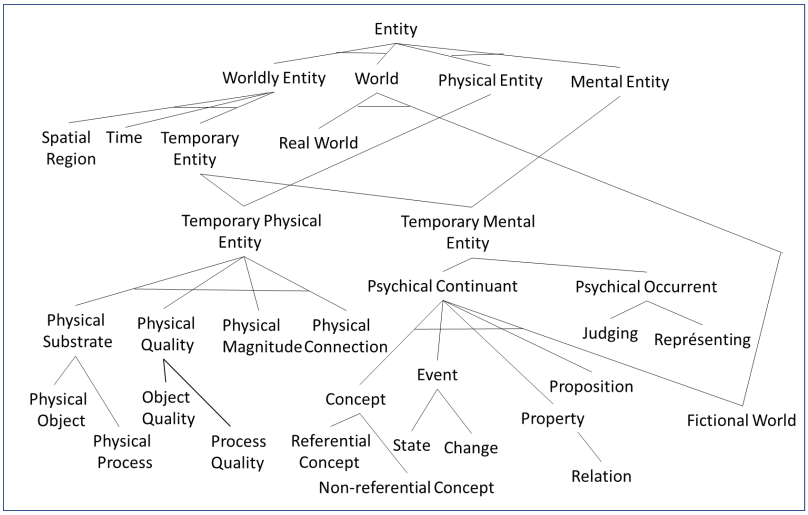

Figure 1. Overview of the main categories in EFO

3.1. Worldly entities: physical and mental

As mentioned above, EFO categories correspond to general objects that reflect how we conceive the world. We posit that thinking about something in the most abstract way possible is equivalent to thinking about an entity that exists in a world (whether real or fictional) that itself exists. The notion of existence referred to here is commonly called *existence simpliciter* in philosophy, meaning that the entity is part of a world; we discuss the spatial and temporal implications of this below. The categories Worldly Entity and World thus constitute a classification axis on EFO's first level, under the root Entity.[7] Being part of a world is equivalent to possessing a singular *nature* or *essence*. Since Aristotle, most philosophers have considered that the property of existence in itself does not participate in the nature of the Entity. The attribution of this property is an act of judgment by a subject. Recognition or denial of existence is handled by the Concept of the Entity (see section 3.2).

Before further developing our concept of a fictional world (see section 3.3), we note that the latter (and even fantastical worlds) often share features with the real world. Like the real world, fictional worlds are populated by subjects capable of representing their world. We use these similarities as a pretext to distinguish (in any World) between Physical Entities (which exist independently of being thought) and Mental Entities. This explains the second classification of Entities on EFO's first level. Let us take this

[7] The EFO categories will then appear in Courier New font.

AKR Advances on Knowledge Representation Journal

opportunity to state clearly that Physical Entities and Mental Entities constitute a partition of Worldly Entities, reflecting the nominalism of Platonic abstract entities.[8] The reader may be surprised to learn that Physical Entities exist in fictional worlds (i.e. imagined in the mind), which should *de facto* be Mental Entities. It should be noted that these entities (such as Sherlock Holmes and John Watson) exist in the world of Conan Doyle's stories independently of being thought of by other beings in that world. Holmes and Watson are therefore Physical Entities in their Fictional World; in contrast, Holmes and Watson's thoughts are Mental Entities.

Let us now turn to the structure and content of a World. With reference to the Real World, we consider that a World is presented to us through space-time (or through Spatial Region and Time) – two entities that exist timelessly. A World is also populated by entities that occupy it temporarily. For these Temporary Entities, existence *simpliciter* necessarily implies existence *at* times. According to a common conception, space is a *dimension* that acts as a container for temporally coexisting entities. These entities can therefore maintain genuine spatial relationships. Time, on the other hand, lacks this property.[9] Intuitively, the author of the article does not consider that he has a genuine temporal relationship with, say, Julius Caesar.[10]

