Joint attention, openness, and self-other (in)differentiation

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Abstract

Joint attention is characterised by openness: when two agents jointly attend to an object, they are immediately and fully aware of each other's attentional states. Existing accounts of openness involve a mental picture in which two agents attend to the same object and where openness is then 'added'. I argue that the experience of opennness comes first. Young infants operate under a *tacit assumption of openness*: they behave as if attentional states were open even when they aren't. The ability to engage in joint attention doesn't arise when infants begin to experience openness, but rather when they can limit these experiences to open interactions. For this, they depend on cognitive processes that detect non-open interactions. Some of these processes develop early and don't require the representation of others' mental states. Other processes develop later and require the infant to differentiate between herself and others as subjects of attentional states.

Introduction

As a friend and I walk down a narrow street, a beautiful cat crosses our path, seemingly oblivious to our existence. She races across the street and then up a nearby tree. I look to my friend, who turns towards me. We exchange a smile and observe the animal a little longer.

The smile punctuating this episode marks a change in our interaction: we now *jointly attend* to the cat. While my friend and I might both have been attending to the cat before, we did not know this. Our attentional states weren't *out in the open*. They weren't, in Sperber and Wilson's (1986) words, *mutually manifest*. Only when we exchange a smile does it become fully and immediately transparent that we are jointly attending (Calabi, 2008). My friend and I are now aware that we're jointly attending to the cat.

Broadly speaking, the literature knows two distinct kinds of approach to openness and joint attention. Knowledge-based accounts claim that two agents jointly attend to an object when they have mutual knowledge about one another's attentional states.

Non-reductive accounts argue that 'joint attention [is] a primitive phenomenon of consciousness' (Campbell, 2005, p. 288) that cannot be reduced to the agents' individual states.

Both approaches spring from a mental picture in which two agents attend to the same object but fail to *jointly* attend to it. They ask, to quote a title by Hobson (2005), 'What puts the jointness into joint attention?' My introductory example illustrates this problematic mental picture: my friend and I attend to the cat and *later* become aware that this is the case. When put like this, inquiry naturally focuses on how attentional states become open to the participants. Essentially, joint attention is attention to the same object to which we *add* openness.

An alternative example helps foreground another way of conceptualising joint attention. Imagine my friend and I continue strolling down the road. I see another beautiful cat and tell my friend, 'Wow, what a beauty!' My friend responds, 'Yes, the tiles really are quite something.' I look over and realise that they're looking at a nearby building – and not the cat I had spotted. I seem to have *assumed* that my friend is jointly attending with me. Only after their incongruent response did I become aware of the lack of joint attention.

My alternative account starts from situations in which an agent attends to an object and experiences joint attention without anyone else attending with them. The experience of joint attention comes first, and we later add the ability to limit such experiences to situations in which they are apt, that is, situations in which another agent jointly attends to the same object.

The promise of an account based on a *tacit assumption of openness* is revealed particularly vividly when looking at infants' development of joint attention. Across various situations, infants initially presuppose that interactions are open. Their behaviour only succeeds in open interactions, but infants behave in this manner no matter whether openness is the case. For example, in early social referencing, an infant may take an adult who expresses fear to indicate that she shouldn't engage with an object, even if the adult isn't attending to the infant.

The development of joint attention requires that the infant become good enough at detecting non-open situations, so that the experience of openness (that is, the experience that attentional states are out in the open) is limited to open interactions (that is, interactions in which attentional states are out in the open). This happens once infants develop and apply two kinds of sensitivity to detect such situations. First, infants become sensitive to being at the other's focus of attention (*sensitivity to attention-to-self*). This sensitivity isn't cognitively demanding. Later, infants become sensitive to sharing the other's focus of attention (*sensitivity to attention-to-same-object*), which requires that they differentiate between themselves and others as distinct subjects of attentional states. By the time we reach adulthood, we become so adept at detecting non-openness that it's easy to forget that a tacit assumption of openness underlies our ability to engage in joint attention.

The proposed account has several advantages. It doesn't demand too much or too little of infants' cognitive abilities. It agrees with the basic insights of non-reductive accounts (that representations of others' mental states don't bring about openness) *and* knowledge-based accounts (that joint attention requires some knowledge of other minds). Unlike Campbell's account and those inspired by him, my proposal doesn't rely on the controversial position of relationalism about perception. Finally, it accounts for the experiential nature of openness and how joint attention can provide a rational basis for joint action.

An improved account of joint attention may benefit a wide range of philosophical and psychological debates. Various authors have argued that joint attention helps explain mutual knowledge (Peacocke, 2005; Seemann, 2019), communication (Campbell, 2017; Eilan, n.d., 2005, 2007; Heal, 2005; Tomasello, 1995), theory of mind (Baron-Cohen, 2000; Campbell, 2012, 2017; Franco, 2005; Heal, 2005; Hobson, 2005; Leavens & Racine, 2009; Moll & Meltzoff, 2011), and joint action (Battich & Geurts, 2021; Campbell, 2005; Fiebich & Gallagher, 2013).

