# OPENNESS IN SITUATIONS OF JOINT ATTENTION[1]

## *Abertura em Situações de Atenção Conjunta*

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## ABSTRACT

Openness is a distinctive feature in the episodes of joint attention. In such an episode, everything is in the open, nothing is hidden (PEACOCKE, 2005, p. 298). But what is this metaphorical description supposed to grasp? On the common knowledge approach, openness is characterized by an infinite list of iterated perceptual knowledge attributions. This approach overloads the cognitive costs of joint attention. On the relational approach, openness is a primitive notion; the phenomenon results from the fusion of perceptions between the agents, a singular experience of co-percipience that explains joint attention for free. This paper aims to argue for an intermediate approach to explain openness. We offer here an account of openness in terms of non-wellfounded situations. We shall argue that it not only fully characterizes mutual awareness in a finite adequate way but that it also preserves the low cognitive burden of the co-presence situation.

**Key-words:** Openness; Joint Attention; Situation; Non-wellfoundedness.

## RESUMO

A abertura é uma característica distintiva nos episódios de atenção conjunta. Em tal episódio, tudo está em aberto, nada está escondido (PEACOCKE, 2005, p. 298). Mas o que esta descrição metafórica deve entender? Na abordagem do conhecimento comum, a abertura é caracterizada por uma lista infinita de atribuições de conhecimento perceptivo iterado. Esta abordagem sobrecarrega os custos cognitivos da atenção conjunta. Na abordagem relacional, a abertura é uma noção primitiva; o fenômeno resulta da fusão de percepções entre os agentes, uma experiência singular de co-percipiência que explica a atenção conjunta de forma gratuita. Este documento tem como objetivo argumentar por uma abordagem intermediária para explicar a abertura. Oferecemos aqui um relato da abertura em termos de situações não fundamentadas. Argumentaremos que ele não apenas caracteriza plenamente

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a consciência mútua de forma finita e adequada, mas que também preserva a baixa carga cognitiva da situação de co-presença.

**Palavras-chave:** Abertura. Atenção conjunta. Situação. Sem-fundamento.

## INTRODUCTION

Situations of joint attention involve at least two agents seeing the same objects and events at the same time. A situation of full joint attention includes not only the perception of the same object or event by agents. Moreover, this situation is characterized by openness, which consists of mutual awareness that the agents themselves converge in the perception. Traditional theories explain openness through the notion of common knowledge. However, the notion of common knowledge seems committed to some kind of intellectualism that doesn't explain the fluent character of the interactions in the situations of joint attention. An alternative to the common knowledge approach is the relational approach. According to this approach, the openness of joint attention is a primitive phenomenon. The other agent is part of what individuates the objects in the visual field of the agent herself. The problem here is that the relational approach has deflated the agent's cognitive burden too much. In doing so, mutual awareness seems to go by the board. This paper aims to argue for an intermediate approach to explain openness: situations of full joint attention are self-involving (non-wellfounded) situations, but finite ones. So the agents can actualize this self-involving information without cognitive overload. We shall argue that this approach preserves the fluent character of the interaction.

## 1.The Hard Problem

Situations of joint attention involve at least two agents seeing the same objects and events at the same time. Consider the following situation: two parents are looking at their son taking his first steps. There is only one aspect of the situation which draws the parent's attention. Moreover, they look at each other and smile. If they were not aware of this perceptual convergence, perhaps they would not react in this way. We can express this po-

int by claiming that situations of joint attention are opening ones. The central idea is that the agents are aware of a situation that includes not only some objects and events, but also includes the fact that they are looking at these objects and events at the same time. More precisely, the agents are in a sharing situation and they somehow access this fact itself. Following Peacocke (2005), it is a situation in which everything is in the open; nothing is hidden.

The openness of the joint attention causes an important stabilizing effect on the coordination of the action. Consider now the situation in which two people, Max and Claire, are jointly changing the position of some objects in the living room. In the course of this joint action, they engage in a patient observation of a new position of a painting. They hang the painting on the wall in a certain position and move around the room to have different points of view of it, and mutually observe each other's reactions. How could one explain all these coordinated reactions? It is not sufficient to claim that Max and Claire are looking at the same object at the same time. Suppose they are separated, each one is inside a different booth in which one can only see the painting. In this case, they observe the same object, but none of them is aware that they are in the same situation. So there is not a shared element in this situation that agents could be based on to coordinate their actions. Of course, they observe the same object, but they are not aware that they share a perceptual state directed to that object.