Let us continue characterizing Temporary Entities in relation to the nature of time. Denying time a dimensional quality leads us to opt for a *presentist* theory of time, according to which a Temporary Entity comes into existence at one point in time and ceases to exist at another. In other words, at the present time, past entities have ceased to exist, while other possible entities will exist in the future (Ingram & Tallant, 2023). Between the moment when the entity comes into existence and the moment when it ceases to exist, the entity *subsists*. There are two main philosophical positions on how an entity subsists: *endurantism* and *perdurantism* (McKinnon, 2002). Endurantists consider that a single entity exists fully – in its full *identity* – at different times. In contrast, perdurantists consider that an entity (i) is extended in time in a manner analogous to its spatial extension and becomes a four-dimensional entity (Sider, 2001), and (ii) has different parts at different times, with the entity's identity being completed as it gains new parts. Like Peter Simons (2000) and Jean-Baptiste Guillon (2024), we recommend relying on a common-sense conception when choosing a theory, i.e. a conception that can be explained by data

[8] The *raison d'être* of this nominalism is to return, *pace* Frege and his followers, to a social objectivism that is taken care of by the mind. For a defense of this position, we refer the reader to (for example) Fronda (2022).
[9] It should be noted that the concept of *space-time* that we adopt here is a common-sense concept. There is nothing to prevent us from eventually integrating a scientific (relativistic) concept of *space-time* (in which time is conceived as a true dimension) into EFO.
[10] The argument is detailed by Jonathan Lowe in (2006, section 8 *Presentism*, 287-288) and has to do with the notion of *external relations*, which we do not introduce here.

AKR Advances on Knowledge Representation Journal

from psychology and the physical sciences. We therefore opt for a presentist theory of time and assimilate our Temporary Entities to three-dimensional endurants.[11]

3.2. Referential *vs* non-referential concepts

Concepts are central Entities in EFO. Entities are only thought of as objects of Concepts, which are specific to a Subject. It should be borne in mind that a Concept is the vehicle that allows a Subject to think about an Entity. All EFO Entities, whether singular or general, are necessarily the object of a single Concept – including Concepts themselves. These in turn become carriers of properties. The information associated with Concepts is potentially very varied. In particular, the information concerns the subject possessing the Concept, the origin of the Concept (communicative, perceptual, or imaginative), the social nature of its content (common sense or scientific), and its mode of subsistence (ephemeral or stable). At this stage of the definition of EFO, we seek to account for two main properties, namely whereby a Concept is *possessedBy* a Subject and whereby a Concept *represents* another entity for a Subject.

Regarding ownership, Concepts are (in standard EFO usage) considered by default to be those of a reference Subject. In advanced usage, EFO makes it possible to represent Concepts from among other Subjects. These concepts can be individual (e.g., enabling the analysis of the content of polyphonic discourse) or generic (e.g., enabling the comparisons of categories from different ontologies).

With regard to representation, two cases must be distinguished: (1) the Concept *represents* (or does not *represent*) an entity in itself, that is, transcendent to the mind of the Subject; (2) the Concept *represents* an Entity of another Concept immanent to the mind of the Subject.[12]

Case (1) corresponds to the judgment of existence *per se* or, in other words, to the question of whether objects "exist" or "do not exist." This is the meaning that Twardowski gives to the notion of a *non-existing object* when he asserts that expressions such as "the square circle" and "the mountain of gold" do not refer to any existing entity. This same conception of non-referential entities was established by Frege (1892) when he noted that expressions such as "the celestial body furthest from the Earth" or "the sequence that converges least rapidly" have a meaning but not a denotation. Indeed, these expressions have a meaning that we interpret as the attribution of properties to objects in the fields of geology and mathematics, respectively. This means that these objects are endowed with (amongst other things) a existence *simpliciter* and an existence at given times. In other

[11] Readers may be surprised to see that this choice leads to classify occurrent entities (processes and events) as enduring - given that they are usually (in the literature) equated with perduring entities. These ontological commitments are set out in (Kassel, 2019).
[12] We deal with this case (2) in section 3.5.

AKR Advances on Knowledge Representation Journal

words, they have a spatiotemporal position in a World. A property attributed to the Concept specifies whether its object has a counterpart in the World in question.

3.3. Fictional worlds and their entities

First and foremost, it should be borne in mind that when we talk about a "fictional character," this term is homonymous because it refers to a *character*$_1$ created by an author to bring a *character*$_2$ to life in a fictional world. Thus, we must distinguish between *Sherlock Holmes*$_1$, created by Conan Doyle and appearing in 1887 in the novel *A Study in Scarlet*, and *Sherlock Holmes*$_2$, the private detective living in 19th-century London, an accomplished violinist, cocaine addict, and master of solving mysteries. *Sherlock Holmes*$_1$ is a cultural artifact that exists in the real world, a mental object with a social identity. *Sherlock Holmes*$_2$ is a mundane entity that exists in a world created by Conan Doyle.