Following this introduction, section 1 discusses why openness presents a puzzle and where the strengths and weaknesses of prior accounts lie. Thereafter, in section 2, I focus on dyadic interactions in early infancy and how they are characterised by a tacit assumption of openness. Here, we also encounter the sensitivity to attention-to-self. In section 3, I turn to triadic interactions, and in section 4, I show how joint attention emerges with the sensitivity to attention-to-same-object. Section 5 examines the account's upshots, and section 6 concludes.

The puzzle of openness

Openness makes joint attention puzzling, and the account proposed in this paper is, above all, an account of openness. It's therefore important to look at what makes openness puzzling and where existing accounts fail.

Consider a case in which openness doesn't obtain. Nakisha and Subhan are secretly in love. They work in the same office and spend a great deal of time surreptitiously observing one another. This has made them adept at detecting one another's focus of attention. Right now, they are both looking at the daily inspirational quote on the whiteboard. Nakisha knows Subhan is attending to the whiteboard, and Subhan knows Nakisha is attending to the whiteboard. However, they aren't aware of this: Nakisha isn't aware that Subhan knows she is attending to the whiteboard, and Subhan isn't aware that Nakisha knows he is attending to the whiteboard.[1]

Why does this interaction lack openness? We might think the answer is straightforward: Nakisha isn't aware that Subhan is aware that she is attending to the whiteboard (likewise for Subhan). However, even if she (and Subhan) were so aware, atten-

[1] This example is inspired by similar cases by Peacocke (2005), León (2021), and Eilan (n.d.).

tional states might still not be fully open. For instance, Nakisha may fail to be aware that Subhan is aware that she is aware that he's attending to the whiteboard. And on it goes: with each additional iteration of awareness, joint attention still requires yet another iteration.

The two kinds of approach to joint attention tackle this puzzle in distinct ways. Knowledge-based accounts aim to reduce openness to the participants' individual mental states. Most commonly, this comes down to the claim that attentional states are open if the participants have the right kind of mutual knowledge. At this point, we arrive at a juncture. First, one might think that openness requires infinite knowledge: an agent is aware of jointly attending to some object because they know that the other attends to the same object, and they know that the other knows that they attend to it, and so forth.[2] The problem lies with what an agent needs to represent to have knowledge that can undergird awareness of joint attention. If it were *just* about attributing knowledge, we might succeed at accounting for infinite knowledge with finite representations. Arguably, an agent may know, for instance, that there are more than a thousand grains of sand on Earth even if they don't represent this fact. It's enough that they're disposed to infer it. However, we're concerned with awareness – an experiential state – and an agent can only be aware of some state of affairs if they *actually* represent it (Peacocke, 2005). Full awareness of openness then requires infinitely many representations, which is impossible given our limited cognitive capacities. For this reason – and since it's unclear whether anyone espouses the view (Battich & Geurts, 2021) – I will not discuss this account further.

Knowledge-based accounts that require participants to have some finite knowledge are more popular (Gilbert, 2007; Peacocke, 2005; Tomasello, 1995) but still face important worries. According to such accounts, agents are aware of joint attention when they have some (limited) knowledge about the co-attender. From this knowledge, an agent may infer the infinite iterations of awareness characteristic of openness. While this dispenses with the need for infinitely many (actually tokened) representations, such accounts suffer from requiring an overly high level of cognitive sophistication (Eilan, 2005; León, 2021), an inability to make sense of agents *experiencing* openness in joint attention (Peacocke, 2005), and a failure to account for how joint attention may provide a rational basis for joint action (Campbell, 2005).

Due to these difficulties, much of the literature has pivoted towards explanations based on irreducibly non-individualistic states (Calabi, 2008; Campbell, 2005, 2012, 2017; Eilan, n.d.; Gómez, 2005; Seemann, 2012). Campbell, for instance, argues that joint attention is a perceptual phenomenon and, hence, doesn't involve any personal-level inferences or judgements. Moreover, for him, perceptual states are relational, and it's therefore impossible to specify an agent's perceptual state without reference to the perceived object. When an agent perceives joint attention, the other agent must

[2] I use the singular 'they' for unnamed adults and 'she' for infants.

figure as a co-attender in the content of the experience. While other accounts in this family differ, they all agree that knowledge of another's mental states cannot explain why an agent experiences joint attention.

While I agree that knowledge of a co-attender's mental states fails to explain openness, I am dissatisfied with existing non-reductionist approaches. To some extent, this is due to the worry – shared by others (Battich & Geurts, 2021; Eilan, n.d.; Gómez, 2005; León, 2021; Vincini, 2024) – that such accounts fail to explain which, and how, psychological processes underpin openness. If we posit that unanalysable non-reductive states explain openness, we risk leaving joint attention no less mysterious than it was before.

Additionally, non-reductive accounts conflict with some of the empirical literature. Findings in developmental psychology indicate a close link between joint attention and infants' abilities to *represent the co-attender's attentional state* (Tomasello, 1995; Woodward, 2005). Infants need to develop such representational capacities before they can engage in joint attention. While infants do not have the sophisticated meta-representational capacities that would support knowledge-based accounts, representations of *some* individual mental states *are* important to explaining joint attention (see also Battich & Geurts, 2021). We may wonder: if 'joint attention [is] a primitive phenomenon of consciousness' (Campbell, 2005, p. 288), why must infants be able to represent others' mental states to engage in joint attention? Existing non-reductive accounts don't explain why and how such representations are important.