Moreover, the mere spatial proximity, or the absence of barriers between agents, is not a guarantee that they jointly observe the same object. Consider a simple gaze-following. In this case, the gaze of an agent is affected by the gaze of the other. A lot of non-human animal species, such as dogs, goats, and ravens can monitor the gaze of their co-specifics.[4] A variety of reactions are caused by this gaze-following. However, there is no evidence that they are aware of the shared aspect of these situations. Thus, a simple gaze-following does not characterize an episode of joint attention.

Nor is it sufficient that each agent be aware that the other is looking at the painting. In an example proposed by Peacocke (2005), Claire and

[4] About dogs, see Hare and Tomasello (1999). About goats, see Kaminsky, Riedel, Call and Tomasello (2005). About ravens, see Schloegl, Kotrschal and Bugnyar (2007).

Max are separated by one glass in such a way that allows Claire to observe Max watching the painting and vice-versa. But none of them is aware that they are being observed by the other. In this case, each agent individually is aware that the other is in the same situation. However, there is a lack of public or shared information in this situation. Indeed, there is nothing that would indicate to the agents that perceptual consciousness is shared.

Without this mutual awareness, situations of full joint attention would not occur. In particular, joint attention would not stabilize the engagement of the agents in the course of an interaction. Note that Max and Claire jointly organize their perceptual attention to achieve common goals. They are faced with a situation of coordination that extends in time. They track and mutually correct their perceptual attention. In this type of situation, there is an interdependence of attention control. Each agent mobilizes its perceptual attention based on its expectations about the choices of the other. Max's choice of attending to certain aspects of the situation rather than others is due in part to Claire's choice, or to the places where he hopes Claire directs her attention. The control of the perceptual attention by each agent is interconnected. It seems that all of these behaviors require mutual awareness; without that, the coordination would not extend in time.

We have seen some aspects about situations of open coordination. These situations are distinguished from closed and semi-open situations. In the first case, the agent's mental states involved in it are simply closed to each other. Surely this kind of coordination can occur between humans. But in many instances of this type of coordination, it is not possible to say that the beings involved in it have some mental state. Even so, the coordination is performed based on some other evidence, for example, perhaps the weight of the precedent, or some other type of salience. This is enough to explain the famous example of the bee dance indicating to the workers where they should go to reach the nectar. In the second case, there is an asymmetry between the agents, such that only one of them can monitor the other's mental state. Here we have a case of unilateral adjustment of perspective. This seems to be the case for certain interactions between humans and animals. On the other hand, exposed coordination involves a mutual adjustment or

bilateral perspective.[5] This mutual adjustment depends on the agents being aware of their mutual perceptual states.

We want to focus here only on the situations of coordination involving openness. And this seems to be precisely the case with the interaction between Max and Claire. Imagine that, during the interaction, Claire approaches the painting and puts it in a position that allows Max to see it from another point of view. But suppose the only perceptual information that Claire has before acting is that Max observes the painting. She does not have the perceptual evidence that Max is aware of her intentions. Suppose that suddenly Max was absorbed by the painting to the point of not noticing Claire's presence. Claire would not have any guarantee that her particular action would be understood by Max. She has no guarantees that she would succeed in coordinating their actions to attain the same goal. Again, this requires that Max and Claire's perceptual states are mutually open along with the joint action and that both are aware of this openness.

In short, what we have here is the following: a full episode of joint attention requires a situation of openness that includes not only the perception of the same object or event by agents, moreover, the openness of this situation includes mutual awareness that the agents themselves converge in the perception. More precisely, there must be a mutual awareness that they share the same perceptual state directed to an object in the world. The question that interests us is how we can explain this essential feature of joint attention.

The problem is that the explanation of this feature requires taking conflicting aspects into account. Mutual awareness seems to involve representations about an intentional agent, i.e., an agent able to pay attention to some objects, as well as able to share attention. However, emphasizing these mindreading capacities might blur the fluent aspect of interaction. As it has been shown by the fluent interaction between Max and Claire, these capacities should not overload the agents; otherwise, there is a risk of interrupting the course of interaction. On the other hand, emphasizing the fluent aspect of interaction and, consequently, relieving the cognitive costs for agents can make us lose sight of the phenomenon of mutual awareness. In this case, the

[5] See Tomasello (2007).

phenomenon of openness goes by the board. We shall see a way to overcome this problem. Before that, however, it is important to see this tension resonating in the contemporary debate that opposes two important approaches: the approach of common knowledge and the relational approach.