This distinction and the reality of *SH*$_2$ presuppose a *modal realism*, as defended in particular by David Lewis (1986) and for which Carola Barbero and colleagues (2024) recently provided a psychological justification. These authors conducted the following experiment with around a hundred subjects who were laymen in metaphysics. The subjects were asked to evaluate the truth conditions of sentences such as "Emma Bovary exists and Barack Obama exists", "Sherlock Holmes exists and Anna Karenina exists", or "Penelope Cruz exists and Snazzo exists"; the terms were varied to refer to real people, fictional people, and non-existent objects (such as "Snazzo"). According to Barbero and colleagues (*ibid.*), the best psychological interpretation of the results is that the subjects considered that (i) terms such as "Barack Obama" and "Emma Bovary" refer to existing objects, whereas terms such as "Snazzo" do not, and (ii) real and fictional objects cannot meet, as they live in separate worlds, which prevents them from having causal interactions.

The conceptualization of EFO is consistent with these analyses. It allows us to consider that (i) Barack Obama, Julius Caesar, Aristotle, Emma Bovary, the gods of Olympus, and other mythological figures exist *simpliciter*, while admitting that (ii) some of these physical entities populate a Real World,[13] while others populate a Fictional World.[14]

3.4. Physical Substrates, Qualities, and Their Magnitudes

This part of the conceptualization of EFO has already been presented in various publications. Therefore, in this section, we shall simply illustrate the main categories by

[13] The generic category Real World is justified by the idea (recently proposed in physics) in which there may be several universes beyond the Universe corresponding to everything that is in causal contact with us.

[14] For space reasons, we do not address judgments concerning fictional entities. In any case, the contents of these judgments must mention the world concerned, as proposed by Lewis (1978).

using an example and taking care to clarify the boundary between the physical (material) and the mental. To this end, we shall consider a patient whose body temperature fluctuates throughout the day. At the end of the day, a physician makes the following assessment: “The patient's temperature has increased since this morning”.

The material reality is populated by the patient and the physician, as living human organisms and a kind of `Physical Object`. According to EFO's conceptualization, two singular objects represent the patient and the physician. Temperature measurements during the day were taken using an artifact, the thermometer. Here, we have another singular `Physical Object` to which a *function* is assigned. As already justified and in accordance with John Searle (1995), we consider that the *function* of the thermometer is not an intrinsic material property but depends on the observer (Kassel, 2023, section 3 *Technical artifacts*). In line with our ontological commitments, we identify function as purely conceptual property. Nevertheless, this property is carried by the singular object, as are the thermometer’s material properties. The temperature is an `Object Quality` inherent to the patient and the magnitude of which varies continuously. The descriptions that we have just established are part of a manifest image of the world.

Ultimately, the physician assesses the occurrence of an `Event`. According to the commitments presented in (Kassel, 2019, 2022), we consider that the `Event` “Increase in the patient's temperature since this morning” accounts historically for a qualitative change but that this change does not exist materially (an `Event` is a kind of `Psychical Continuant`). Here, the representation of the material world is a type 1:n relationship. The truthmakers of the occurrence of the `Event` are inherence facts of the patient’s temperature, represented by the `Physical Connection` category (Kassel, *forthcoming*).

3.5. Various representations of objects

To conclude our overview of EFO’s conceptualization, we shall discuss how a subject can maintain several Concepts of the same object and can represent that object according to different aspects. To illustrate this, let us consider a subject leafing through a photo album dedicated to a person named “Paul” and imagine the subject thinking, as he/she turns the pages, about “Paul on his 10th birthday”, “Paul at his graduation”, “Paul doing his military service”, etc. In doing so, we postulate thought experiments involving multiple co-referential representations. In the literature on mental files, these concepts are equated to “ephemeral” files relating to the same object (Recanati, 2012, 2016).

As mentioned in section 3.2, we account for the content of these thought experiments by means of *representation* links between Concepts: these links represent the fact whereby the object of Concept$_1$ *represents* the object of another Concept$_2$. In our example, each 'spatio-temporalized Paul' is an object of an individual Concept which represents, in a sense, an 'idealized Paul' as the object of an encyclopedic file. However,

AKR Advances on Knowledge Representation Journal

do not endurantist and perdurantist theories assume the existence of a single (idealized) entity, thus justifying the ability to mentally select particular aspects of these entities?