Knowledge-based accounts and non-reductive accounts hence face a puzzle – a puzzle I hope to (dis)solve. In this section's remaining paragraphs, I want to give a quick preview of what's to come by means of situating my approach in the literature. In particular, I will compare the examples I've advanced so far to those more commonly discussed in the literature.

People often intentionally bring about joint attention, and they often do so within the framework of joint activities. You and I are trying to attack simultaneously. When the target appears, 'You point and I nod. Straightway we hit the buttons' (Campbell, 2012, p. 417). We're engaging in a joint activity whose goal we can only achieve by acting jointly and coordinating our attentional states. Alan and Barbara are having a conversation, and 'Alan points at a nearby sidewalk and says to Barbara "Did you see my dog run by here?" ' (Clark, 1996, p. 13). Alan intentionally directs Barbara's attention so that they jointly attend to the sidewalk. In these cases, agents use *indices* – 'signs [...] "physically connected" to the thing they want to refer to' (Clark, 1996, p. 165) – to bring about joint attention. Such intentional coordination is missing in the cases I've discussed so far. Joint attention arises (if it arises) spontaneously through the participants' individual actions. Recall, for instance, the example of my friend and I seeing a cat. Our eyes meet as we look up, causing us to experience openness. Joint attention comes about without intentional coordination of attentional states.

I don't focus on the intentional coordination of attentional states because my dis-

agreement with the literature lies with the so-called *monitoring* processes (see Campbell, 2005). While coordination processes yield attention to the same object, monitoring processes track others' attentional states. Both are required for an agent to exhibit the full gamut of joint attention behaviours. Without coordination, agents are unlikely to attend to the same object, and without monitoring, agents don't know when joint attention behaviours are appropriate and when coordination is needed. When I exclaimed, 'Wow, what a beauty!', I committed a monitoring mistake. I thought my friend was jointly attending with me when they weren't. Had I avoided this mistake, I might have intentionally re-established joint attention by pointing to the cat and saying, 'Look at that beautiful cat!'

My account attempts to overcome the puzzle of openness by re-interpreting what monitoring processes do. Monitoring processes aren't in charge of detecting openness and bringing about the states underlying experiences of openness. As we've seen, when we try to specify these states we run into the puzzle of openness. Instead, monitoring processes detect when openness *fails* and cause agents to drop their pre-existing assumption of openness. Hence, to explain the case of Nakisha and Subhan, we must begin by looking at the factors that caused them to drop their pre-existing assumption. To *return* to an experience of openness, we need to identify the factors that could override the earlier classification. For instance, if lack of eye contact caused them to drop their assumption, openness might be re-established by an exchange of eye contact. At least on the face of it, such an approach renders the puzzle significantly less puzzling.

What remains to be explained is the notion of an underlying tacit assumption of openness and how, precisely, various monitoring processes serve to detect non-open situations. It is to this that we now turn.

The assumption of openness in dyadic interactions

Young infants engage exclusively in dyadic interactions, namely face-to-face interactions with their caregivers. Only later do they engage in triadic interactions, which relate them to another person and an object. While joint attention is a triadic interaction, we'll see that openness – more specifically, the tacit assumption of openness – also characterises dyadic interactions.

In emotional contagion, an infant automatically absorbs others' emotional states (Hatfield et al., 1993). For example, when a newborn cries, other neonates nearby will reliably follow suit (Bühler & Hetzer, 1928; Simner, 1971). While contagious crying might be the only form of emotional contagion at birth, other forms soon develop (Fonagy et al., 2007; Heyes, 2018). Infants' responses to others' – especially their caregivers' – facial expressions are particularly important to us (Leppänen & Nelson, 2009). Roughly speaking, infants tend to cheer up when their caregivers smile and become fearful when caregivers frown.

Through emotional contagion, caregivers may help regulate infants' affective states when infants' capacity to regulate their own emotions is still limited (Heyes, 2018; Taipale, 2016). A caregiver's reassuring smile may, for instance, help calm an infant startled by a loud noise. The infant is drawn to exhibit a positive emotion appropriate given the non-threatening situation.[3]

Adults only succeed at regulating an infant's emotions when they express an emotion that is appropriate for the infant. The caregiver only reliably expresses such an emotion if they're aware of both the infant's object of attention (the source of the startling sound) and the infant attending to the caregiver. When these conditions occur, the caregiver likely expresses an emotion that is about the infant-object relation and is intended to be absorbed by the infant.

When these factors don't obtain, the caregiver is likely to express – and the infant is likely to adopt – an inappropriate emotion. For instance, if a caregiver expresses stress and anxiety while on a work-related phone call, a happy infant may become distressed. Distress isn't here appropriate for the infant.

Young infants inflexibly take on others' emotional states, which shows that they tacitly assume a certain state of affairs. Emotional contagion is only appropriate when the caregiver attends to the same object and is aware of the infant's attentional state. The infant, however, adopts the caregiver's emotional state even if these conditions aren't fulfilled. She tacitly assumes that these conditions are fulfilled across all interactions. I will now argue that among these assumptions, we find the assumption that openness is the case.