## 2. Openness as common knowledge

The traditional notion of common knowledge, as proposed by Lewis (2002) and Schiffer (1972), can be a candidate to explain openness. Of course, we have seen cases of mutual perception that do not necessarily involve beliefs. And the cases that Lewis and Schifer have in mind are more sophisticated than the perceptual ones. But we can do this approximation by removing "that-clauses" of the sentences that represent common knowledge. Suppose Max and Claire have common perceptual knowledge of some fact σ. Let τ be the fact of common perceptual knowledge, i.e., the fact that both perceptually know σ. The openness, here represented by τ, is characterized by iterated knowledge of σ: Max perceptually knows σ, Claire perceptually knows σ, Max perceptually knows that Claire perceptually knows σ, Claire perceptually knows that Max perceptually knows σ, and so forth. In this vein, the openness consists of open-ended iterations about mutual perceptual knowledge of the τ. The closure of the situations is explained by the lack of these iterations or by the lack of reciprocity between the agents involved in it. For instance, if Claire iterates more than Max, the situation is not symmetric and so it is not open. Finally, the situation remains closed if the agents are not able to deal with iterations. These limitations should not be taken as limitations of the situation itself but as limitations on the ability of the agents to deal with all aspects made available by the openness.

A remarkable aspect of common knowledge is the fact that reciprocal attributions are based on additional premises related to psychophysical laws. According to Schiffer (1972), Max sees Claire looking at the painting since he knows a law that relates mental states with physical events. Max must, at least, know a psychophysical law according to which people with open eyes in face of some objects have a perceptual experience related to these objects. Thus, this notion of common knowledge demands that agents

should have a theory of mind to engage in the full joint attention episode. Moreover, they need to have a higher ability of reasoning to iterate in an open-ended way.

However, it is not certain that this notion of common knowledge could clarify the openness of joint attention. It is important to point out some aspects about that: first, it seems that it is always possible to extend the list of iterations to the point that the agents would have no guarantees of the success of coordinating their actions. But this just is not the case of joint attention. Indeed Max and Claire do not need to be certified of the open-ended iteration to coordinate their actions. They do not need to imagine in isolation what occurs in the mind of each other. Second, the notion of common knowledge seems committed to some kind of intellectualism. Schiffer seems to bear in mind ideal agents provided with higher rational capacity. But it is not certain that common agents have this ability.

A way to diminish the strength of these objections is recognizing that the open-ended iterations are aspects that the openness situation merely includes. These iterations do not need to figurate in the actual agent's reasoning to characterize the openness of the situation. All these iterations can have a dispositional sense, including the knowledge of psychophysical laws. The agent doesn't need to figurate all this knowledge in her mind to attribute mental states to others. This remark seems correct to us. But it is not enough to clarify the openness of joint attention. What matters most is that the agents are mutually aware of the fact that their mental states are open to each other. As we shall see, this mutual awareness is more basic than what is involved in the notion of common knowledge. This movement leads us to the relational approach.

## 3. Openness in the relational approach

We have seen some problems related to the common knowledge notion explanation about the openness in the joint attention episodes. Now we should look for an alternative notion to relieving the agent's cognitive burden without losing sight of the mutual awareness phenomenon. This alternative may be the relational approach, proposed by John Campbell (2005).

According to Campbell, the joint perceptual experience has a distinct *nature* of the perceptual experience of a single agent, in isolation. Campbell invites us to imagine the situation where an agent alone observes a scene and, after that, she goes on to observe the same scene, but now, with another agent. The difference is that, in the second moment, the other agent plays the role of a co-percipient. There is, as it were, a fusion of perspectives. The other agent is part of what individuates the objects in the visual field of the agent herself. The other agent is a constituent of perceptual experience. According to Campbell, the other is not an object of the agent's attention. The other is not visible because he is situated at the limit of the visual field of the agent.

The other agent is not an external entity to joint attention episodes whose mental state should be represented by the agent. As co-percipients, part of what drives the perceptual perspective of each agent is just the perspective of the other. In order to coordinate their actions, the agents do not necessarily go beyond the fact that their perceptual attention is directed to the world itself. The mental states shared around the common perceived aspects in the situation is a condition rather than a result of the coordination of actions. In this regard, Campbell argues that joint attention is a primitive phenomenon. This means that it is impossible to analyze the mental states of an agent without taking the mental states of the other agent into account. That is the reason why it is named relational approach. It is important to note that this approach is very different from the common knowledge one.

