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A study in the cognition of individuals' identity: Solving the problem of singular cognition in object and agent tracking

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Abstract

This article compares the ability to track individuals lacking mental states with the ability to track intentional agents. It explains why reference to individuals raises the problem of explaining how cognitive agents track unique individuals and in what sense reference is based on procedures of perceptual-motor and epistemic tracking. We suggest applying the notion of singular-files from theories in perception and semantics to the problem of tracking intentional agents. In order to elucidate the nature of agent-files, three views of the relation between object- and agent-tracking are distinguished: the Independence, Deflationary and Organism-Dependence Views. The correct view is argued to be the latter, which states that perceptual and epistemic tracking of a unique human organism requires tracking both its spatio-temporal object-properties and its agent-properties.

Keywords: Object; Agent; Tracking; Reference; Object perception; Self; Identity; Person; Ontology; Attention

1. Introduction: referring to and tracking individuals

Animals and humans must refer to and trace *individuals*, both in perceptual tracking and in other forms of cognitive tracking (e.g., indirect spatio-temporal localization, linguistic reference, communication, and reasoning). Targets for reference and tracking are stationary physical objects (e.g., rocks, plants) and moving individuals (e.g., human beings). Such individuals follow continuous spatio-temporal paths, have cohesive parts and possess causal powers. Perceptually tracking them through space and over time requires possessing sensory-motor systems that enable the perceiver to anchor on to their bodies and apprehend their properties. There is reason to think, however, that tracking *intentional agents*—i.e., creatures to whom it is natural to attribute intentional states such as beliefs, plans, and desires—exploits or requires further abilities and strategies. This raises the problem of how the tracking of non-intentional objects relates to the tracking of intentional agents. Here we extend recent work on perceptual tracking to the tracking of intentional agents.

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Section 2 provides an introduction to our conceptual framework, as well as the Problem of Singular Cognition and the Principle of the Ontological Commitment in Agent Tracking. Section 3 introduces the theory of 'singular-files' in the context of perceptual cognition. In Section 4, we apply the theory of singular-files to the study of the tracking of intentional agents. To clarify the nature of 'agent-files', we distinguish three distinct views about the relationship between object and agent tracking: the Independence, the Deflationary and the Organism-Dependence Views. We argue for the Organism-Dependence View, which states, first, that human trackers must sometimes trace intentional agents *as physical objects* by tracking the object-properties of their organism (Section 5). This kind of ability may suffice to explain a number of interacting and situated behaviors in social contexts with intentional agents. Second, however, tracking individuals *as intentional agents* requires additional capacities for detecting and understanding intentional states and certain further properties which creatures with such states can exhibit (Section 6).

2. The problem of singular cognition in object- and agent-tracking

The framework to be used here is grounded in two fundamental concepts: reference and tracking. Reference is the ability to think and communicate about individuals and universals. It is paradigmatically associated with the use of linguistic items—so-called 'singular terms' (Devitt, 1974; Evans, 1982; Frege, 1892; Quine, 1960; Strawson, 1956), such as proper names (Kripke, 1980), which refer to individuals. Reference has become a central topic in discussions of perception (Clark, 2000, 2004; Matthen, 2005; Pylyshyn, in press; Sellars, 1959, 1961), experience and consciousness (Campbell, 2002; McGinn, 1983), indexicality (Perry, 1979, 2000, 2001b), language learning (Bloom, 1993, 2000; Xu, 1999), memory (Anderson & Hastie, 1974; Shelton & McNamara, 2001), and imitation and communication (Arbib, 2005; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Here, it is assumed that understanding the cognitive bases of singular reference requires studying tracking procedures; as a result, we term this framework a 'procedural[1] theory of reference'.[2]

Within such a framework, '*tracking*' is a technical expression. It refers to the ability of cognitive system or agent—a *tracker*—to acquire information about the location and identity of external[3] and traceable individuals, while maintaining (whenever possible) an ability to trace them over space, time and change. Tracking depends on a variety of cognitive means for information acquisition—perception, spatial memory, situated reasoning, communication, and so on. It can be based on the use different kinds of frames of reference, including both ego- and environment-centered frames. A rudimentary acknowledgment of this variety requires distinguishing perceptual and epistemic tracking (see Table 1). *Perceptual and motor tracking* refers to the ability of a tracker to trace directly a target individual by a sensory-motor system (e.g., Cavanagh & Alvarez, 2005; Craik, 1947; Poulton, 1952; Pylyshyn & Storm, 1988); in such a situation, the tracker perceives or manipulates the target individual and can approximately locate it at least with respect to an ego-centered frame of reference (e.g., Evans, 1982; McDowell, 1990; Peacocke, 1991). *Epistemic tracking* refers to cases in which the target individual cannot be perceived but can be located or identified on the basis of indirect information gathered by such sources as reasoning or communication. For instance, historians and archeologists are expert epistemic trackers because they routinely locate and identify bygone individuals (persons and artifacts) on the basis of indirect evidence, such as archives or archeological vestiges. Similarly, to help with the epistemic tracking of millions of individuals after the Second World War, a German humanitarian institution named 'Central Tracing Bureau' and, later, the 'International Tracing Service' has, since 1946, sought 'to trace non-Germans, missing or displaced during the war, and to assist in reuniting families which at that time had become separated' (ITC, 2006 [1999]).

The notion of tracking external individuals is most naturally understood within a form of empirical/physical realism, whereby the world is composed of *individual physical bodies* with specific persistence and identity

[1] The use of 'procedural' in this context is defended at greater length in Bullot (2005).

[2] Our attempt to unify and expound different views about the link between reference and tracking is a continuation of work by such writers as Strawson (1959, 1997), Evans (1981, 1982, 1985), Wiggins (1997, 2001), Kaplan (1989a, 1989b), Campbell (1994, 2002), Millikan (1990), Perry (2000, 2001b) and Pylyshyn (Pylyshyn, 1989, 2000, 2003; Pylyshyn & Storm, 1988).

[3] The focus of the present article is the tracking of external agents and objects; we do not consider the special case of keeping track of oneself, one's mental states or one's actions.