To do so, we need to understand the concept of *awareness of openness*. Awareness involves a non-factive experiential component and a (factive) state of affairs. An agent who is, say, aware of a chair experiences a chair, and their experience is caused (in the right way) by the chair. Similarly, when an agent is aware of openness, they experience openness, and an open interaction causes their experience (in the right way). These components may separate: we may experience attentional states to be open when they're not.

When agents are aware of openness, they're experiencing a state of affairs in which each participant is (immediately and fully) aware of the other's attentional states. Importantly, this involves awareness that the other is also so aware. Moreover, because awareness has an experiential and factive component, when agent A is aware of openness, they are aware of agent B experiencing a certain state of affairs and for that state of affairs to be the case. Since the state of affairs experienced by B necessarily involves agent A being aware of openness, a distinction between the two agents' awareness of openness is merely conceptual. If agent A is aware of openness, then agent B is neces-

[3] Emotional contagion isn't the only, nor the most important, way an adult may help regulate an infant's emotions (Fonagy et al., 2007). For instance, it's more common – and more effective – for a parent to soothe their infant by picking her up. The claim I develop over the next paragraphs – that emotional contagion manifests a tacit assumption of openness – isn't affected by these complications.

sarily also aware of openness.

When an agent *assumes* that openness is the case, they assume that the relevant state of affairs obtains. Thus, when agent *A* assumes that openness is the case, they assume that agent *B* experiences a certain state of affairs and that this state of affairs is the case.

When I say that infants *tacitly*[4] assume that openness is the case, I mean that the assumption manifests in the agent's behaviour *without* the agent representing the assumed state of affairs. When infants inflexibly take on others' emotional states, they behave – across both open and non-open interactions – as if the other were aware of their attentional state. They behave in a way that presupposes for its success that openness is the case.

Importantly, infants do not represent a differentiation between their attentional states and those of the other person, which they subsequently utilise to represent that these states are open to the other. They don't represent two distinct subjects of attention, and they cannot conceive of attentional states failing to be open. The tacit assumption of openness manifests a lack of self-other differentiation rather than the overcoming of such a differentiation.

Infants behave in ways that tacitly assume openness because they instantiate certain kinds of sensorimotor representations. I am here inspired by the views of Campbell (2005), Seemann (2012), and Roessler (2005), who employ the concept of sensorimotor representation to explain infants' ability to engage in joint attention. Sensorimotor representations, as their name implies, link sensory input to motor output. In infants, these links cause infants to behave in ways that manifest a tacit assumption of openness. Roughly speaking, given an input characteristic of an adult's presence, infants respond in ways that only succeed if the adult is aware of the infant's attentional states.

Due to their sensorimotor representations, infants experience caregivers as the source of certain affordances. For instance, and as the case of emotional contagion illustrates, young infants experience caregivers to afford emotional regulation, and they do so whether the caregiver is aware of the infant's attentional states or not. The tacit assumption of openness is implicit in the affordances presented to the infant, and these affordances involve a (pre-reflective) experience of interactions as open.

The relevant sensorimotor representations arise early on (rather than around the age of one year when joint attention behaviour appears). Infants token these representations before they can detect when they are accurate.

Infants hence experience openness and behave as if openness were the case in open and non-open interactions. They have the right kinds of experience – but not

[4] What I call *tacit* (after Dennett, 1982), others call *implicit* (Dienes & Perner, 1999; Musholt, 2013; Seemann, 2012). The notion of tacit assumption also has intriguing links – that space constraints bar me from elaborating – to the notions of *fictionalism* (Eklund, 2015; Sainsbury, 2010; Yablo, 2001) and *unarticulated constituents of thought* (Dienes & Perner, 1999; Perry & Blackburn, 1986; Recanati, 2002).

always in the right kinds of situation. When an interaction isn't open, their tacit assumption turns out to be wrong, leading to potentially inappropriate behaviour.

To avoid inappropriate behaviour, processes that detect non-open situations develop. Of particular importance are those building on infants' pre-existing abilities to detect when others fail to attend to them. Evidence for this ability exists from birth (Farroni et al., 2002) and becomes more varied at around two months (Reddy et al., 1997; Reddy, 2005). Infants smile in mutual gaze, avert their gaze when attention becomes too much, and call their caregivers when these are absent or inattentive.

Eventually, infants apply this ability – which I shall call a *sensitivity to* (*failure of*) *attention-to-self* – to modulate when they take on others' emotional states. When an infant detects that her caregiver isn't paying attention to her, she no longer adopts the other's emotional state. An infant who sees her absent-minded caregiver express anxiety can thus avoid taking on an inappropriate emotion. This marks the beginning of infants overcoming the tacit assumption of openness. They now detect *some* situations in which this assumption is false and respond more appropriately. This increased behavioural flexibility doesn't, as such, repose on an ability to detect when others attend to the infant. Instead, the behaviour is based on the ability to detect when others *fail* to attend. It's when infants detect such failures that their behaviour departs from the tacit assumption of openness.