4. Outline of an axiomatic system for EFO

In this short section, we shall outline the formalization of EFO. The objective is to illustrate the type of axiomatic system that we wish to provide for EFO and to highlight a few technical aspects. Since EFO's conceptualization involves objects with properties, first-order logic appears *a priori* to be appropriate for axiomatizing the ontology[15]. Put simply, and unlike the axioms established for common foundational ontologies, the domain of quantification is composed of (and restricted to) singular thought objects, rather than particular instances of universals.

4.1. Physical and mental worldly entities

Axiom A1 introduces a *simpliciter* existence. The predicate 'in(x,w)' holds for "the `Worldly Entity` *x* occupies a spatiotemporal place in `World` *w*". Axiom A2 expresses the non-permeability of `Worlds`.

A1 $\text{in}(x, w) \rightarrow \text{WorldlyEntity}(x) \wedge \text{World}(w)$

A2 $\text{WorldlyEntity}(x) \rightarrow \exists!w(\text{World}(w) \wedge \text{in}(x,w))$

Axiom A3 introduces temporary existence. The predicate 'presentAt(x,t)' means that "the `Temporary Entity` *x* is *`presentAt`* `Time` *t*". A `Temporary Entity`

[15] At this stage in our definition of EFO, we have not committed to the precise nature of the objects; they may be prototypes (Rosch, 1975) or stereotypes (Putnam, 1975). If necessary, we shall adapt our choice of formal logic.

AKR Advances on Knowledge Representation Journal

is present at `Times` without being eternally present (A4) and temporarily occupies a `Spatial Region` (predicate 'position(x,r,t)' and axioms A5-7).

A3 presentAt(x,t) → TemporaryEntity(x) ∧ Time(t)

A4 TemporaryEntity(x) → ∃t(Time(t) ∧ presentAt(x,t)) ∧ ∃t(Time(t) ∧ ¬présentAt(x,t))

A5 position(x,r,t) → Entity(x) ∧ SpatialRegion(r) ∧ Time(t)

A6 position(x,r,t) → presentAt(x,t)

A7 TemporaryEntity(x) → ∃r,t(SpatialRegion(r) ∧ Time(t) ∧ position(x,r,t))

4.2. Referential *vs.* non-referential concepts

According to our notion of the `Concept`, the latter is possessed by a subject and gives the said subject the ability to think about entities and to represent them (according to a phenomenon of lieutenancy).

Axioms A8-9 deal with the possession of `Concepts` by a subject. The predicate 'possessedBy(x,y)' holds for "the `Concept` ***x*** is *`possessedBy`* `Human Being` ***y***." At this stage, EFO's conceptualization does not allow for a general notion of *subject* that encompasses a *collective subject*.[16] Consequently, we shall simply mention the category `Human Being`, which we consider to be subsumed by the category `Physical Object`.

A8 possessedBy(x,y) → Concept(x) ∧ HumanBeing(y)

A9 Concept(x) → ∃!y(HumanBeing(y) ∧ possessedBy(x,y))

Since a `Concept` is specific to a subject, the same applies to its content. Theoretically, as seen in section 3.2, the content of a `Concept` (its conception) is likely to change over time. However, its object remains identical and (since the `Concept` is *`possessedBy`* a subject) is dependent on the subject. To account for this dependency, we propose representing the link between the `Concept` and its object by the predicate 'object(x,y)', meaning that "the `Concept` *x* has the `Entity` *y* as its object". Conceptually, this property and its converse 'objectOf(x,y)' do not refer to the entity itself but to an entity thought by a subject. In the "being-such" (to use a Meinongian terminology) of an entity (a physical entity, for example), these properties do not therefore have the same status as a property of color, shape, etc., relating to an entity in itself. In

[16] We would need this to represent (for example) concepts from other foundational ontologies, as attributed to the authors of the said ontologies.