Table 1
Epistemology and psychology of singular reference: the procedural framework

Components of singular reference and cognition	
Thesis of the procedural framework: singular cognition/reference is based on procedures for tracking individual objects/organisms, and depends on resolving the PSP	
Perceptual and motor tracking of ***o***	Epistemic tracking of ***o***
The individual ***o*** is present in a sensory field of the tracker's perceptual systems and can be selected by perceptual attention	The individual ***o*** is outside of any sensory field of the tracker and has to be located via memory, reasoning and communication
Examples: tracking visually ***o***; sensorimotor interaction with ***o***; visually guided reaching for and grasping of ***o***; perceptual recognition or re-identification of ***o***	*Examples*: spatial memory of ***o***'s space-time location; linguistic reference to ***o*** which is not based on present perception of ***o***; reasoning about ***o***'s location; communication about ***o***'s identity and location

conditions, conditions which can be stated, at least in principle, in terms of objective causal properties and composition principles. Our procedural framework relies on linking the former ontology with an *individual-based epistemology*—that is, a theory of knowledge in which the primary objects of human cognition are particular mind-independent individuals.[4] In order to interact with target individuals, to access their properties, to ascribe to them abstract properties or to reason about them, human trackers need to be able to pick them out, secure a unique referential link with them and maintain that link over time. However, because target individuals can change some of their properties while persisting as the same individuals, and because the available properties or descriptions of an individual ***i*** (at a given moment) are not always sufficient to single ***i*** out and refer to ***i*** as the same individual, trackers are confronted with a *uniqueness problem* for tracing an individual in many situations. We will term the latter the *Problem of Singular Cognition* (PSC):

What are the (non-conceptual or conceptual) capacities that are to be taken into consideration if one wants to explain how a cognitive agent performs *singular cognition*, *i.e.*, the perceptual and epistemic individuation or tracking of an individual ***i*** as the same *unique* (*i.e.*, token-identical, numerically identical) individual perceived or known at successive moments in time?[5]
(Each single character in italicized and bold fonts, such as '***i***' or '***o***', stands for a proper name referring to a single individual.)

An individual-based epistemology must hold that trackers possess capacities enabling them to trace perceptually or epistemically ***i*** as the same continuing individual. To enable tracking ***i***'s uniqueness, these capacities must allow the cognizer to *distinguish* over time ***i*** from all the other individuals of the same kind. When used for conceptual thinking, this ability involves what philosophers have referred to as singular representations and judgments satisfying 'Russell's principle' (Evans, 1982, pp. 89–120) or the 'know which' requirement (e.g., McDowell, 1990; McDowell, 1998, pp. 22–23; Peacocke, 1991; Strawson, 1997). According to Pylyshyn (2003, p. 201), there is good reason to think that such an ability must be ascribed to the visual system itself.

Another important characteristic of singular cognition in human trackers is that they track tokens of *different kinds* of individuals. On the one hand, they are able to interact with and reason about ordinary physical

[4] A pioneering philosophical analysis of human knowledge based on the cognition of individual objects can be found in Strawson (1959). Philosophers such as Evans (1981, 1982), Perry (2001b), Campbell (1994, 2002), Clark (2000) have developed this view of cognition in the philosophy of mind and perception. Views expressed by philosophers of language such as Kripke (1980), McDowell (1984, 1990), and Recanati (1993) are also consistent with it. Lastly, recent work in the psychology of perception and development by Kahneman et al. (1984; 1992), Spelke et al. (1990; 1995), Pylyshyn (2003), Carey and Xu (2001) and Bloom (2004) may provide empirical ground for an understanding of the cognition of individuals.

[5] What is specific to PSC, as opposed to other, related problems, such as the Parsing Problem (Spelke, Gutheil, & Van de Walle, 1995, pp. 298–300), the Binding Problem (Treisman, 1996), the Correspondence Problem(s) (Pylyshyn, 2000, 2003) or the Many Properties Problem (Clark, 2004, pp. 447–451; Matthen, 2005, pp. 277–282)? PSC refers to the study of the agent's capacity to track or know the target's uniqueness/distinctness and numerical identity (Evans, 1982; Locke, 1975 [1689]: Bk. II, ch. 27; Parfit, 1986, pp. 200–204; Strawson, 1959, pp. 31–38), whereas works on perceptual object recognition or parsing can be limited to the recognition of the kind of object.

objects devoid of mental states. Tracking the observable behavior of such objects requires a grasp of some of the principles describing the regularities underlying physical phenomena. Elementary forms of cognitive grasping of these principles might be available at early stages in the development of human cognition (e.g., Baillargeon, 2001; Spelke, 1990), with a more explicit understanding of them emerging in adult sensorimotor skills (Ballard, Hayhoe, Pook, & Rao, 1997; Gibson, 1979; Noë, 2004) and adult 'folk physics' (McCloskey, 1983; McCloskey, Caramazza, & Green, 1980). On the other hand, humans can also interact with and reason about existing, dead or fictional animated[6] and *intentional agents*—i.e., animated creatures to whom we ascribe *intentional states* such as beliefs, desires and intentions (e.g., Astuti, 2001; Bloom, 2002, 2004; Bonatti, Frot, Zangl, & Mehler, 2002; Dennett, 1971, 1987; Koenig, Clément, & Harris, 2004; Malle, Moses, & Baldwin, 2001; Puccetti, 1968). In order to account for the behavior of such agents we need to add principles not reducible to those used to track physical objects.

The distinction between object and agent tracking is required by many doctrines. Consider what Paul Bloom (2004) calls '*commonsense dualism*'. According to Bloom (2004, p. 191)—see in addition Kuhlmeier, Bloom, and Wynn (2004) and Bering (in press)—, humans are 'natural born dualists'—they see the world divided in material objects and immaterial souls. Insofar as commonsense dualism embraces distinct ontologies for souls and for objects (including bodies), thereby allowing for the soul's survival after bodily death, it implies that tracking the soul of a particular deceased agent would require tracking specific supernatural cues available *after* the death of the agent's organism.

Another example is provided by views that admit the in-principle possibility of fusion or fission of intentional agents. Philosophers (Lewis, 1976; Parfit, 1971, 1986; Wiggins, 1967) have discussed this radical thought experiment about personal identity: Imagine that your brain is divided, and that each half, containing all your psychological characteristics, is housed in a new body. Both resulting people have your character and your apparent memories. Question: What happens to you? There are three possibilities: (1) you do not survive; (2) you survive as one of the two people; (3) you survive as both. Whatever the favored response, if you are given the task of tracking the resulting intentional agent(s), you have first to clarify the *ontology* of what you count as 'intentional agent' so that you can assess how many of them can be tracked in this kind of scenario. If you adopt an ontology according to which the agent's persistence is determined by her psychological states, you might consider that the agent's tracking can be performed on the basis of the tracking of memory states.

As these examples indicate, agent tracking is performed as a function of multiple assumptions about the target *agent's (purported) ontology* (Bullot, in press)—that is, a representation (implicit or explicit) of the birth, persistence, survival and extinction conditions of the tracked agent. Philosophers have distinguished bodily (Thomson, 1997; Williams, 1970), biological (Johnston, 1987; Olson, 1997a) and psychological criteria (Baker, 1999; Parfit, 1971, 1986; Quinton, 1962; Shoemaker, 1959, 1999b) for the survival of an intentional agent. As has been argued in the discussion of sortal concepts (Carey & Xu, 2001; Hirsch, 1982; Pylyshyn, 2003; Wiggins, 1997, 2001), in order to direct their agent-tracking attitudes and actions appropriately, trackers *must* thus possess information about some uniquely distinctive features of the target agent. This can be expressed by this principle of the *Ontological Commitment in Agent Tracking*:

The skill or method that a human tracker (or a cognitive system) ***t*** uses to track a unique target intentional agent ***a*** are dependent upon the ontology that she (or it) ascribes implicitly or explicitly to ***a***.

