

Editorial Manager(tm) for The Review of Philosophy and Psychology
Manuscript Draft

Manuscript Number: ROPP96R2

Title: Shared emotions and joint action

Article Type: Joint Action: What is Shared?

Keywords: Joint action; shared emotions; social interaction; social cognition; embodiment

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Response to Reviewers: I have tweaked the passage in question as recommended, adding this here: It must be noted that the authors remain non-committal about whether cases in which participants do not represent each other as intentional agents qualify as joint actions. Their proposal is not intended to capture necessary and sufficient conditions for joint actions but to articulate a minimal architecture, which models the basic components underlying the online coordination of movements in joint action, and which does not depend upon long-term planning, reasoning, or mental concepts like 'belief' and 'intention'.

Shared emotions and joint action

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Abstract In recent years, several minimalist accounts of joint action have been offered (e.g. Tollefsen 2005; Sebanz, Bekkering and Knoblich 2006; Vesper et al. 2010), which seek to address some of the shortcomings of classical accounts. Minimalist accounts seek to reduce the cognitive complexity demanded by classical accounts either by leaving out shared intentions or by characterizing them in a way that does not demand common knowledge of complex, interconnected structures of intentions. Moreover, they propose models of the actual factors facilitating online coordination of movements. The present proposal aims to enrich a minimalist framework by showing how shared emotions can facilitate coordination without presupposing common knowledge of complex, interconnected structures of intentions. Shared emotions are defined for the purposes of this paper as affective states that fulfill two minimal criteria: (i) they are expressed (verbally or otherwise) by one person; and (ii) the expression is perceived (consciously or unconsciously) by another person. Various ways in which the fulfillment of (i) and (ii) can lead to effects that function as coordinating factors in joint action are distinguished and discussed.

1. Introduction

Most people would readily agree that joint actions, such as dancing the tango or painting a house together, are distinct from individual actions and also from what might be called non-cooperative aggregate actions.¹ Unlike individual actions, they involve the actions of multiple participants, and unlike non-cooperative aggregate actions, such as a traffic jam or John Searle's (1990) famous example of a crowd of picnickers all running toward a pavilion in the park to avoid a sudden rainstorm, they involve the coordination of those multiple participants' actions to produce a global effect. Thus, classical accounts of joint action (Bratman 1992, 1993, 1997, 2009; Tuomela 2005; Gilbert 1990) seek to demarcate the class of joint actions by appealing to the notion of shared intention (or collective intentionality), which (according to these classical accounts) requires that participants have common knowledge of a complex, interconnected structure of intentions and other mental states. In recent years, however, minimalist accounts (Tollefsen 2005, Sebanz et al. 2006; Vesper et al. 2010; Pacherie and Dokic 2007), have been offered, which either do not assume that shared intentions (or collective intentionality) are necessary, or characterize shared intentions in a way that does not require participants to have common knowledge of each other's intentions or other

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¹ I use the term "non-cooperative aggregate action" to refer to cases in which the actions of multiple individuals produce a global effect, but in which the global effect is not due to any of the individuals' taking each other's actions into account, nor to any of the individuals' having the intention of producing the global effect.

mental states, or the relations among the various participants' mental states. Moreover, some of these accounts have the additional virtue of including models of the actual factors facilitating online coordination of movements. Surprisingly, none of these minimalist proposals has addressed the potential role of *emotions* as coordinating factors in joint actions. In fact, no proposal of any kind has addressed this issue. The present approach aims to fill in this gap by showing how emotions can facilitate coordination in joint actions. Insofar as it does not require common knowledge of complex, interconnected structures of beliefs, intentions, and other mental states, it can be seen as an enhancement of minimalist accounts. In section 2, classical accounts of joint action are briefly characterized in order to illustrate their limitations and motivate minimalist approaches, which are then briefly introduced in section 3. In section 4, shared emotions are defined and four central kinds of shared emotion are distinguished. In section 5, the coordinating roles that they can play in joint actions are discussed.

2. Classical accounts of joint action

To see why classical accounts that explain the coordination of individuals' actions by appealing to shared intentions under conditions of common knowledge require that participants' represent complex interrelated structures of intentions, beliefs and other relevant mental states, consider Michael Bratman's influential account (1992, 1993, 1997, 2009). The central component of Bratman's account of 'shared cooperative activities'² is that of meshed subplans. Individual participants' actions within a joint action make sense in light of each other and in light of a shared intention to which they are committed. In light of a group's shared intention to play a G chord, then, it will make sense for x to play a G, y to play a B and z to play D. In order to make these subplans mesh appropriately, individual participants must be aware of each other's intentions, i.e. they must shape (and be prepared to modify) their sub-plans to mesh with those of the others. Note that this account demands that the individuals' intentions are common knowledge. X must know that y is going to play a B, otherwise she would not know that her playing a G is the best way to produce a G chord together. But y also has to know that x knows that y intends to play a D, because x might otherwise play a different note, such as a D, in which case y should play a G, etc.