AKR Advances on Knowledge Representation Journal

the Meinongian school, this difference in status corresponds to a distinction between *nuclear* properties and *extranuclear* properties (Griffin, 2017).[17]

A10 object(x,y) → Concept(x) ∧ Entity(y)

A11 Entity(x) → ∃!y(object(y,x))

Let us now turn our attention to the property of `Concepts` as representations of entities. In section 3.2, we distinguished between two situations, depending on whether the entity represented is an entity in itself (transcendent to the subject's mind) or an entity thought of as the object of another `Concept`.

In the first situation, and given that the represented entity is outside the domain of quantification (because the latter is restricted to thought objects), the reference cannot be represented by means of a relation. We therefore introduce the predicate 'existsInItself(x)', meaning that "the `Concept` x represents a transcendent existing entity" (A12). The categories `Referential Concept` and `Non-Referential Concept` are defined by means of this property (D1-2).

A12 existsAsSuch(x) → Concept(x)

D1 ReferentialConcept(x) =def Concept(x) ∧ existsInItself(x)

D2 Non-ReferentialConcept(x) =def Concept(x) ∧ ¬existsInItself(x)

To account for the second situation, we introduce the predicate 'represents(x,y)', meaning "the object of `Concept` x *`represents`* the object of `Concept` y" (A13). The fact that an object of a `Concept` exists in itself propagates along a chain of representation links (A14-15).

A13 represents(x,y) → Concept(x) ∧ Concept(y)

A14 represents(x,y) ∧ ReferentialConcept(y) → ReferentialConcept(x)

A15 represents(x,y) ∧ Non-referentialConcept(y) → Non-referentialConcept(x)

5. Conclusion

In this article, we have laid down guidelines for defining a foundational epistemic ontology whose categories correspond to objects of mental conceptual representations, and we have identified issues relating to its definition. The guidelines include the choice of metaphysical principles on which the ontology can be based – a choice largely dictated

[17] Technically, in EFO, this choice is dictated by the non-introduction (for the sake of simplicity) of representation objects into the ontology. The reader will note that axiom A10 constrains the object to be a singular object. In other words, we only account for singular concepts. To extend the axioms to general concepts, we would need to reify the predicates and introduce a second-order predicate.

by the rehabilitation of cognitive psychology in metaphysics. A number of the challenges remain, including a renewed analysis of knowledge and its boundary with the material stratum of reality – as demonstrated in particular by our critique of Fine's notions of 'qua-objects' and embodiment. The author's goal is to complete this work by integrating the missing domains of entities and thus to arrive at an ontology that is sufficiently complete for use in concrete applications.

References

Albertazzi, L. (2006). *Immanent Realism. An Introduction to Brentano*. Synthese Library, *Studies in Epistemology, Logic, Methodology, and Philosophy of science*, *333*, Dordrecht: Springer.

Barbero, C., Domaneschi, F., Enrici, I. & Voltolini, A. (2024). What is Existence? A Matter of Co(n)text. *Acta Analytica*, *39*, 1-39.

Borgo, S., Galton, A. & Kutz, O. (2022). Foundational ontologies in action, *Applied Ontology*, *17*(1), 1-16.

Brandl, J.L. & Woleński, A. (Eds.)(1999). *Kazimierz Twardowski. On actions, products and other topics in philosophy*. Poznań Studies in the philosophy of the sciences and the humanities (Vol. 67), translated and annotated by A. Szylewicz, Amsterdam: Rodopi.

Byrne, A. & Hilbert, D.R. (2003). Color realism and color science. *Behavioral and Brain Science*, *26*(1), 3-21.

Chrudzimski, A. (2013). Brentano and Aristotle on the Ontology of Intentionality. In D. Fisette and G. Fréchette (Eds.), *Themes from Brentano* (pp. 121-137), Amsterdam: Rodopi.

Chrudzimski, A. & Smith, B. (2004). Brentano's ontology: from conceptualism to reism, in D. Jacquette (Ed.), *The Cambridge Companion to Brentano* (pp. 197-219), Cambridge University Press.

Dubucs, J. & Miśkiewicz, W. (2009). Logic, act and product. In G. Primiero (Ed.), *Knowledge and Judgment* (pp. 209-215), Springer-Verlag.

Dummett, M. (1991). *Frege and Other Philosophers*. Oxford: Clarendon Press.

Dupré, J. (1993). *The Disorder of Things. Metaphysical Foundations of the Disunity of Science*. Harvard University Press.

Eddington, A.S. (1928). *The Nature of the Physical World*. New York: The MacMillan company.