Further illustration of the principle is provided by the example of supernatural agents (Bering, in press; Bering & Bjorklund, 2004; Bloom, 2004; Boyer, 2000, 2003). 'Tracking' a particular god is based on the presumed ontology ascribed to it: the ways Christians and Animists track their respective gods, for instance, differ because of the difference in their purported properties. The same kind of reasoning holds for objects and intentional agents: if you ascribe distinct ontologies to objects and intentional agents, you must track them via different means.

[6] Animacy should be distinguished from intentionality. On the perception of animacy, see for instance (Gelman, Spelke, & Meck, 1983; Gelman, Durgin, & Kaufman, 1995; Leslie, 1995; Rakison & Poulin-Dubois, 2001).

3. Theoretical background: The notion of 'singular file' in understanding the tracking of individuals

Taken together within the framework described in Section 2, a realist ontology and an individual-based epistemology have a remarkable implication: token individuals can be *identified* and *re-identified* by trackers (Campbell, 1993; Johnston, 1987; Strawson, 1959), because they exhibit *sameness* properties which are traceable over time and change. A fundamental challenge is thus to determine *how* trackers solve the PSC for the perceptual and epistemic tracking of unique individuals.[7] Several analyses[8] have introduced an intuitive answer to this question, either as a useful metaphor (Perry, 2001a: pp. 51–52) or as an explanatory concept in psychology (Kahneman & Treisman, 1984; Kahneman, Treisman, & Gibbs, 1992). This answer is based on a set of distinctions introduced by what we name 'the theory of singular-files'. The concept of *singular file* is used to express the idea that subjects store, accumulate and update information about individuals or objects in a 'mental repertory' called a 'file', which is a state exhibiting singular content that can be split (if its referent divides or appears to be two individuals) or fused with another file (if two files happens to have a single referent). A singular file is not merely a mental state with 'intentional content' (Brentano, 1973; Searle, 1983)—i.e., a state that it is 'about' or 'of' something else. It is specialized for tracking a *unique* individual of thing—it is a *singular* mental state.

Why is the theory of files relevant to solving the PSC? The challenge posed by the PSC is that of determining the nature of the capabilities that enable a tracker to trace a unique object/element as the same in spite of its property changes. The notion of a file is relevant because it refers to a cognitive (sub)system that has the function of tracking a changing physical element by performing specialized updating operations, which maintain active a singular content. For this reason, it is not surprising that several accounts of the PSC and other analogous problems invoke the notion of a singular file. It is one of those rare concepts considered to be explanatorily relevant simultaneously by theorists of mental and linguistic reference and by psychologists of perception (Kahneman et al., 1992).

In the psychology of vision, several authors have hypothesized that the visual system uses temporary 'object files' for tracking and identifying objects. For example, D. Kahneman and A. Treisman (Kahneman & Treisman, 1984; Kahneman et al., 1992; Treisman, 1992) suggest that the main result of processing visually a particular scene is to construct a set of separate (visual) files, whose function is to store information about objects in the visible scene. An object file is responsible for the perceived continuity of the seen object (Kahneman et al., 1992, p. 177). In contrast to the causal theories of names (Bach, 1987; Perry, 2001b) in which files are a storage mechanism of long-term recognition networks, Kahneman and Treisman hypothesize that the construction of object files can be independent of long-term visual recognition and long-term beliefs (Kahneman et al., 1992, p. 176). An object file in this sense is a mechanism that allows the visual tracking of an individual in a perceptual field.

The distinction between temporary representation and long-term recognition of objects is justified by Kahneman et al. (1992, p. 176) by reference to such things as the primacy of objects in determining the allocation of attention (e.g., Baylis & Driver, 1993; Duncan, 1984; Egly, Driver, & Rafal, 1994; Noles et al., 2005; Pylyshyn, 2003: pp. 181–200). Attention to any one property of an object causes irrelevant properties of that object to be attended to, as in the Stroop effect (Stroop, 1935). Moreover, the division of attention between relevant attributes is facilitated if the attributes belong to the same object (Treisman, Kahneman, & Burkell, 1983). Kahneman et al. (1992) have also found an 'object-specific matching effect' or 'object-specific preview benefits' (Noles et al., 2005): the focusing of attention on a target object not only enhances the salience of all its current properties—it also selectively reactivates the recent history of that object. In the same tradition, Pylyshyn (2001, 2003) has further suggested that these object files are 'linked to' individual distal items via an indexing mechanism called a 'visual index' (or 'FINST,' from 'FINgers of INSTantiation'). This analysis

[7] This amounts to resolving what Bullot (2006) terms the 'Problem of Singular Perception', which is the problem of tracking, and referring to unique individuals in perception. It is subordinate to what we term here the 'PSC'.

[8] For object files in thought and language, see e.g., Perry (1980, 2001a, 2001b), Bach (1987), Recanati (1993); for object files in vision, see e.g., Kahneman et al. (1984; 1992), Pylyshyn (1989, 2003), Palmer (1999), Saiki (2003), Mitroff, Scholl et al. (Mitroff, Scholl, & Wynn, 2005; Noles, Scholl, & Mitroff, 2005).

allows not only to account for the encoding of object-property information in a singular file, but also for its production and persistence.

The foregoing suggests that one can sketch a taxonomical classification of the properties that can exogenously trigger and control a file. A first group of properties encompasses the properties governing the initial anchoring of a file, which cause the visual indexing of an object (Pylyshyn, 2001, 2003) and the opening of a visual object file (in Kahneman's and Treisman's terminology). This procedure is exemplified by the exogenous capture of visual attention. Thus, a tracker is initially anchored onto an object ***o*** if and only if:

File Initial Anchoring: A direct relation occurs between (1) a set of ***o***'s properties and (2) the tracker's visual mechanisms of attentional capture and multimodal anchoring.

The detailed specification of the properties responsible for the initial visual anchoring of visual attention is an open empirical question, which relates to the debates about automaticity and attentional control—cf., e.g., Yantis (1998) and Folk and Gibson (2001). For instance, it is known that abrupt visual onsets capture attention. Possible mechanisms for explaining this phenomenon include a luminance-change detection system and a mechanism that detects the appearance of a new perceptual object (Yantis, 1998; Yantis & Hillstrom, 1994).