It is apparent that this account is tailored to complex actions involving rational deliberation and planning, and thus presupposes that participants in a joint action are capable of rational deliberation and planning. Moreover, it requires that each party has the ability to metarepresent the other party's intentions and beliefs, as well as sophisticated concepts such as 'belief' and 'intention', since the other's beliefs and intentions figure in the content of each individual's intention. Bratman's account is therefore not readily applicable to non-human animals or young children. This must be regarded as a serious limitation in view of the fact that children as young as 9 months, and certainly by 12-15 months, are able to engage in joint action (Tomasello et al. 2005). This is not to deny that children may have an implicit theory of mind by 12 months and may be able to implicitly understand belief states (Apperly and Butterfill 2009; Onishi and Baillargeon, 2005; Surian, Caldi and Sperber 2007), but an

² Bratman (1992) uses the term 'shared cooperative activity' to pick out the class of interactions that his theory aims to account for. It must also be noted that Bratman (2009) acknowledges a broader class of 'shared intentional activities', which are characterized by 'modest sociality'. The relevant point at present is that for an interaction to qualify for membership even in this broader class, there must be a shared intention under conditions of common knowledge, and there must be meshed subplans.

account based upon *recursively embedded* belief states must nevertheless appear *prima facie* inappropriately complex for non-human animals and young children. Hence, an account that avoids such complexity appears to be required for these cases.³

Of course I have not demonstrated that no account of shared intention could be given that does not place such heavy cognitive demands upon participants. The goal of this brief sketch of Bratman's account has been to illustrate the complexity inherent in the intuitive notion of a shared intention, and thereby to motivate an approach that seeks to account for the coordination of individuals' actions within a joint action without requiring the capacity to metarepresent others' intentions. Minimalist accounts do just this, and are therefore better suited to explain less sophisticated cases of joint action. Of course, this does not undermine the appropriateness of classical accounts for more sophisticated joint actions, especially for those requiring long-term planning. But minimalist accounts may have a broader scope. And if some of the components of joint actions picked out by minimal accounts are also present in more sophisticated joint actions, minimalist accounts may complement classical accounts by telling us something about sophisticated cases of joint actions that classical accounts do not tell us (and do not aim to tell us). For example, minimalist accounts address at least one issue that classical accounts do not address but which is likely also to be relevant for some sophisticated examples, namely the problem of accounting for the actual, online performance of joint actions, which demands that individuals predict, monitor and adjust to each others' movements.⁴

A further possibility is that some of the components of joint actions picked out by minimalist accounts may not only be present in more sophisticated joint actions alongside the features picked out by classical accounts, but may be developmentally necessary for some of the latter features. Although I will not be able to argue in detail here that this is the case, I will offer an example to illustrate this possibility. The example bears upon a feature that is central to classical accounts, namely that of *commitment*. Margaret Gilbert (1990), in particular, argues that having a shared goal entails being committed to that goal. What this means, for Gilbert, can be cashed out in terms of obligations and entitlements. Thus, if two people share the goal of walking together, to use her famous example, then each is obliged to walk at about the same pace as the other, to refrain from veering off or stopping abruptly without any explanation, etc. Conversely, each is entitled to rebuke the other for failing to fulfill these obligations. The role of commitments, then, relies upon participants' capacities to draw inferences using sophisticated concepts such as 'obligation' and 'entitlement'. Bratman (1992) also makes use of this notion in his account of shared cooperative activities. For Bratman, participants to a shared cooperative activity are characteristically committed to the intention of performing the action together and to mutually supporting each other, i.e. to correcting and compensating for each other. The flip side of these obligations is that each

³ Roughly the same argument is formulated in Tollefsen (2005). Admittedly, it is not conclusive, as there may be room for Bratman to defend his position against these claims.