First triadic interactions

Triadic interactions (between an infant, a caregiver, and an object) develop in a manner that parallels dyadic interactions. Initially, infants tacitly assume that openness is the case, and only later can they detect when the assumption is false.

Infants encounter a multitude of objects once they start crawling at around 7 months (Adolph et al., 1998; Adolph & Franchak, 2017). These objects evoke emotions, which guide how the infant engages with her environment. On seeing a toy, an infant may become excited and move towards it, whereas a dog may scare the infant and cause her to retreat. However, emotions aren't always this clear. When an infant encounters a novel object, she may end up in an ambiguous emotional state that fails to indicate a course of action.

To resolve emotionally ambiguous states, infants often engage in *social referencing*: they turn to their caregiver for emotional cues (Feinman, 2013; Hornik et al., 1987; Klinnert et al., 1983; Striano & Rochat, 2000; Walden & Ogan, 1988). Social referencing leads to characteristic behaviour: infants tend to explore unknown objects when seeing their caregiver express a positive emotion and disengage when perceiving a negative emotion.

At first, social referencing proceeds unaffected by others' attentional states. Striano and Rochat (2000) investigated how infants respond to a barking dog toy (combin-

ing features of an exciting toy and a scary dog) and found that 7-month-olds engage in social referencing whether the adult is looking at the infant or absent-mindedly reading a newspaper. This indicates that 7-month-olds don't modify their (social referencing) behaviour when others fail to attend to them. Infants seem to be as insensitive to attention-to-self in early triadic interactions as in early dyadic interactions. They engage in social referencing when adults fail to attend to the same object or aren't aware of infants' attentional states.

At 10 months, infants begin to adapt their social referencing to others' attentional states. Striano and Rochat (2000) show that infants develop a sensitivity to attention-to-self: they only turn to the adult for social referencing if the adult attends to the infant. When adults are absent-minded, infants no longer use their expressions to disambiguate emotional states and guide responses to the barking dog toy.

In addition to sensitivity to attention-to-self, joint attention requires *sensitivity to* (*failure of*) *attention-to-same-object*. Infants must be sensitive 'to the fact that the adult may not be attending to what engrosses the child' (Eilan, 2007, p. 133). Striano and Rochat (2000) don't show that infants are sensitive in this way. Their experiment fails to establish that infants distinguish between situations in which the other is merely aware of the infant (but not the toy) and situations in which the other is aware of the infant *and* the infant's object of attention.

If 10-month-olds fail to be sensitive to attention-to-same-object, they may assume openness even when the other attends to a different object. They may, for instance, engage in social referencing when the adult fails to attend to the same object. Such behaviour is likely inappropriate because the adult, unaware of the infant's object of attention, expresses an emotion that isn't about the infant-toy relation. Imagine an infant attending to a (scary, non-toy) dog. If the adult isn't aware of the infant's object of attention, they might engage with the infant by smiling, leading the infant to approach a potentially dangerous object. Here, the infant engages in inappropriate behaviour that manifests a tacit assumption of openness. The infant behaves in a way that is appropriate if the adult shares her object of attention, but she does so even when this isn't the case.

Joint attention

We've seen that young infants tacitly assume that others attend to the same object. Once infants can detect when others *do not* attend to the same object, they become able to engage in joint attention. We now look at how infants develop this sensitivity to attention-to-same-object.

To understand the next step in attention cognition we have to take a step back and look at how infants start to follow others' gazes. Gaze-following develops at around 6 months when infants begin to inflexibly follow others' gazes (Butterworth & Jarrett,

1991; Senju & Csibra, 2008). Infants are pushed to shift their attention so that they end up attending to the same object as the adult.

Automatic gaze-following is rooted in self-other indifferentiation. Young infants possess only a limited capacity to endogenously direct their attention, so that salient objects and events attract their attention with little voluntary, top-down control (Krueger, 2013; Posner & Rothbart, 1998). Infants' limited capacity for top-down control of attention combines with a predilection for features associated with other human beings – famously a preference for human faces (for instance, Fantz, 1961; Valenza et al., 1996) – to pull infants to attend to others' objects of attention. This is a purely behavioural response to others' gaze, which doesn't rely on infants being able to conceive of the gaze as indicative of attentional states.

Unlike some previously discussed behaviours, inflexible gaze-following doesn't manifest an assumption of openness. In gaze-following, infants don't inflexibly behave as if others attend to the same object. After all, infants turn to attend to the other's object of attention, which would make little sense if they tacitly assumed to already be attending to said object.

Gaze-following doesn't manifest an assumption of openness but makes it more likely that the assumption comes out true. When an infant follows an adult's gaze, both agents end up attending to the same object, thus bringing it about that at least one condition on openness in joint attention (namely two agents attending to the same object) obtains. Hence, gaze-following is an important part of being able to engage in joint attention.

Gaze-following doesn't imply that the infant is sensitive to attention-to-same-object. It doesn't require that the infant represent the *relation* between her own and the other's attentional states; it merely requires detecting the other's gaze direction and responding to it (viz. Tomasello, 1995). What the infant needs, to develop sensitivity to attention-to-same-object, is an understanding of the other (and oneself) as subjects who attend to objects. Only when the infant represents attention as a relation can she be sensitive to attending (and failing to attend) to the same object as some other agent.