The fact that joint attention is considered a primitive phenomenon shows that the agents would not need to make much cognitive effort in order to coordinate actions. Campbell claims that the common knowledge approach misses that essential aspect of the co-presence situations. Max's presence does not relieve the cognitive burden, because he has to represent Claire's mental states anyway. The common knowledge approach would be reductionist in a problematic sense. We agree with this remark. But, in face of these aspects of the relational approach, how can we understand the mutual awareness that constitutes openness?

Now, we think that the relational approach does not accommodate this phenomenon. The reason is that Campbell has deflated the agents' cognitive burden too much. In doing so, mutual awareness seems to go by the

board. This seems to be the case. After all, according to Campbell, the agents do not need to be aware of the openness of the situation. At least, they do not need it to engage in the typical situations of joint attention. But the problem is that in these situations the agents must make sure that each other are still engaged in the interaction. As we have seen, sometimes Claire will have to focus her attention on Max and vice-versa. This is a constitutive aspect of interaction, as it extends in time. And this means, in turn, that they need to access their mutual mental states.

Another explanatory proposal, which could be an alternative between the common knowledge approach and the relational approach, would state that each of the agents only needs to verify whether the attentional behavior of the co-percipient is still available for manipulation.[6] Although interesting, this proposal is not adequate to clarify situations of full joint attention. As we have seen, the problem is that just verifying the intentional behavior of co-percipient can occur unilaterally, i.e., independently of shared situations. Experiments carried out by Call and Carpenter (2001) show that chimpanzees are able to see what their co-specifics see and react accordingly. However, there is no evidence that chimpanzees can engage in situations of full joint attention. On the other hand, according to Liszkowski and colleagues (2004), twelve-month-olds infants, not chimpanzees, are able to perform protodeclarative gestures, that go beyond to mere protoimperative gestures. Both gestures depend on a check of the other's perceptual attention, but protodeclarative gestures depend on the child's attunement to the shared situations. Therefore, a situation of full joint attention demands access to other's minds, which goes beyond the mere verification of the other's perceptual attention.

In short, the problem of the relational approach is that it is committed to two conflicting requirements. On the one hand, the agent should be aware that the other is present as a co-percipient - otherwise, there would be no difference between a solitary perceptual experience and a joint perceptual experience. On the other hand, it seems that the requirement of mutual awareness overloads common agents, and this can mischaracterize joint attention episodes.

[6] We would like to thank the anonymous reviewer for his useful comment at this point.

## 4 - Openness in non-wellfounded situations of joint attention

As we have already stressed, openness is a distinctive feature of joint attention. In situations of joint attention, *everything is in the open*. Despite the accuracy of such a metaphorical description, we have been looking for a literal explicit definition of it. It is not yet exactly clear what this openness of joint attention is. As previously done by Peacocke (2005), we shall stress the role of self-reference (fixed points) for openness, but against him, we insist on non-wellfounded situations as an adequate tool for modeling the openness of joint attention.

The openness of joint attention puts two main important challenges. First, we should find a way to put down openness in a finite schema, since agents are finite ones. As the common knowledge approach has emphasized, that kind of situation is characterized by an infinite (open-ended) list of iterated knowledge. So our first task is to find a way to represent an infinite situation in a finite one. Second, we should represent joint attention in a way that preserves the cognitive economy it shows in the real world. As emphasized by relational approaches, it is not adequate to take joint attention as a result of some long inferential journey, like the ones common knowledge approaches seem committed to. Roughly speaking, we have to explain how agents act based on real situations of joint attention.

A well-known way to get infinite lists like $\tau$ in a finite schema is by using fixed points, as suggested by Barwise (1988). A fixed point of a function $f(x)$ is any value for the input variable $x$ that results in itself as the output of the function, $f$, i.e., $\theta$ is a fixed point of $f(x)$ iff $f(\theta) = \theta$. We are going to show here how to get everything in an infinite list like $\tau$ from a finite situation, one that figures as a fixed point. First, we need to introduce situations and related notions.[7]

Situations are determined by the insertion of informational agents in space-time locations, a situation is what an agent (a perceptual organism) sees in a given space-time location, what is informed to him given his per-

[7] The notion of situation we use here is heavily based on Barwise and Perry (1983), and Barwise (1988, 1989).

ceptual-cognitive-attentional resources, and his location. We understand "agent *a* sees σ" as "*a* has the information σ". Thus situations have a relational perspectival nature, they always relate to agents and space-time locations. Different agents can (and do) have different perceptual resources, and this causes different sorts of attunements to the same environment. Nevertheless, this is not supposed to flirt with relativism or any sort of anti-realism since actual situations are always based on the same reality.