⁴ Classical accounts cannot be faulted for ignoring this issue since they target a different explanandum. Nevertheless, it is a virtue of minimal accounts that they also target this explanandum.

party is entitled to rebuke the other for abandoning the joint action, for free-riding or for refusing to give support.⁵

I will be suggesting that in cases where commitments are present, participants are commonly disposed to experience emotions appropriate to those commitments, such as anger, offence, shame and compassion. Further, these kinds of affective disposition can be present in minimal cases without complex concepts such as ‘obligation’ and ‘entitlement’, and can instantiate a minimal analogue of commitment. Finally, and more speculatively, I will suggest that affective dispositions may be developmentally necessary for understanding commitments and the concomitant concepts. But first let me say a bit about minimalist accounts of joint action.

3.Minimalist accounts of joint action

In the past few years, a number of theorists have offered accounts of joint action that do not require mutual knowledge of shared intentions and thus reduce the complexity inherent in classical accounts (Tollefsen 2005; Sebanz, Bekkering and Knoblich 2006; Vesper et al. 2010). Deborah Tollefsen (2005), for example, has proposed that joint attention can suffice as a substitute for common knowledge of an interconnected structure of intentions (Tollefsen, 2005). Joint attention involves two individuals attending to the same object or event, and being mutually aware that the other is also attending to the same object or event. It can be characterized as follows (Cf. Peacocke 2005):

- (i) x perceives o and y perceives o;
- (ii) x perceives y perceiving o and y perceives x perceiving o;
- (iii) x perceives y perceiving x perceiving o and y perceives x perceiving y perceiving o, etc...

It is apparent, then, that joint attention has the same recursive structure as a common knowledge situation. Nevertheless, it is simpler, since it does not require that participants represent each other’s mental states but only perceive each other perceiving, which children are clearly able to do by 12 months at the latest, as revealed by their sophisticated use of pointing to manipulate others’ attentional states (Liszkowski et al. 2004). As Tollefsen (2005) argues, joint attention may suffice (in combination with some other capacities) for some joint actions, since it enables partners in the interaction to know that they are engaged in the same task and mutually aware of this. Moreover, Brownell, Ramani and Zerwas (2006) provide evidence that children’s ability to engage in joint attention is correlated with their ability to engage in joint actions.

While Tollefsen’s account is relatively undemanding in that it does not require common knowledge of an interconnected structure of intentions, Vesper et al. (2010) go even further in that they do not even require that participants represent each other as intentional agents. It must be noted that the authors remain non-committal about whether cases in which participants do not represent each other as intentional agents qualify as joint actions. Their proposal is not intended to capture necessary and sufficient conditions for joint actions but to articulate a minimal architecture, which models the basic components underlying the online

⁵ As noted above, Bratman (2009) acknowledges a broader class of ‘shared intentional activity’ characterized by ‘modest sociality’, for which obligations and entitlements are not necessary, although they are ‘extremely common’ (151).

coordination of movements in joint action, and which does not depend upon long-term planning, reasoning, or mental concepts like ‘belief’ and ‘intention’. The basic components of this minimal architecture are *representations*, *processes*, and what the authors call *coordination smoothers*. I will say just a bit about each. The account requires that, at a minimum, an agent *represent* her own task and the goal state, but not necessarily any other agent’s task. The account further requires that an agent be aware that the performance of her own task is not sufficient for achieving the goal state but relies also upon some other event(s) in her vicinity, which result(s) either from the actions of another intentional agent or from a non-intentional external force (such as the wind). Although the account does not demand that an agent ascribe an intention to, or represent the task of, the agent or force bringing about the relevant event(s) in the vicinity, it does not exclude this possibility either. On the contrary, the authors note that it is ‘generally useful’ for participants in a joint action to represent each other’s tasks, and include such representations as an optional additional component in the minimal architecture. In fact, as the authors note, there is abundant evidence from co-representation studies that people tend to represent tasks that other people are performing next to them, even when it is counterproductive for them in that it interferes with performance of their own task (Atmaca et al 2008, Sebanz et al. 2005, Tsai et al 2008).

In addition to representations, the minimal architecture includes two kinds of process that operate on these representations, namely *prediction* of the sensory consequences of one’s own and other participants’ (or forces’) actions, and *monitoring* of the actual sensory consequences of one’s own and other participants’ (or forces’) actions. *Predictive* processes are necessary in order to coordinate the joint effects of one’s own and others’ (or other forces’) actions, since they enable one to initiate actions on the basis of expected effects rather than actual effects, which are obviously only available after an action and therefore too late to be of use in selecting or planning the action. *Monitoring* enables one to identify prediction errors and adjust one’s internal models accordingly, and also to maintain an overview of overall progress toward one’s own or the group’s goal. There is ample evidence from EEG and imaging studies that people tend to automatically monitor their own and other’s errors, and indeed there is an overlap in the neural areas that are activated for detection of one’s own and others’ errors (van Shie et al 2004, de Bruijn et al 2009).