Infants understand attention as a relation by grasping gaze as *directed at* objects. Woodward (2003, 2005) conducted an experiment to elucidate how this understanding develops at around 9 to 12 months. First, during a habituation phase, an adult attends to one of two toys (say, toy *A*). Once the infant is habituated, the experimenters swap the positions of toys *A* and *B*. During the test phase, the adult looks either towards a new toy (toy *B*, located where toy *A* had previously been) or a new side (toy *A*, located where toy *B* had previously been). Starting at around 12 months, infants look longer on new-toy trials than on new-side trials. The result indicates that infants recognise that there's something novel in the new-toy trials. Given that nothing changed regarding the side to which the adult attends, Woodward concludes that infants noticed a change in the relation between adult and toy.

Infants' sensitivity to attention-to-same-object builds on the representations that allow them to detect changes in other agents' attention relations. To detect when another agent's attention relation changes, infants must be able to compare attention relations across two moments in time. These comparisons require infants to instantiate structured representations with tokens standing for the other agent and the other agent's objects of attention. With such representations, infants can detect when another agent attends first to one object and then to another. When infants token such structured representations (and token them both for the other and oneself), they can compare their object of attention with that of the other agent and thus become sensitive to attention-to-same-object.

We can now finally explain how infants engage in early forms of joint attention. Consider the following case (adapted from Bakeman & Adamson, 1984): A caregiver looks towards an infant, and the infant meets the adult's eyes. The caregiver smiles and looks at a toy truck, prompting the infant to shift her gaze. The infant picks up the toy and starts pushing it around. The infant then looks back and forth between the caregiver and the truck. When their eyes meet again, the infant smiles excitedly at the caregiver, who reciprocates with a similar expression.

When the infant smiles at the caregiver, she engages in behaviour that succeeds (almost) only in open interactions. Only if the caregiver is aware of the infant's focus of attention and is aware of the infant being likewise aware of the adult's focus of attention, can the infant depend on her smile being correctly understood by the adult. In this situation, the caregiver correctly understands the smile as communicating the infant's excitement about the toy.

Various psychological processes enable infants to ascertain when interactions are open. The detection of eye contact and gaze-checking, in particular, are important since they implement aspects of the two sensitivities discussed.

Being able to detect eye contact is crucial for the sensitivity to attention-to-self and, hence, for joint attention. Infants' first bouts of joint attention are almost invariably initiated by an adult through eye contact (Striano et al., 2006; Striano & Stahl, 2005). When the adult fails to meet an infant's eyes, the infant may think that the situation isn't open and fail to engage in the kinds of behaviour required for joint attention. When the adult meets the infant's eyes, the infant won't classify the interaction as non-open and joint attention behaviour can proceed. Thus, when the adult shifts their gaze from the infant to some object, the infant may follow the adult's gaze, adding an object to the dyadic interaction and turning it into one of joint attention.

Note that eye contact doesn't, as such, indicate that an interaction is open. Rather, eye contact's importance lies in how an *absence* of eye contact indicates an *absence* of openness. This isn't to say an experience of openness cannot be brought about by two agents' eyes meeting. However, such a case must be preceded by an earlier classification of the situation as non-open. Only when they first classify the interaction as non-open can they later rescind that classification when eye contact is established.

Even young infants experience attentional states as open, and these experiences do not depend on eye contact.

Gaze-checking is a second important behavioural aspect of joint attention (Masur, 1983; Matthews et al., 2012). In gaze-checking, infants alternate their gaze between an object and an adult to ascertain whether the adult's focus of attention is, as the infant's, on the object in question. As infants grow older, gaze-checking becomes more sophisticated, manifesting an overcoming of the assumption that others attend to the same object. For instance, while infants may at first only check others' gaze *after* trying to establish attention to a common object, they later also check adults' gaze *before* attempting to direct others' attention (Franco, 2005). Here, too, infants don't use attention-to-same-object as indicating that an interaction is open. Rather, a failure of attention-to-same-object indicates that an interaction isn't open. Detection of a failure of attention-to-same-object thus operates in a manner analogous to the detection of a failure of attention-to-self.

Upshots

I've shown that infants initially tacitly assume that attentional states are out in the open. In the course of development, infants begin to employ various sensitivities to detect non-open interactions, allowing them to drop the assumption when it isn't appropriate. Once infants use their sensitivities to attention-to-self and attention-to-same-object to identify non-open situations, they develop a minimal ability to engage in joint attention.

However – and this is why I've spoken of a *minimal* ability for joint attention – even with the two sensitivities just mentioned, infants don't gain an ability to detect open situations as such. Consider the following case: an infant and a caregiver are attending to the same object, and each is aware of the other attending to said object, but neither is aware that the other is aware of their attentional state. An infant furnished only with the two sensitivities discussed so far cannot identify this interaction as non-open. The reason openness is lacking is at a level of iteration beyond the infant's sensitivities.