Fine, K. (1982). Acts, Events and Things, in *Language and Ontology*. Proc. of the *Sixth International Wittgenstein Symposium* (pp. 97-105), Vienna: Holder-Pichler-Tempsky.

Fine, K. (1999). Things and Their Parts. *Midwest Studies in Philosophy*, *23*(1), 61-74.

Franda, F. (2022). Social Kinds: A User's Manual. Dissertation, University at Buffalo. URL = https://philpapers.org/archive/FRASKA-2.pdf

Frege, G. (1892). Sinn und Bedeutung, *Zeitschrift für Philosophie und philosophispshe Kritik*, *100*(1), 25-50.

Griffin, N. (2017). Nuclear and Extra-nuclear Properties. *IFColog Journal of Logics and their Applications*, *4*(11), 3629-3658.

Gruber, T.R. (1993). A Translation Approach to Portable Ontologies. *Knowledge Acquisition*, *5*(2), 199-220.

Gruber, T.R. (1995). Toward principles for the design of ontologies used for knowledge sharing. *International Journal of Human and Computer Studies*, *43*, 5/6, 907-28.

Guarino, N. & Giaretta, P. (1995). Ontologies and Knowledge Bases: Towards a Terminological Clarification. In N. Mars (Ed.), *Towards Very Large Knowledge Bases: Knowledge Building and Knowledge Sharing* (pp. 25–32), Amsterdam: IOS Press.

Guillon, J.-B. (2023). The Dynamic Strategy of Common Sense Against Radical Revisionism. *Topoi*, *42*, 141-162.

Guillon, J.-B. (2024). If presentism is false, then I don't exist. On common-sense presentism. *Synthese*, *203*, article 168.

Ingram, D. & Tallant, J. (2023). Presentism. In E.N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Winter 2023 Edition), URL = https://plato.stanford.edu/archives/win2023/entries/presentism/

Inwagen, P. van (1990). *Material Beings*. Ithaca, Cornell University Press.

Kassel, G. (2019). Processes Endure, Whereas Events Occur. In S. Borgo, R. Ferrario, C. Masolo & L. Vieu (Eds.), *Ontology Makes Sense: Essays in honor of Nicola Guarino* (pp. 177-193), Frontiers in Artificial Intelligence and Applications, *136*, IOS Press.

Kassel, G. (2022). Abstract Events in Semantics. *Philosophia*, *50*(4), 1913-1930.

Kassel, G. (2023). A plea for epistemic ontologies. *Applied Ontology*, *18*(4), 367-397.

Kassel, G. (2025). Le legs twardowskien d'une ontologie épistémique. *Philosophiques*, *52*(3), 81-108.

Kassel, G. (forthcoming). Connexions et relations. *Revue Ouverte d'Intelligence Artificielle*.

Kistler, M. (2020). Powers, dispositions and laws of nature. In A.S. Meincke (ed.), *Dispositionalism: Perspectives from Metaphysics and the Philosophy of Science* (pp. 171-188), Dordrecht: Springer.

Kripke, S.A. (1980). *Naming and Necessity*. Cambridge, MA: Harvard University Press.

Lewis, D. (1978). Truth in fiction. *American Philosophical Quarterly*, *15*(1), 37-46.

Lewis, D. (1986). *On the Plurality of Worlds*. B. Blackwell.

Lowe, J. (2006). How Real Is Substantial Change? *The Monist*, *89*(3), 275-293.

McKinnon, N. (2002). The endurance/perdurance distinction. *Australian Journal of Philosophy*. *80*(3), 288-306.

Mellor, D. H. (2000). The Semantics and Ontology of Dispositions. *Mind*, *109*, 757-780.

Merrill, G.H. (2010). Ontological realism: Methodology or misdirection? *Applied Ontology*, *5*(2), 79-108.

Mumford, S. (1998). *Dispositions*. Oxford, Oxford University Press.

Murez, M. & Recanati, F. (2016). Mental files: an Introduction. *Review of Philosophy and Psychology*, 7(2), 265-281.

Nassau, K. (2001). *The Physics and Chemistry of Color: The Fifteen Causes of Color*. Second Edition, New York, Wiley-Interscience.

Nef, F. (2017). *L'Anti-Hume. De la logique des relations à la métaphysique des connexions*. Paris, Vrin.