The other element that the minimal architecture includes is what the authors call *coordination smoothers*. By this they mean anything that ‘reliably has the effect of simplifying coordination’ (Vesper et al. 2010: 2), such as exaggeration of one’s movements or reduction of variability of one’s movements to make them easier for the other participant to interpret; giving signals, such as nods; and synchronization, which makes partners in a joint action more similar and thus more easily predictable for each other.

Perhaps surprisingly, proponents of minimalist approaches have not addressed the question of what role *emotions* might play as coordinating factors in joint actions. In fact, neither has anyone else either. In sections four and five, I will attempt to fill in this gap. I will be arguing that various kinds of shared emotions not only motivate participants to engage and remain engaged in joint actions, but also facilitate representation, monitoring and prediction, and can act as coordination smoothers, and that they can do so without participants’ having mutual knowledge of each other’s intentions.⁶ I will also suggest how shared emotions can instantiate

⁶ Obviously, if shared emotions can have these effects in the absence of mutual knowledge of shared intentions, they can also have them when mutual knowledge of shared intentions *is* present.

a minimal analogue of commitments, which does not rest upon sophisticated concepts such as ‘obligation’ and ‘entitlement’. But first I will elucidate the notion of shared emotions.

4. Shared Emotions

Before discussing the role of shared emotions per se, it will be necessary to make a few remarks about the term ‘emotion’. Obviously, a comprehensive account of emotions would be far beyond the scope of this paper, but it will nevertheless be helpful to begin with a list of typical features of emotions. Emotions typically involve:

- (i) physiological features: physiological arousal, hormonal changes, effects upon skin conductancy;
- (ii) expressive features: facial, postural, vocal;
- (iii) phenomenal features: a subjective qualitative feel;
- (iv) cognitive features: cognitive antecedents, such as appraisals, and cognitive successors, such as effects upon decision-making, attention, memory;
- (v) an intentional object: e.g. a dangerous snake;
- (vi) behavioral features: certain action tendencies, such as a tendency to run away from a dangerous snake.

Although various theories of emotions emphasize different features, they tend to agree that these features are typically present and must be accounted for (e.g. Prinz 2004, Charland 1997, Newen and Zinck 2008, Scherer 2000, de Sousa 2010). In order to avoid the difficult problem of defining emotions, I will stipulate that the term ‘emotion’, in the following, refers to the widely recognized class of phenomena, called ‘emotions’, which, as a class, typically have these features.⁷

One more terminological remark is also in order. My account of shared emotions will also include two classes of affective phenomena that are distinct from but related to emotions, that can be shared (as I will explain in a moment) in the same ways as emotions, and that can have similar coordinating effects within joint actions. The first, moods, are affective states like emotions but are generally regarded as comprising a class unto themselves (de Sousa 2010; Prinz 2004; Kelly and Barsade 2001; Frijda 1994). Although there is no consensus about precisely how to distinguish moods from emotions, there is widespread agreement that they are generally less intense than emotions, that they tend to last longer, and that they either lack cognitive objects or have non-specific cognitive objects, such as ‘how we are faring in general’ (Prinz 2004: 185). Given these three characteristics, it is no wonder that moods, along with their effects upon one’s job performance and one’s behavior in general, go unnoticed more often than emotions (Forgas and George 2001). The second class of related affective phenomena that my account will include are sentiments. Sentiments are valenced appraisals of things, situations or people, such as liking or disliking them, which dispose one to feel certain emotions toward their objects (Kelly and Barsade 2001; Frijda 1994; Prinz 2004). If you like someone, for example, you will be disposed to experience sadness when they leave, happiness when they return, fear when they are in danger, etc.

⁷ It is not a necessary condition for E to be a member of the class of emotions for E typically to have *all* of these features.