In addition, one must distinguish the former group of properties from the properties of sustained maintenance of the visual file (e.g., Kaufman, Csibra, & Johnson, 2005; Noles et al., 2005), which correspond to the continued visual tracking of the object. A human subject visually tracks an object ***o*** in a situation σ if and only if:

File persistence: There is a relation maintained between (1) a set of persistent properties of ***o*** and its surrounding situation σ and (2) the visual processes ensuring ***o***'s dynamic visual tracking in spite of disturbances during movements and actions (e.g., the maintenance of perceived continuity during occlusions or saccades via trans-saccadic integration).

It is likely that the properties that cause the initial anchoring onto the object of visual attention are different from those which make it possible to maintain an open file for the same object in spite of temporary occlusion.

A third group includes the properties which are encoded in the visual file during the performance of tracking. They can be expected to determine the content of visual experience. They are properties about which internal states of the file deliver information to visual working memory or conscious visual experience. These internal states of the file are vehicles for an intentional content and serve as descriptions of the properties which are available for further cognitive processing. In this analysis, a tracker ***t*** encodes information about the properties of an object ***o*** by visual means if and only if:

Encoding in a file: The internal states of an object file referring to object ***o*** (in perceiver ***t***'s visual system) accumulate descriptive information (e.g., perceptual predicates) about features or properties of ***o***.

This notion of property encoding is helpful for distinguishing the 'contents' of a file. In philosophical terms, a visual object file has an intentional content; it refers to, or is about an external target, which is the broad content of the file. However, the object file is not identical with its referent. The content of the visual file is a narrow[9] and presumably descriptive intentional content.

4. Different approaches to applying the singular-file theory to agent tracking: The Independence, Deflationary and Organism-Dependence Views

To our knowledge, most research employing the notion of singular files in cognitive science has not explored the specific nature of intentional-agent tracking. On the face of it, this is a shortcoming. For while tracking *intentional agents* would appear to exploit abilities beyond those used to track objects, since agents are *unique* individuals, agent tracking might yet be explained by appealing to a system of 'agent files' akin to the 'object files' of visual perception. In the remainder of this article, we explore this idea, hypothesizing the existence of *agent files* in order to discuss their probable characteristics. Within philosophy, the conjecture that there exists

[9] I.e., dependent upon an observer and a 'point of observation', in Gibson's sense (Gibson, 1979, p. 65).

Table 2
The Independence, Deflationary and Organism-Dependence Views of agent tracking

	Independence View	Deflationary View	Organism-Dependence View
Ontology of intentional agents	*Dualism*: Each intentional or supernatural agent is necessarily distinct from a physical body/object (that may nonetheless temporarily 'embody' the agent).	*Identity Theory*: Each intentional agent is numerically identical with his/her body, which is a physical object	*Biological dependence*: The persistence conditions of each human intentional agent are dependent on (or supervenient on) her/his existence as a *human biological organism/body*, which is a special *kind* of physical object
	Examples: substance dualism; common-sense dualism	*Example*: The approach of the Identity Theory to the mind-body problem; physicalism in cognitive science	
Epistemology and psychology	*Thesis*: Agent tracking is independent of object tracking; object files do not share any common feature with agent files	*Thesis*: Agent tracking is reducible to object tracking; agent files are object files	*Thesis of organism tracking*: Perceptual and epistemic tracking of a unique human organism ***o*** requires tracking ***o***'s spatio-temporal object- and agent- properties
	Example: tracking the soul of a deceased agent does not require tracking her body	*Example*: visually tracking someone walking on the sidewalk as a moving physical object	*Thesis of the specificity of agent files*: Agent tracking is not reducible to the tracking of non-intentional objects; agent files are triggered by and contain information about specific properties of intentional agents

such a dedicated agent tracking system has been briefly considered.[10] However, the questions of how such files are related to object files in vision, and of what kind of ontology is embedded in the functional architecture of a system dedicated to agent tracking, have been overlooked. Here we are presented with at least three distinct options, each of which combines intertwined ontological and epistemological theses (see Table 2):

According to the epistemology of the *Independence View*, agent tracking is completely independent of object tracking: object files and agent files do not share any common feature(s) and are dedicated to gathering information about distinct domains. It is natural to adopt this View if one believes the ontological thesis that each intentional (or supernatural) agent is necessarily distinct from a physical body. In philosophy, the paradigm example of such a doctrine is *substance dualism* (e.g., Descartes (1644, paragraphs 52 and 53); 1984 [1641]), which asserts that the world encompasses two types of substances: minds (*res cogitans*) and bodies (*res extensa*). Substance dualism is generally dismissed in recent philosophy of mind and cognitive science as inconsistent with the scientific view of the world—see for instance Searle (1992, 2004). Importantly, however, even if the ontological thesis of the Independence View were false, this would not imply the falsity of the epistemological thesis. For human beings might rely on dualistic *assumptions* for tracking individuals. Indeed, if human beings are 'natural born dualists', they may track objects and agents via distinct mechanisms, even if that architecture relies on certain illusory assumptions. There is no guarantee that the cognitive resources for agent tracking are immune to errors with regard to the ontology assumed by the tracking system.

In the space of solutions to PSC, at the other end of the spectrum is a materialist approach. According to the epistemology of this *Deflationary View*, there is a single type of mechanism that tracks either an object or an agent; the construct 'agent file' thus reduces to the concept of 'object file', because each intentional agent is identical with the agent's body, itself a physical object. The Deflationary View will of course appeal to those who espouse a physicalist view—a version of the Identity Theory[11] whereby each agent is identical with a

[10] Perry (2001a: pp. 51–52; 2001b: pp. 123–146), e.g., suggests that information about agent identity can be stored in 'files' and that acquiring further perceptual information about an agent can lead to the opening, merging, splitting, or enriching a file.
[11] Early philosophical statements about the Identity Theory are, for instance, in Place (1956) and Smart (1959).

particular living body. In this ontology, there is a one-to-one mapping of an agent to a spatio-temporally bound physical object.[12] The epistemological thesis of the Deflationary View is a logical consequence of the presumed identity of agents and their bodies.

According to an *Organism-Dependence View* of agent tracking, we track intentional agents by tracking their bodies, or organisms,[13] which respect non-trivial objecthood criteria and exhibit specific agency-related properties. The ontological thesis that is most naturally associated with the Organism-Dependence View is that the persistence conditions of each intentional agent are dependent on her existence as a biological organism. This implies that the persistence conditions of a human agent are dependent on the characteristics of the biological organism, a material entity composed of regular physical particles—something that is implied by, but does not require, the ontological thesis of the Deflationary View. However, since a biological organism, especially when it manifests the presence of mental states, exhibits distinctive characteristics not possessed by inanimate objects, the epistemological side of the View is that, although agent tracking is dependent on organism tracking, agent tracking *cannot be reduced* to object tracking (see Section 6, below). In the following sections, we argue in favor of the epistemological thesis of the Organism-Dependence View. We will attempt to refine it so as to make it immune to objections naturally leveled against the Deflationary View. For present purposes, we will assume,[14] rather than argue for, the ontological thesis[15] of the Organism-Dependence View.