> Different organisms can rip the same reality apart in different ways, ways that are appropriate to their own needs, their own perceptual abilities and their own capacities for action. This interdependence between the structure its environment displays to an organism and the structure of the organism with respect to its environment is extremely important. For while reality is there, independent of the organism's individuative activity, the structure it displays to an organism reflects properties of the organism itself. (BARWISE & PERRY, 1983, p.11)

Suppose Max is sitting inside the living room of his house in Palo Alto, CA, at 11 am on December 1 of 2021, while his dog Arf, in the yard, barks at some hidden cat on the roof and something is burning in the kitchen. All this is noticed by Max when he suddenly wakes up from a nap in his living room, he can listen to Arf's barking and cat's movements on the roof, he can smell the burning and he can even see the time, day, month and year in an old wall clock. Shortly, the facts listed above can be seen by Max, and that happens because of the way the world is in a certain space-time location, but also because of the specific way Max's perceptual apparatus works. Suppose we are not at Max's address anymore, but her neighbor, Claire, at the same time. Maybe she can listen to Arf but she cannot listen to the cat's movements on Max's roof, so the situation she sees is different. Also, Arf is probably capable of noticing different smells around Max and Claire's houses but cannot see it's December 1, even if some nice clock is available in front of its eyes. Arf also grasps a different situation.

Of course, situations do not only inform what the agent sees in a given space-time location, but also what he can infer from it. When Max wakes up in his living room he sees the white wall clock, his white t-shirt, he sees his own body, the table in front of himself, but he also could see, in a

different way, that he is not a dog, that the wall is not yellow, nor brown, nor red, and so on. An infinite number of facts (or states of affairs, SOA's) can be said to hold in each situation, and in a certain way, it makes sense to say that we can see them all when we see the situation in which they hold, but at the same time it's wrong to take very deep or hidden facts of the situation as in the same ballpark of the superficial and directly selected ones.

Let us say that situations provide information at two levels, the actual and the inferential (merely available). Roughly speaking, the idea is that we can carry information that we did not yet extract. The actual level includes everything the agent actually sees, which is determined by his cognitive-perceptual-attentional resources and selections. The inferential level is indirect and mediated by constraints. For the agent to infer an episode of fire from seeing the smoke, he must be attuned to the relevant constraint that links these two different types of situations. Constraints are tracked by regularities across situations. Of course, not everyone is attuned to the same sort of constraints. It explains why not all informational agents are social and linguistic agents, it explains why ants are not attuned to constraints relating sounds with meanings, but it also explains why an expert looking at the rings of a stump can see the age of the tree.

We say that a SOA is a constitutive fact of a given situation if it is actually extracted by the agent. A situation is formally represented as a set of SOA's, the set of its constitutive facts. Everything else the situation informs must be taken as merely available information. Let's introduce a satisfaction relation between situations and SOA's. We say that the SOA σ is true in the situation $s$ (and we write $s$ ||- σ) iff either σ is a constitutive fact of $s$ (that means, σ ∈ $s$) or σ can be inferred from $s$, (we write $s$ => σ). Notice as well that we use a double arrow for a general notion of consequence to represent inference. As already explained, there are different sorts of constraints, which produce different sorts of consequence relations. For example, the rule "smoke means fire" obeys a constraint that doesn't coincide with the one under which "something is colored" follows from "something is red".

The logical consequence is one (actually, the strongest) kind of consequence. We add a principle according to which situations are closed under logical consequence, which means, if $s$ ||- ρ, and σ |= ρ, then $s$ ||- σ. This is

usually called the Principle of Logical Omniscience. The reader might be worried that such a principle would put too much weight on what agents of any sort see in any sort of situation, but she should remember that not all available information of a situation must be actualized by the agent. As rightly observed by Barwise, "[i]nformation travels at the speed of logic, genuine knowledge only travels at the speed of cognition and inference" (BARWISE, 1988, p. 368). Thus a situation might carry much more information than the agent actually extracted.

Considering the satisfaction relation and the general relation of seeing (in the sense of having all available information) between agents and facts (or SOA's, i.e., states of affairs) or situations (sets of SOA's), we can also add two more principles. Let's represent the fact that agent *a* sees the situation *s* with the tuple (*S*, *a*, *s*), and the fact that agent *a* sees the fact σ with the tuple (*S*, *a*, σ). Let *s* and $s_1$ be arbitrary situations, let *a* be any agent, and let σ and ρ be arbitrary facts. Thus:

**3.** If $\sigma \in s$, then $s \Vdash \sigma$.
**4.** If $s \Vdash (S, a, s_1)$, and $s_1 \Vdash \sigma$, then $s \Vdash (S, a, \sigma)$.
**5.** If $s \Vdash \sigma$, and $\sigma \Rightarrow \rho$, then $s \Vdash \rho$.