It may help to think of the infant's budding ability to detect non-open situations in the following way: In the beginning, the set of interactions the infant takes to be open includes (almost) all interactions. As the infant matures, that set is progressively whittled down to exclude increasingly many non-open interactions. Eventually, the set of interactions in which the infant assumes openness approaches the set of open situations.

The infant doesn't exclude all non-open interactions from those in which she assumes openness just because she's sensitive to attention-to-self and attention-to-same-object. In fact, even the development of more sophisticated sensitivities cannot bring this process of exclusion to an end. Consider an infant with the cognitive

wherewithal to represent when the caregiver fails to be aware of her awareness of the caregiver's object of attention (and thus correctly classify the preceding interaction as non-open). This infant has not developed the ability to detect open situations as such. Her ability to detect non-open situations has improved – but there remain non-open interactions that she cannot even in principle detect.

A certain remnant of the assumption of openness remains no matter how sophisticated an agent's ability to detect non-open situations becomes. But this doesn't matter (or doesn't matter much): if recognition of the relevant situations is good enough to get things right in most of the (important) cases, responses will generally be appropriate (when it matters).

My proposal unites features of reductive and non-reductive accounts. On the one hand, it claims that knowledge of one's co-attender's mental states doesn't bring about experiences of openness (because such experiences are basic). On the other hand, it claims that these experiences are due to sensorimotor representations, which, on the face of it, are entirely due to an agent's individual states. But an account cannot be both reductive and non-reductive – which is it?

When asking whether a certain account of joint attention is reductive, we're asking whether the account posits that we can reduce each agent's awareness of joint attention to this agent's individual states. To address this question, we must start from a situation in which two agents attend to the same object. This is needed because we're interested in *awareness* of openness, a factive state requiring that another agent co-attend to the same object. We then enquire whether each agent's awareness of openness can be explained by reference to that agent's states 'without this already implying that there is joint attention' (Campbell, 2005, p. 288). In other words, for an account to be reductive, we must be able to specify which of an agent's states constitute, or give rise to, awareness of joint attention without thereby implying that another agent is jointly attending with them.

According to the account I propose, the experience of openness is basic in the sense of being logically (and developmentally) prior to any experience of non-openness. The experience of openness is rooted in indifferentiation, and the experience of non-openness requires the development of differentiation. Moreover, even young infants can be *aware* of openness, namely when there is another agent who attends to the same object while being aware of the infant's attentional states. The fact that experiences of openness are basic doesn't imply that this awareness is primitive in Campbell's (2005, 2012, 2017) sense of not being reducible to individual states. An agent is aware that attentional states are open when they are presented with certain (accurate) affordances, and these affordances in turn depend on sensorimotor representations. Given the right sensorimotor representations, an agent behaves in a way that manifests a tacit assumption of openness. We can specify these sensorimotor representations without implying the existence of another agent who co-attends to the same object.

Since experiences of openness don't require any knowledge of others' mental states, my account manages to be reductive without having to wrestle with infinitely iterated knowledge structures. Infants initially *experience* openness across a wide variety of both open and non-open situations, and they do so without having any knowledge of others' mental states. Infants are *aware* of attentional states being open when they experience them being open in a situation where they are indeed open. It's consequently possible to be aware of others' attentional states without having any knowledge of these states.

The account becomes no less reductive if we look at what's required for an infant to engage in minimal joint attention. A mature infant can engage in joint attention because she applies the sensitivities to attention-to-self and attention-to-same-object to restrict her experiences of openness to the appropriate interactions. She is disposed not to experience joint attention when joint attention isn't the case. The states that give rise to this disposition – the disposition's causal basis (Choi & Fara, 2018) – are also an agent's individual states. They are the states that underlie the two sensitivities, and there is *prima facie* no reason to think that these shouldn't be reducible to an agent's individual states.

Campbell claims that only a relational (and, thus, non-reductive) account of joint attention can make sense of how joint attention provides a rational basis for joint action. We are now in a position to see why this claim is false. Imagine that my friend and I are attempting to catch our missing cat, an endeavour whose success depends on us both acting jointly. Let's say I spot the cat, look towards my friend, meet their eyes, and move to catch the cat. When our eyes meet, our interaction loses the property that previously caused it to be classified as non-open. I consequently experience the interaction as open and spring into action. The same applies to my friend. It's rational for us to spring into action because we both – given our mature ability to detect non-open situations – instantiate processes that make it so that we reliably only experience attentional states to be open when they are.

Campbell's challenge has no bite since, on my account, the experience of openness comes first and doesn't depend on any representation of others' mental states. His challenge is premised on the idea that we must have an *immediate and full* awareness of openness for joint attention to be able to provide a rational basis for action. If a (knowledge-based) account implies that the relevant knowledge about the other's attentional states must first be inferred, it cannot account for how joint attention *immediately* provides a rational basis for joint action. On my account, however, an agent who experiences openness has a rational basis for joint action because they are disposed *not to* experience openness when attentional states *aren't* out in the open. Hence, as long as an agent is disposed in the right way, an experience of openness can present them with a rational basis for joint action.

Moreover, unlike relational accounts, my proposal explains why and when experiences of openness are reliable enough to ground rational action. It doesn't just explain

why the experience of openness may provide a rational basis for joint action *if that experience is accurate*.