5. The organism-dependence view I: Locating agents by tracking organisms considered as spatio-temporal objects

5.1. Sketch of an argument in support of the Deflationary and Organism-Dependence Views

If one rejects dualism, one may adopt either the Deflationary or the Organism-Dependence View. A common intuition in support of both views suggests a robust correlation between agents' bodies and object properties. Given the usual connection between intentional agents and their organisms, on the one hand, and agents' organisms and object properties, on the other, being able to track object properties can be expected to provide a means for tracking agents. A tentative argument can be expressed as follows. (It will be revised below in order to support the Organism-Dependence View over the Deflationary View):

Premise 1, thesis of the agent's dependence upon biological organism: The persistence conditions of a unique human agent ***a*** are necessarily dependent on the persistence conditions of her unique biological body (or organism) ***b***.

[12] The ontological thesis of the Deflationary View is rejected by dualism and, in addition, by the doctrines in which criteria of personal identity are not reducible to objecthood or bodyhood criteria, but pertain to other genera such as psychological continuity (Parfit, 1971, 1986; Shoemaker, 1959, 1999a, 1999b) and social relationships such as shared intentionality and social folk psychology (Ames et al., 2001; Tomasello et al., 2005). To the prevalent psychological approach to personal identity, the identity (or sameness) of an intentional agent is dependent on the *psychological continuity* of her mental states instead of that of her body's or organism's spatio-temporal continuity. Even though it may remain dominant, the Psychological Approach has been challenged by accounts based on bodily continuity (Thomson, 1997; Williams, 1970) and organism's biological continuity (Olson, 1997a, 1997b).

[13] When we employ the term *organism*, we refer to the biological concept of an individual living system, composed of cells, that is constituted to carry on the activities of life by means of homeostatic processes among parts or organs, and is thus capable of reproduction, growth, and maintenance. For discussion of the concept, see for instance Holmes (1944), Wright (1953), and Richardson (2000). The necessity to study in cognitive science the human agent as a biological organism is held by many, including Norman (1980) and contemporary writers in cognitive psychology and neuroscience. In an earlier version of this work (Bullot & Rysiew, 2005), we named our view the 'Object-Dependence View' in order to emphasize that agent tracking was dependent on object tracking. However, since the dependency is that of agent tracking on the tracking of a living organism, the view is better termed the 'Organism-Dependence View'.

[14] We justify this assumption on two grounds. First, because we suspect that most philosophers and scientists, being non-dualists, would wish to endorse at least the ontological thesis of the Organism-Dependence View, with most probably wishing to go further and endorse the Identity Theory (the ontological side of the Deflationary view). And second, because justifying the specifically ontological issue would lead us far astray from our primary goal, which is to expound and defend the epistemological and psychological underpinning of the Organism-Dependence View.

[15] Philosophical accounts which can be read as supporting this thesis are, for instance, van Inwagen (1990), Olson (1997a) and Merricks (2001). van Inwagen (1990) and Merricks (2001) uphold that each person persists over time because this person is identical to the biological organism he/she is strictly. For instance: '(...) there is exactly *one* thing where we truly believe there to be a human person and a human organism (and a human body). Obviously, this implies that the person is identical with the organism (is identical with the body).' Merricks (2001, p. 86).

Premise 2, thesis of organism tracking: Perceptual and epistemic tracking of a unique human organism ***b*** requires tracking ***b***'s spatio-temporal object-properties.

From these two premises, one can conclude:

The perceptual and epistemic tracking of (the persistence conditions of) a unique human agent ***a*** requires tracking the object-properties of ***a***'s unique biological body ***b***.

As explained in the preceding section, we will assume Premise 1 without further argument, since we will focus our analysis on the epistemological thesis of the Organism-Dependence View. Taking for granted that the conclusion follows from the two premises, we will discuss Premise 2. Our arguments are based on the ideas that biological organisms fulfill objecthood criteria (Section 5.2), and that human agents are treated as spatio-temporal objects in a number of circumstances of tracking (Section 5.3).

5.2. Organism tracking requires tracking spatio-temporal object-properties because organisms fulfill objecthood criteria

First, organism tracking requires tracking spatio-temporal object-properties because organisms fulfill objecthood criteria. This premise seems simply to fall out of an examination of some basic assumptions about the spatio-temporal characteristics of human bodies. As an individual biological organism, a human body fulfills a number of ordinary objecthood criteria, which *must* be used by any system that has to track an individual human *organism* over space and time. These object properties relate namely to continuity, cohesion, shape, impenetrability, and biological unity and uniqueness.

Consider the example of *spatio-temporal continuity*. Spatio-temporal continuity is a common and familiar objecthood criterion.[16] The development of a human organism is continuous over time; it begins, it continues through various stages of maturation and development during adolescence, adulthood, old age, and ends with the death of the biological individual and the destruction of the corpse. The temporal boundaries of the human individuals' histories—both at her beginning and her end—are controversial topics (Becker, 1975; Goodhart, Rooney, & Heffernan, 1981; Hershenov, 2005; Olson, 1997a; Unger, 2000; Walters, 1997). However, the fact that each human organism follows a continuous and unique spatio-temporal path from birth to death is a clue as to its uniqueness, since that path itself is very likely to be unique.

Consider now *cohesion*: a human organism has *cohesive* parts (limbs, organs) that are functionally and hierarchically organized. Phenomena which threaten the cohesion and unity of the organism threaten the very existence of that organism as a living unit. In addition, like continuity, this unity is linked to the organism's uniqueness. The cohesion of the organism's parts bestows the organism a defined *shape*, which is delimited by surfaces (skin, hair, nails, etc.) that are boundaries between internal organs and external objects. Consider *impenetrability*: a human organism is mostly impenetrable in a weak sense: a human body cannot strictly coincide in space with another human body—several bodies can be in close contact but cannot fuse or overlap in space. Similarly for *unity*—each organism can be counted among groups of several individuals because it is a unit; and *being located*—a human organism can be located within different spatial frames of reference.

An argument in support of Premise 2 is thus that, taking for granted that organisms respect a set of non-trivial objecthood criteria, the perceptual and epistemic tracking of a particular organism requires tracking these object-properties. For instance, visually tracking an individual organism (a cat) requires tracking at least some of its cohesive parts (e.g., its tail, ears, paws, and/or abdomen). Such visual tracking may be based on the assumption that the spatio-temporal path followed by the organism is continuous. (That the target cat, moving left to right, will not suddenly next appear 30 feet behind one in the air.) Many of the entities' properties which are assumed to be used in order to open and maintain a visual object file are object properties in the sense that they fulfill objecthood criteria (Carey & Xu, 2001; Kahneman et al., 1992; Pylyshyn, 2003).