Principle 3, as explained before, is a general version of Logical Omniscience. Situations inform (in the sense of making available) everything that follows from it. Principle 1 is just based on the definition of satisfaction relation, which means, constitutive facts of a situation are obviously true in it. Principle 2 is based on how we understand the relation of seeing. We take the relation of *seeing* as co-extensional with *informing* (in the sense of making available the information). Thus, principle 2 says that agents see everything the situations they see informs.

Another important assumption behind principle 2 is that situations can take place inside SOA's, like the ones expressing that agents see situations. Situations have a pervasive nature, "we are always in situations; we see them, cause them to come about, and have attitudes toward them" (BARWISE & PERRY, 1983, p.7). Of course, not all agents can see situations that include facts about situations, but those are especially important for our

regular linguistic and communicative coordination. As explained before, what we see depends on how attuned we are to the environments and the constraints we are under.

Now we come to situations of joint attention. What we argue here is that such situations are especially characterized by constitutive facts that provide the aforementioned feature that allows agents to coordinate their actions, the feature we earlier called openness. We provide here an explanation of openness as a special type of situation. As we shall argue, such situations explain openness without any mysterious evasive fusion of experiences, and they also dismiss with infinite cognitively expensive inferences.

Suppose Max (*m*) and Claire (*c*) are jointly attending some fact σ. So they share a situation that can be represented as the following one:

$$s_\tau = \{\sigma, (S, m, s_\tau), (S, c, s_\tau)\}$$

Thus $s_\tau$ is a finite way to represent the situation in which Max and Claire are jointly attending to some fact σ, basically, they share a situation that has the following constitutive facts: σ and the facts that they both see the situation $s_\tau$ itself. Max and Claire see the situation itself in which they are. This nice schema of situations is a fixed point, a non-wellfounded situation that includes itself inside the transitive closure of itself, that means,

$$s_\tau \in s_\tau \cup Us_\tau \cup UUs_\tau \cup UUUs_\tau \ldots$$

From principles 1-2, we can prove that $s_\tau$ is enough to obtain the mutual open-ended perceptual availability list τ mentioned as a requirement to the common knowledge approach. In fact, an induction proof can be delivered to obtain the infinite list τ: let's enumerate the infinite steps of τ. Step one is: $s_\tau$ ||- (*S*, *m*, σ) and $s_\tau$ ||- (*S*, *c*, σ). Step two is: $s_\tau$ ||- (*S*, *m*, (*S*, *c*, σ)), $s_\tau$ ||- (*S*, *m*, (*S*, *m*, σ)), $s_\tau$ ||- (*S*, *c*, (*S*, *m*, σ)), and $s_\tau$ ||- (*S*, *c*, (*S*, *c*, σ)). Further steps follow so on. Step one is proved with Principles 1, 2, and the definition of $s_\tau$. Now we assume that Step *n* is true and prove (under such an assumption) that Step *n*+1 is also true. Let Step *n* establishes that facts $\rho_1, \rho_2, \ldots, \rho_k$ all hold in $s_\tau$. Thus what we need to prove is: $s_\tau$ ||- (*S*, *m*, $\rho_1$), …, $s_\tau$ ||-

($S$, $m$, $\rho_k$), $s_\tau$ ||- ($S$, $c$, $\rho_1$), …, $s_\tau$ ||- ($S$, $c$, $\rho_k$). The assumption of Step $n$ together with Principle 2 and definition of $s_\tau$ suffice to show everything we need to establish Step $n$+1. By induction, we conclude that all steps on the list $\tau$ hold.

We said before that a mutual open-ended perceptual availability list is a necessary requirement to correctly characterize the openness of joint attention (or mutual awareness). The requirement is filled by non-wellfounded situations. So, in a sense, we put available for the agents in $s_\tau$ everything we need to call $s_\tau$ a situation of joint attention, we have everything we need to call this situation an open one. At the same time, not everything entailed by the situation $s_\tau$ is constitutive of the situation itself, so we can finitely represent this openness. Each SOA of the list $\tau$ is entailed by $s_\tau$, and so, each one of these SOA's is also available for the agents, they see these SOA's, but they don't have to actually see all the SOA's entailed by $s_\tau$, the situation just carries these as part of the available information.