Okasha, S. (2002). Darwinian metaphysics: Species and the question of essentialism. *Synthese*, *131*(2), 191-213.

Otte, J.N., Beverley, J. & Ruttenberg, A. (2022). BFO: Basic Formal Ontology, *Applied Ontology*, *17*(1), 17-43.

Pasnau, R. (2009). The event of color. *Philosophical Studies*, *142*(3), 353-369.

Petitot, J. & Smith, B. (1996). Physics and the Phenomenal World. In R. Poli & P.M. Simons (Eds.), *Formal Ontology* (pp. 233-254), Nijhoff International Philosophy Series, *53*, Dordrecht: Springer.

Putnam, H. (1975). The Meaning of Meaning. In *H. Putnam, Mind, Language and Reality, Philosophical Papers* (215-271), *2*, Cambridge: Cambridge University Press.

Recanati, F. (2012). *Mental files*. Oxford University Press.

Recanati, F. (2016). *Mental Files in Flux*. Oxford University Press.

Rosch, E. (1975). Cognitive representation of semantic categories. *Journal of Experimental Psychology General*, *104*, 192-233.

Schaar, M. van der (2015). *Kazimierz Twardowski: A Grammar for Philosophy*. Poznań Studies in the philosophy of the sciences and the humanities (Vol. 103), Leiden: Brill, Rodopi.

AKR Advances on Knowledge Representation Journal

Schaar, M. van der (2022). Judgement and inference: the relevance of Twardowski's distinction between actions and products for philosophy. In A. Brozek & J.J. Jadacki (Eds.), *At the Sources of the Twentieth-Century Analytical Movement: Kazimierz Twardowski and His Position in European Philosophy* (pp. 25-49), Boston: Brill.

Schaar, M. van der (2023). Judgement and Intentionality in Early Brentano. *Grazer Philosophische Studien*, *100*(1-2), 151-172.

Searle, J. (1995). *The Construction of Social Reality*. New York: NY: Free Press.

Sider, T. (2001). *Four-Dimensionalism. An Ontology of Persistence and Time*. Oxford: Clarendon Press.

Simons, P. (2000). How to exist at a time when you have no temporal parts. *The Monist*, *83*(3), 418-436.

Smith, B. (2003). Ontology. In L. Floridi (Ed.), *Blackwell Guide to the Philosophy of Computing and Information* (pp. 155-166), Oxford: Blackwell.

Smith, B. (2004). Beyond Concepts: Ontology as Reality Representation. In A. Varzi & L. Vieu (Eds.), Proc. of the *3rd International Conference on Formal Ontology and Information Systems (FOIS 2004)*, IOS Press.

Sober, E. (2000). *Philosophy of biology*. 2nd edition, Routledge.

Spelke, E.S. (1990). Principles of Object Perception. *Cognitive Science*, *14*, 29-56.

Strawson, P.F. (1959). *Individuals. An Essay in Descriptive Metaphysics*. Garden City, N.Y.: Routledge.

Taieb, H. (2017). Intentionality and Reference: A Brentanian Distinction. *The Monist*, *100*(1), 120-132.

Twardowski, K. (1977 [1894]). On the Content and Object of Presentation: A Psychological Investigation. The Hague: M. Nijhoff; translated and with an introduction by R. Grossmann of (1894) *Zur Lehre vom Inhalt und Gegenstand der Vorstellungen. Eine psychologogische Untersuchung*, Vienna: Hölder.

Twardowski, K. (1999 [1903/1914]). The Essence of Concepts. In J. Brandl and J. Woleński (Eds.), *Kazimierz Twardowski: On Actions, Products and other topics in philosophy* (pp. 73-98), Rodopi; translated by A. Szylewicz of (1903/1914) Über begriffliche Vorstellungen, *Wissenschaftliche, Beilage zum 16. Jahresberichte der philosophischen Gesellschaft an der Universität zu Wien* (pp. 1-28), Leipzig: Barth.

Vieu, L., Borgo, S. & Masolo, C. (2008). Artefacts and Roles: Modelling Strategies in a Multiplicative Ontology. In C. Eschenbach & M. Grüninger (Eds.), Proc. of the *fifth Internation Conference on Formal Ontology in Information Systems (FOIS 2008)* (pp. 121-134), IOS Press.