[16] On objecthood criteria in philosophy, see Strawson (1959), Joske (1967), Hirsch (1976, 1978, 1982, 1997), Quinton (1979), Ayers (1997), van Inwagen (1990) and Merricks (2001); on objecthood criteria in psychology, see namely Spelke et al. (Spelke, 1990; Spelke, Breinlinger, Macomber, & Jacobson, 1992, 1995), Carey and Xu (2001), Pylyshyn (2003), Bloom (2000, 2004), Bonatti et al. (2002), Scholl et al. (Noles et al., 2005; Scholl, Pylyshyn, & Feldman, 2001).

In particular, they are related to cohesion and spatio-temporal continuity. For instance, in the standard MOT experiment (Pylyshyn & Storm, 1988), the only available feature to distinguish targets from non-targets is the spatio-temporal path followed by each element. Although the system for visual tracking can deal with short periods of occlusion, tracking abilities are clearly impaired as soon as the target element infringes on the cohesion principle via transformations similar to 'pouring' or exploding (vanMarle & Scholl, 2003). These results are evidence that physical objects may be typical targets for visual tracking. Hence, given that human bodies fulfill at least some of the major objecthood criteria, human bodies may be typical targets for visual tracking. If the Organism-Dependence View is correct, this observation about visual/perceptual tracking may generalize beyond mere visual tracking to multimodal tracking, in a way which should be congruent with a variety of cognitive strategies for tracking individuals in the world.

5.3. Human agents are treated as spatio-temporal material objects in a number of circumstances of tracking, reasoning and depiction

A second series of arguments in support of Premise 2 is that human agents are or must be *treated as spatio-temporal physical objects* in a number of circumstances of tracking. By 'treated as spatio-temporal physical objects', we mean considered, at least temporarily, as such in abstraction from their real or presumed intentional or mental characteristics. This idea justified and accepted by a substantial number of examples and views.

For instance, when a surgeon is performing a particularly complicated operation, she will often not have to track the patient's mental states. Instead the surgeon focuses her tracking abilities on surgical tools, spatio-temporal states of the organ and steps of the ongoing surgery operation on the tissues and so on. In circumstances like this, where interactions with the object-properties of the agent's organism matters more than with the interaction with her mental states, Premise 2 seems correct.

The same phenomenon is present in the domain of social life. Human beings can be in 'minimal social interactions' in which they react to a human organism in a way that takes into account their object-properties but not their intentional states, or certainly none which would be *unique* to the perceived agent. Think, for example, of threading your way down a crowded sidewalk—you step to avoid collisions, but often without hypothesizing about the psychology of this or that person in particular. The change blindness paradigm provides more dramatic illustrations of the same phenomenon. In one experiment by Simons and Levin (1998) an experimenter initiated a conversation with a pedestrian. During the interaction he the experimenter was surreptitiously replaced by a different experimenter. Only half of the pedestrians detected the change. This once again suggests that a perceptual mechanism such as a (visual) object file is used to perceptually track the experimenter agent—a mechanism that uses basic spatio-temporal cues for tracking instead of elaborate visual descriptions of a unique agent. This is what allows the subject to incorrectly interpret the surreptitious replacement as a temporary occlusion of the *same* visible object.[17]

Another way to corroborate Premise 2 is to consider the conceptual inferences one draws about human bodies when one is tracing a particular organism via intuitive causal reasoning, for many of the inferences that one can make about a human organism are based on implicit assumptions about object-properties (e.g., McCloskey, 1983; Sperber, Premack, & Premack, 1995). Thus, if one knows that Paul is in the aircraft number 743, one can infer the spatio-temporal location of Paul's body on the basis of the knowledge of that aircraft's allocentric position (this is a case of epistemic tracking). In addition, the eventuality of the aircraft's crash has its deadly implications *because of* our persistent assumptions of all the previous characteristics (that is, the physics of the human body is known to be such that it *will be* destroyed by any event that would cause destruction of the aircraft). Even a proponent of the Independence View would recognize that Paul's *body* would probably be damaged or killed in a plane crash.

Finally, there is plenty of anecdotal evidence we could cite in still further support of Premise 2. Consider the core assumptions of common sense dualists. In addition to believing that bodies and souls are separate (onto-

[17] This type of analysis is consistent with the deictic or interactive approaches to vision (Ballard et al., 1997; Churchland, Ramachandran, & Sejnowski, 1994; O'Regan & Noë, 2001; Pylyshyn, 2000), according to which situated vision is not a rich and infallible description of the visible scene but involves direct relations to objects in the vicinity, which are probed or explored only when required.

logically distinct), they hold that 'souls' are immaterial, and hence not perceivable by the usual means. However, if this is so then *souls cannot be tracked perceptually and directly*; whereas, agents' organisms—which peoples' souls somehow 'inhabit'—*are* among 'the furniture of the world'. Hence, agents' organisms are the only public, traceable objects relating to agency even from the dualist viewpoint. (Cf. Wittgenstein: 'The best picture of the human soul is the human body' (Wittgenstein, 1953: p. 178).) The common sense dualism's assumption of 'one body/organism, one soul' implies that body and soul are co-instantiated at least for the period of 'terrestrial life'. In this way, commonsense dualism may require the epistemological thesis of the Organism-Dependence View as regards human 'terrestrial' life. There appears, thus, to be an internal tension within the conceptual scheme of common sense dualism. This same tension is nicely revealed by the (implicit) ways common sense dualism conceives of or depicts 'traveling souls'. For, depictions of souls leaving a particular body often take the form of ghostly *bodies*—translucent *corporeal* entities—leaving the body of flesh-and-blood. This is not surprising, for how else could souls be depicted—or, we ask, how else could they be tracked?[18]

In a surprising experiment, Kuhlmeier et al. (Kuhlmeier, Bloom et al., 2004; Kuhlmeier, Wynn, & Bloom, 2004), examined whether infants perceive that human beings are material objects, subject to these same principles. They reported that 5-month-old infants apply the constraint of continuous motion to inanimate blocks, but not to people. This suggests that young infants have two separate modes of construal: one for inanimate objects and another for human individuals. (Rakison & Cicchino (2004) have concerns about the experiments.) These results may seem to conflict with our view, but in fact they do not, for they can be compatible with Premise 2 (and Premise 2′ below). For our purposes it suffices to note that insofar as infants are natural dualists, they may not regard agents as always, or flawlessly, respecting objecthood criteria. Our claim in support of the Organism-Dependence View is that it is not clear how tracking such souls/agents is possible, if not by means of tracking the bodies with which they are typically co-instantiated. The latter, as Kuhlmeier and colleagues seem to acknowledge (Kuhlmeier, Wynn et al., 2004, p. 102; Kuhlmeier, Bloom et al., 2004, p. 111), may be a lesson which infants have to learn.