The special feature that defines the openness of situations of joint attention is that they include SOA's relating the agents to the situation itself, it includes as facts that the agents see the situation itself. This is what allows us to obtain an infinite list of the available information in a finite one. Of course, infinite sets of available information is not what explains how agents succeed in coordinating actions, this is a lesson we learned from the criticism against the common knowledge approach. The openness of situations is a special kind of feature that some (not all) agents can see. An agent attuned to situations of openness also sees important constraints that allow them to keep track of everything that matters for coordinating actions. As before, the constraints under which openness holds arises from regularities across situations. Thus, there is a bottom-up explanation of how people come to engage in such an intricate type of situation.

Notice that we are not saying that in situations of joint attention, the agents are in the same situation. Against the relational approach, we don't think that openness commits us to the fusion of experiences or any episode of co-percipience. In the situation in which Max and Claire jointly attend to some painting, they might be differently inserted. First, they can not be precisely described as sharing the same space-time point, only the (somehow

vaguely pointed as) same region of space-time. Each one also has perceptual and perspectival singularities, maybe Claire is taller while Max has blurry vision. Maybe their attention mechanisms select different aspects of the same environment. Nevertheless, if their attunement to the environment suffice for them to engage in joint attention, part of what each one of them sees is a non-wellfounded situation like $s_\tau$.

Peacocke (2005) raises a similar view on the openness of joint attention, but he rejects non-wellfounded situations as metaphysically illegitimate. According to him, "... the world itself must be well-founded" (PEACOCKE, 2005, p. 318). To keep the benefits of non-wellfoundedness without committing himself to an exotic ontology, Peacocke replaces non-wellfounded situations with self-referential mental states, that means, mental contents including awareness of its very contents. As we shall argue next, Peacocke is wrong about the metaphysical status of non-wellfounded situations. We also believe that self-referential mental states don't offer an explanation that conciliates with the cognitive economy of the most basic aspects of coordination.

The argument behind Peacocke's remark might be somehow summarized like this: Openness situations are non-wellfounded. Situations are parts of reality. Therefore, the reality is non-wellfounded. We agree that actual situations are parts of reality. This implies that everything true in an actual situation is actually true, which some have been calling the Veridicality Principle of Information.[8] Thus there can be no false information, what actual situations inform is true. We also agree that some actual situations are non-wellfounded ones. However, Peacocke takes these two premises to conclude that reality itself is non-wellfounded, we deny this last step.

The argument above takes for granted that there is an all-inclusive situation, a situation that contains as parts all actual situations, something like the actual world. In fact, there seem to be very good arguments against the consistency of models with such an amazing power of inclusion.[9] That means, if there is a maximal and complete actual situation, then we can ar-

[8] See Barwise (1989, p.12).

[9] Grim (1991) presents very general arguments against the existence of absolutely inclusive entities like worlds, the set of all truths, and the set of all sets.

gue that it is an inconsistent one, which would also imply that reality itself is inconsistent. Well, the reader might ask, are you arguing against reality? Of course not, we are not saying that there is no such thing as reality. What we are precisely denying here is the existence of a situation that corresponds to reality. Thus the claim according to which reality is non-wellfounded mistakenly assumes reality to be a set under the membership relation, and then it ends up being somehow just a vague nonsensical claim.

Remember that actual situations are determined by the insertion of informational agents inside space-time locations. Therefore, the existence of a maximal complete situation would demand something like a universal agent and also a universal space-time location. The incompleteness of actual situations doesn't push something like the non-existence of reality. Of course, reality is not ontologically dependent on actual situations, but the inverse relation holds.

To make our objection against Peacocke's argument clearer, remember the relational perspectival nature of situations. Given its nature, it is somehow unfair to talk about its properties as talking about the things they are about. Situations are about reality, but they are not ontologically independent, they depend both on reality and agents. Thus we should think of non-wellfoundedness behind openness as an intentional-semantic (informational) kind of entity, which we believe strongly relieves the metaphysical costs of our approach.

We also believe that Peacocke owns an explanation of how the agent is supposed to use self-referential mental states in episodes of coordination. As said before, it is not the same to characterize an episode of openness with all it needs and to explain how agents act in such an episode. Explaining action as based on inferences over a mutual open-ended perceptual availability list of information neglects cognitive economy. Even if information travels way faster than knowledge, the problem here is not about how fast inference can travel. We believe that our approach based on non-wellfounded situations provides a bottom-up explanation. In situations of joint attention, the agents directly see a non-wellfounded situation, and this kind of situation is especially constrained, it is constrained in ways that allow the agents to keep track of everything that matters for coordination.