According to relational accounts of perception, we must distinguish between two subjectively indistinguishable possibilities (viz. Crane, 2006). First, an agent may be perceiving the other as jointly attending to some object. This perceptual state is (like all perceptual states) relational and, hence, factive – that is, when an agent *perceives* attentional states to be out in the open, another agent is necessarily jointly attending to the object. Second, as Campbell admits, an agent may believe they are experiencing attentional states as open but be mistaken about this experience. Given that perception is relational, this isn't a perception of joint attention.[5]

For Campbell's account to succeed in explaining how joint attention can provide a rational basis for joint action, agents must reliably perceive joint attention rather than find themselves in the subjectively indistinguishable non-perceptual state. If the phenomenal state didn't reliably enough indicate openness, it would result in incorrect behaviour to the point where it would be difficult for joint attention to serve as a rational basis for joint action. What I find problematic about Campbell's account is the failure – beyond insistence on what he calls monitoring and control processes (Campbell, 2005) – to explain why we *reliably* perceive joint attention (rather than experience the subjectively indistinguishable non-perceptual state). My account, in contrast, describes some of the psychological processes that ensure that (mature enough) agents only experience openness when openness obtains. The two sensitivities I discuss (and the psychological processes underpinning the sensitivities) are the monitoring processes to which Campbell alludes.

Admittedly, my proposal lacks a thorough treatment of the kinds of process that *coordinate* (or *control*, in Campbell's terminology) agents' attentional states. Monitoring processes alone do not reliably bring about joint attention – there must also be processes that cause agents to attend to the same objects. In an earlier section, I briefly mentioned how infant gaze-following is one such process, but many other processes also coordinate attentional states. Especially early on, caregivers follow infants' attentional states to such an extent that infants may engage in joint attention without having to deploy sophisticated monitoring processes (Bakeman & Adamson, 1984). Later on, other processes become more important, for instance pointing (see Gómez, 2005) and vocalisation (see Clark, 1996).

More needs to be said about monitoring and coordination processes for us to approach anything resembling a satisfying account. Importantly, this involves explaining situations in which participants intentionally draw attention to an object. Recall the case where '[y]ou point and I nod. Straightway we hit the buttons.' When I nod, you experience joint attention – but why? A promising strategy[6] sees my nod as sig-

[5] This is an instance of relationalism's well-known disjunctivism about veridical and non-veridical perception.

[6] For which I have to thank a reviewer.

nalling my *uptake* of your request (Clark, 1996; see also Austin, 1962). On the present account, such uptake shouldn't be taken to imply that the other communicates that they're aware of one's focus of attention and attending to the same object (and so forth). As we've seen, such knowledge is insufficient for openness. Rather, uptake means that the other accepts a bid to return to the basic state of openness. A complete account would need to spell out in detail how this is possible.

My account shows how the development of joint attention progresses in stages and how these are linked to infants' increasing cognitive sophistication. The psychological processes involved in the sensitivity to attention-to-self (such as detection of eye contact) don't depend on sophisticated representations of self and other as subjects of attention. These processes develop early in infancy. In contrast, infants' sensitivity to attention-to-same-object does depend on the representation of others' attentional states, develops comparatively late, and implies an explicit differentiation between self and other as subjects of attention. The level of cognitive sophistication that my account requires is therefore of the sort actually seen in infant development.

A puzzle remains concerning the difference between genuine experiences of openness and those where attentional states aren't fully out in the open. How is it possible, given that my account implies that openness is experienced as long as non-openness isn't detected, that Subhan and Nakisha don't experience their interaction as open? After all, they represent each other as attending to the same object, and seemingly nothing they represent indicates a non-open interaction. And, if nothing rules out openness, then, on my account, it seems they should be experiencing openness. However, they do not.

The solution to the puzzle lies in the diversity of the psychological processes with which we identify non-open interactions. While some of these depend on representations of others' mental (more precisely: attentional) states, others – such as the processes involved in detecting attention-to-self – do not. Even if Subhan and Nakisha don't represent any mental states that would rule out openness, they might be detecting non-openness by some other (non-representational) process. An agent may represent mental states compatible with openness while still failing to experience the situation as open.

Consider what could turn Nakisha and Subhan's interaction into an open one. Imagine Nakisha and Subhan looking up at the same time so that their eyes meet. When this happens, their experience of the situation shifts. They are now aware of being at the other's focus of attention, and the fact that they both co-attend to the whiteboard is now open to them. They now jointly attend to it.

Before their eyes met, Nakisha and Subhan attended to each other covertly. They avoided eye contact and experienced the situation as non-open. When their eyes finally do meet, this changes. They no longer rule out openness, and the situation is consequently experienced as open, giving rise to joint attention.

Concluding remarks

Young infants tacitly assume that openness is the case. They experience openness and behave as if openness were the case even in interactions that aren't open. This assumption is progressively limited to interactions which *are* open. When infants become good enough at ensuring that their experiences of openness track the state of the world, the ability to engage in joint attention arises. Some of the psychological processes involved in detecting non-open interactions don't require representing others' mental states. Other processes, in contrast, require that infants are able to represent a differentiation between their own and others' attentional states.

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