Similar considerations hold even once dualism is rejected. For while materialism about the mind entails that *intentional states* (e.g., beliefs or desires) are or supervene upon *physical states*, there is no suggestion among current materialist theories that the intentional states are just the observable surfaces of a person's organism (or body). Materialists disagree about just which physical states *do* constitute intentional states. But none of the most promising and popular candidates—certain states of the brain (e.g., Dennett, 1978; Shoemaker, 1997), perhaps together with facts about those states' history, their relation to other such states, and so on—are any more readily accessible by unaided perception than the immaterial souls posited by the dualist. Given that an intentional agent's organism *is* directly observable, the default (pre-scientific) strategy of the agent tracker can only be to trace the target agent by tracking her organism.

6. The Organism-Dependence View II: Deepening the differences between tracking intentional agents and tracking non-intentional objects

The arguments reviewed so far are compatible with both the Deflationary and Organism-Dependence Views. In the terminology of the singular-file theory, the conclusion would be that object files may, on occasion, be put to use in tracking intentional agents; agent-files would be thus sometimes reduced to basic object-files, which do not encode mental properties. However, we suggest that the two Views have to be kept distinct because the explanatory power of the Organism-Dependence View is superior. The problem of the Deflationary View is that it overlooks the specific agency features displayed by agents' organisms. The failure has its root on the ontological thesis of the Deflationary View, which asserts the strict identity between the agent and the body as a physical object. This ontological reduction of the agent to a *generic* or undifferentiated object prevent the unraveling of the specific characteristics of the psychology and epistemology of tracking individuals exhibiting agency properties and intentional states. In contrast to the Deflationary View, the

[18] Note that it is of course by depicting human *organisms* that painters have represented the souls of 'The Blessed' in Paradise and of 'The Damned' in Hell. See for instance 'The Last Judgment' (1431) by Fra Angelico.

Organism-Dependence View emphasizes the specificity of the dependence with regard to the human biological organism and to the agent-properties exhibited by this kind of individual. Strictly speaking, it should thus reject Premise 2 when stated as: 'Perceptual and epistemic tracking of a unique human organism ***o*** requires tracking ***o***'s spatio-temporal object-properties.' The reason is that the phrase '***o***'s spatio-temporal object-properties' fails to refer to agent-properties which are specific to individual human organisms—such as moving according to a specific gait pattern and having mental states—and can be relevant to assessing the identity of a particular human individual (concrete examples of these agency properties are provided below). The correct reasoning is thus the following:

Premise 1, thesis of the biological dependence: The persistence conditions of a unique human agent ***a*** are necessarily dependent on the persistence conditions of her unique biological body ***b***.
Premise 2′, thesis of organism tracking: Perceptual and epistemic tracking of a unique human biological body ***b*** requires tracking ***b***'s spatio-temporal object- and agent-properties.

From which it is possible to conclude that tracking (the persistence conditions of) a unique human agent ***a*** requires tracking the spatio-temporal object- and agent-properties properties of ***a***'s unique body ***b***. To spell out this argument and avoid circularity, we have to show in what way uniqueness characteristics are shown in both object-based and agent-based varieties.

6.1. Argument related to means of direct perceptual-motor anchoring onto an individual human agent

First, arguments can be found with respect to an examination of the anchoring on to agents. There are important specificities in the properties that can trigger and maintain singular agent perceptions—i.e., agent files—as opposed to object files for individuals lacking mental states, and not just in the descriptive information carried out by the singular perceptual representation. Specific mechanisms seem to anchor the mind on properties that are usually co-instantiated with intentional agents, and that appear as *direct* means for perceptually tracking them.

For instance, humans can efficiently detect and track *biological motions* which are specific to agents (e.g., Downing, Bray, Rogers, & Childs, 2004; Johansson, 1950, 1973; Rakison & Poulin-Dubois, 2001). Studies by Johansson (1973, 1975), for example, showed that people are able to detect the movement of a human body from just the motion of the body's *joints*. Further studies suggest that observers are even able to discriminate between male and female walkers who have lights placed just on their ankles, knees, and hips (Cutting, Proffitt, & Kozlowski, 1978)—see also Troje (2002).

Also, there is evidence that certain specific types of motion lead to the attribution of specific types of *intentional* states (e.g., Gergely, Nadasdy, Czibra, & Biro, 1995; Heider & Simmel, 1944; Jacob & Jeannerod, 2003, pp. 222–226). Heider and Simmel (1944) showed that certain patterns of motion among geometrical figures led subjects to use highly intentional verbs to describe their behavior—e.g., that the triangle 'chased', 'attacked', 'caressed' or 'comforted' the circle. In the same tradition, Blythe, Todd and colleagues (Blythe, Miller, & Todd, 1996, 1999; Todd & López, 1998) have explored a simple visual cue-based algorithm for judging intention from motion. Participants generated motions of two moving 'bugs' on a computer screen, corresponding to simple intentional categories including pursuit, evasion, fighting, courtship, and play. Other participants were later able to categorize the intentions of the 'bugs' with high accuracy from their trajectories alone. This study supports the notion that animate *intention* can be determined using only a few simple spatio-temporal cues such as relative heading, relative distance, relative velocity, and vorticity or 'loopiness.'

Moreover, in the visual domain, there is evidence that the visual system does not rely on the same resources for recognizing non-face objects as opposed to faces (e.g., Grill-Spector, Knouf, & Kanwisher, 2004). This suggests that the presence of a face—an agent-specific cue—can contribute to a specific file indexing, an agent-based anchoring. This could be the case not only in vision, but also in auditory perception and cross-modal integration. It seems plausible, for instance, that noises that bear the specific signature of human or animal behavior trigger the opening of an agent file—i.e., we can detect and track a person just by hearing a sound that bears the specific signature of a human body (voice, footsteps). This is the case when one is detecting a sound related to the phonological part of the body (e.g., Handel, 1995).

6.2. Argument from parsimony for the direct access to agency

An argument from parsimony supports the idea that there are two distinct kinds of files. It is often necessary to direct the focus of perceptual attention specifically toward agents in order to engage in collaborative actions (from shared intentionality in word learning to team sports), or to evaluate judgments involving intentional relations. In one possible reading of the Deflationary View, the only difference between object and agent tracking would be in terms of the descriptive content that each singular file would encode. This implies that agent tracking would always be based on a descriptive- or content-driven search for intentional properties in object files, which seems computationally costly. Against this approach, one can speculate that the singular files can be typed by an addressing mechanism *as object* or *as agent*; this mechanism would make agent seeking and tracing easier for the tracker. For instance, one might speculate that files could be sorted by a non-conceptual 'tag' signaling directly that it is a '(mere) object file' or an 'agent file'; such a tag would avoid the need to access the descriptive content of a file so as to target one of the two kinds of entity for any attentional or motor routine (e.g., routines such as 'escaping from a predator', 'seeking for help' or 'searching for a team member').