One last word about the philosophical goals intended by our own approach might be useful. It should be emphasized that non-wellfounded situations mainly concur as an alternative conceptualization of openness. In this sense, we intend our approach to both points out the conceptual problems behind the models provided by common knowledge and relational approach, and to provide a better conceptualization of openness. Moreover, we also have been trying to show that our approach better conciliates with an important requirement on explaining joint attention, its cognitive economy. In this sense, we also believe our approach might deserve some space in the explanatory aspects of the subject.

## CONCLUSION

The relational approach states that the agents don't see each other in situations of joint attention. This is because openness includes the perceptual convergence between the agents. However, the problem is that the relational approach is focused on symmetrical situations. Moreover, this approach doesn't explain the fact that agents engaged in a full joint attention episode have to go beyond the objects of the situation. The common knowledge approach also states that agents can't see each other's points of view. But this position is insensitive to the difference between co-presence situations and situations in which the agents are separated. In this vein, the agents have to use high-level mindreading skills to access each other points of view. The problem here is that they can't take advantage of the low cognitive burden of the co-presence situation.

We propose that a situation of openness, such as full episodes of joint attention, is non-wellfounded but finite. It is a situation that carries information about itself. This allows such situations to make available an infinite list of information required to fully characterize mutual awareness. Behind this, we offer a whole account of how agents attune to the same environment and cut different situations with a common non-wellfounded part. In our account, openness is not a primitive nor a metaphorical notion, and we do preserve the differences between the symmetrical and asymmetrical situations. At the same time, what explains the attunement to situations and the inferen-

ces the agent takes from it is his cognitive-perceptual-attentional resources. Therefore there is a bottom-up explanation of how agents engage in situations of joint attention, how they stabilize, and how agents coordinate actions based on them. Different from the common knowledge approach, we don't neglect the low cognitive burden of the co-presence situation.

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**REFERÊNCIAS**

BARWISE, Jon. "Three views of common knowledge", In M. Vardi (ed.), *Proceedings of the Second Conference on Theoretical Aspects of Reasoning about Knowledge*. Los Altos, Calif.: Morgan Kaufmann, 1988, pp. 365–79.

BARWISE, Jon. *The Situation in Logic*. CSLI Lecture Notes 17. Stanford, Calif,: CSLI. 1989.

BARWISE, Jon; PERRY, John. *Situations and Attitudes*. London: The MIT Press, 1983.

CALL, Josep; CARPENTER, Malinda. Do apes and children know what they have seen?. *Animal Cognition* (4), 2001, pp. 207-220

CAMPBELL, John. "Joint Attention and Common Knowledge". In EILAN, Naomi; HOERL, Christoph; MCCORMACK, Teresa; and ROESSLER, Johannes. *Joint Attention: Comunication and other minds.* NY: Oxford University Press, 2005, pp 287-297.

GRIM, Patrick. *The Incomplete Universe: Totality, Knowledge, and Truth*. London: The MIT Press, 1991.

HARE, Brian; TOMASELLO, Michael. Domestic dogs use human and conspecific social cues to locate hidden food. *Journal of Comparative Psychology*, 113(2), 1999, pp. 173-177

KAMINSKI, Juliane; RIEDEL, Julia; CALL, Josep; TOMASELLO, Michael. Domestic goats, Capra hircus, follow gaze direction and use social cues in an object choice task. *Animal Behaviour,* 69(1), 2005, pp. 11-18.

LEWIS, David. *Convention: a philosophical study*. Great Britain, Blackwell Publishers, 2002.

LISZKOWSKI, Ulf; CARPENTER, Malinda; HENNING, Anne; STRIANO, Tricia; TOMASELLO, Michael. Twelve-months-olds point to share attention and interest. *Developmental Science* 7(3), 2004, pp. 297-307.

PEACOCKE, Christopher. "Joint Attention: Its Nature, Reflexivity, and Relation to Common Knowledge". In EILAN, Naomi; HOERL, Christoph; MCCORMACK, Teresa; and ROESSLER, Johannes. *Joint Attention: Comunication and other minds.* NY: Oxford University Press, 2005, pp 298-324.

SCHIFFER, Stephen. *Meaning*. NY: Oxford Claredon Press, 1972.

SCHOEGEL, Christian; KOTRSCHAL, Kurt; BUGNYAR, Thomas. Gaze following in common ravens, *Corvus corax*: ontogeny and habituation. *Animal Behaviour*, 74 (4), 2007, pp. 769-778.

TOMASELLO, Michael; CARPENTER, Malinda. Shared Intentionality. Developmental Science 10(1), 2007, pp. 121-125.