6.3. Rationality and agency

Evidence for/against rationality is also relevant to tracking intentional agents, but not objects. Thus, e.g., if someone consistently violates obvious norms of reasoning (e.g., *modus ponens*), it becomes difficult to even make sense of them as intentional agents (e.g., Davidson, 2001 [1980]; Dennett, 1969, 1971)—though, of course, it is not difficult at all to continue to track their bodies. Similarly, when someone consistently exhibits markedly different patterns of behavior/reasoning in different domains (cf. discussions of 'compartmentalized thinking', and/or 'false consciousness'), even if these differences do not correlate to marked differences in features of their body, we sometimes find it necessary to suppose, in effect, that there are two agents there even though there may be seamless continuity in her body. This assumption is invited by the idea of 'possession', and is manifested in a pathological way in conditions such as the Capgras syndrome, where the patient believes that his/her near ones have been replaced by substitutes occupying the same body. In short, considerations of a conspecific's (ir-)rationality is a criterion relevant to the opening, maintenance, and updating of agent files, but it is not relevant at all to (non intentional) object files.

6.4. Sketch of a taxonomy of two types of singular files: object-files and agent-files

Our analysis of the Organism-Dependence View, which acknowledges the fundamental difference between non-intentional and intentional individuals, can be summarized with a discussion of the possible but partial parallel between the taxonomy of properties that trigger and characterize agent- and object-files, as kinds of singular files whose distinctness is captured by the Organism-Dependence View. *Ex hypothesis*, the taxonomy of properties associated with the theory of singular files described in Section 3 should apply to the specific case of agent-files for the purpose of singular agent tracking:

As discussed in Section 5, in a number of circumstances, human agents are or must be treated in a way which, at least temporarily, puts into brackets their status as intentional agents. In these types of cases, it is imaginable that human trackers perform agent tracking while using procedures associated with an object-file, i.e., a mechanism triggered and maintained by spatio-temporal properties which are specific of objects lacking mental states (cf. the second column of Table 3). However, and as against the Deflationary View, this is an incomplete account of the phenomenon. To track in perception an agent such as a one of your relatives or colleagues, you need to pick out and be anchored on to a single perceivable *intentional* entity, to maintain attentive tracking of her over time and change, and encode perceptible properties about her mental states. In a crucial number of cases, human agent trackers use, or must use an agent-file operating along very specific procedures:

As regards the *anchoring* of an agent-based singular-file, there are agent-anchoring procedures/properties that initiate the direct perceptual access to an intentional agent—and open an 'agent file'. We mentioned above specific forms of biological motion, or shape (face or face-like shapes) or even acoustic phenomena (voices).

Table 3
Singular anchoring and singular identification via object and agent files

Functions of the singular file (apt to resolve the PSC)		Tracking of non-intentional objects via an object-file	Tracking of (human) intentional agents via an agent-file
Sensory-motor anchoring of the perceptual file (perceptual files only)	*Initial anchoring of the perceptual file*	Spatio-temporal object properties such as abrupt luminance onset or object appearance	Based on the features that allow specific anchoring of agency features and bodies
	File persistence	Spatio-temporal object properties such as cohesive spatial parts, shape, relative impenetrability, continuity of spatio-temporal path, etc.	Based on the features that allow the persistence of a perceptual agent file
Descriptive information encoded in short-term or long-term files (long-term files are generated on the basis of a subset of short-term files)		Communicated information about agents using singular terms The file contains non-mental predicates about spatio-temporal properties: *Shape*(x); *Fast*(x), etc.	Communicated information about agents using singular terms The file contains mental predicates such as *Believe*($\boldsymbol{o}, p$), *Desire*($\boldsymbol{o}, y$), Rational($\boldsymbol{o}$), etc.

There might be cues in other modalities as well (e.g., agent-odors in smell perception, skin-like or limb-like textures or resilience in tactile and haptic perception) and cross-modal effects associated with agent-based detection and anchoring (e.g., lip-reading and voice-hearing combination).

As regards the *encoding* of properties of the target, the most straightforward difference between the contents of an object-file and of an agent-file is that only the latter is expected to contain descriptions of mental states. For instance, if one considers that, in perception, a singular file contains perceptual predicates, then one can expect that agent-files contain mental predicates such as *Desire*($\boldsymbol{o}$, t) (to express the idea that the individual $\boldsymbol{o}$ desires to perform the task t). One can speculate that the mental predicates in an agent-file are weighted by epistemic and emotional assessments.

As regards the agent-file *persistence* and maintenance, it is likely to be different from non-intentional object-files since they may require the persistence of some properties or cues that specific to agent-based anchoring and encoding.

The detailed description of this taxonomy of properties remains a long-term project for conceptual and empirical research. Our goal here has been simply to claim that a conceptual unification of the diversity of phenomena associated with object and agent tracking is a possibility within the conceptual framework we are advocating. In addition, the Organism-Dependence View can be used to suggest directions for further research. For instance, a number of classical experiments have been carried out on object perception and multiple-object tracking in vision, in various conditions (e.g., Blaser, Pylyshyn, & Holcombe, 2000; Cavanagh & Alvarez, 2005; Pylyshyn & Storm, 1988; Scholl et al., 2001; vanMarle & Scholl, 2003; von Hofsten, Vishton, Spelke, Feng, & Rosander, 1998). It would be interesting to see what the results would be in analogous experiments concerning visual multiple-agent tracking. What sorts of changes (in motion? behavior? intention?) are/are not relevant to subjects for maintaining the same agent file rather than opening a new one? Can one produce in an experimental display cases where persons-as-bodies and persons-as-agents 'come apart' (as when 'the soul rises to heaven', or 'body-switching' cases)?

7. Conclusions

We have examined the likely basis of our ability to track intentional agents as opposed to objects lacking mental states. We have argued that the Organism-Dependence View is the correct approach to the relationship

between object and agent tracking. In addition, we have suggested that it is possible to draw a parallel between the classes of properties that characterize and produce agent and object files (anchoring, preservation and encoded properties or cues). The architecture of non-intentional object files and agent files rest on similar—though not identical—procedures for anchoring onto target individuals and preserving and encoding the content files. The exact relation between them remains an open question, which we have only begun to explore. However, at least the following seems true: As against the Independence View, we must suppose that agent tracking routinely exploits the resources of object tracking by anchoring the agent file on perceptible features of agents' bodies. As against the Deflationary View, however, just because intentional agents differ from non-intentional objects, object files and agent files are distinct in their anchoring, preservation and encoding procedures.

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