What can it mean, then, for emotions (including moods and sentiments) to be shared? As a starting point, consider the everyday locution of ‘sharing one’s emotions’. A paradigmatic way of sharing an emotion, in this sense, would be expressing it verbally to another person with the intent of getting her to respond in an appropriate way. Jim might, for example, tell his friend Sue that he felt hurt that she did not invite him to go with her and some of her other friends to the cinema. This paradigmatic case suggests two minimal criteria, which I will regard as necessary conditions for sharing an emotion:

- (i) x expresses his affective state (verbally or otherwise);
- (ii) y perceives this expression;

A few remarks about these criteria are in order. First, although the expression in our paradigmatic case is a verbal one, I think it is also natural to speak of sharing one’s emotions when one expresses them non-verbally, i.e. with facial expressions, posture or prosody, or by initiating any other such perceptible behavior that is a reliable indicator of one’s affective state. Secondly, I do not interpret (i) to mean that the expression has to be initiated consciously or deliberately. Imagine that Jim and Sue differ with respect to their emotional expressiveness such that one always knows how Jim is feeling on the basis of his facial expressions, posture and/or prosody, whereas one never really knows how Sue is feeling. Imagine further that Jim is unaware of his emotional transparency, and that Sue is unaware her emotional opacity. One might nevertheless say that Jim has a tendency to share his emotions readily, or that Sue appears not to be very comfortable sharing her emotions. Thirdly, the other person might perceive the expression without being aware of doing so. In other words, a case of unconscious perception suffices to fulfill (ii).

I think that these qualifications are consistent with the everyday locution of sharing one’s emotions, but not much hinges upon this. My aim is not to explicate that everyday locution, but to use it as a starting point in demarcating a range of phenomena that are systematically related to each other and that (as I will try to show in section 5) can function as coordinating factors in joint actions, and to specify the conditions under which they can so function.⁸ But, in view of this latter goal (to specify the conditions under which shared emotions can function as coordinating factors in joint actions), there is a problem with (i) and (ii). As it stands, they fail to exclude some phenomena that are clearly not pertinent to joint action. For example, x may express her affective state by carving ‘I hate z’ into an obscure corner of her hotel room, and y may read this many years after x’s death.⁹ Given (i) and (ii), this example qualifies as a case of shared emotion, and yet it is hard to imagine it being relevant to any joint action. So, in the following, I will limit the discussion to shared emotions that also fulfill a third criterion:

- (iii) y’s perception of x’s expression leads to effects that function as coordinating factors within an interaction between x and y.

I think that when (i) and (ii) are fulfilled, it will often (though not always) be the case that (iii) is also fulfilled. I also think that there is a good reason for this, namely that (iii) expresses a

⁸ I also acknowledge that other definitions of shared emotions may be more appropriate for other purposes.

⁹ I thank Steve Butterfill for this example.

function that is typical of (though not necessary for) shared emotions and that renders them pertinent to joint action. When we share our emotions, we generally do so in order to elicit an appropriate response. Recall the paradigmatic example of Jim telling Sue that he felt hurt about not being invited to the cinema. Jim would normally do so with the intent of getting Sue to console him, to spend more time with him in general, to invite him to social occasions with her friends in the future, etc. In this example, the expression is conscious, deliberate and verbal, and its function is to elicit a response because the expresser intends to elicit a response. But even when the expression occurs unconsciously, automatically, and/or non-verbally, it is likely that it occurs because there is (or at some point was) an evolutionary function associated with some effect that emotional expression has upon others' behavior (e.g. Ekman and Friesen 1989).

Again, let me emphasize that (iii) is not necessary for being a shared emotion. Its purpose is to restrict the range of phenomena to shared emotions that can be pertinent to joint actions. Distinguishing among different ways in which (iii) can be fulfilled – i.e. in which y's perceiving x's emotional expression can lead to effects upon y that function as coordinating factors – enables us to distinguish various kinds of shared emotion that can function as coordinating factors in joint actions. I will focus on four, although there may be other related varieties of shared emotion that fulfill (iii) and are therefore also relevant to joint action.

(a) Emotion detection: As a result of y's perception of x's emotional expression, y detects x's affective state, and this detection has effects that function as coordinating factors in an interaction between x and y. Detection goes beyond mere perception of the expression insofar as y acquires the information that x is in the affective state. Note that although y may become aware of x's affective state, this is not necessary for all of the effects I will be discussing (in section 5), and I will not consider it a requirement for emotion detection.

(b) Emotion/mood contagion: y's perception of x's emotional expression causes y to enter into an affective state of the same type (presumably via unconscious mimicry). It is not necessary that y thereby detect x's affective state. In other words, it is possible that y's perception of x's expression could cause y to enter into the affective state without y thereby acquiring the information that x is in the affective state.¹⁰

(c) Empathy: y's perception of x's emotional expression causes y to enter into an affective state of the same type, and y thereby becomes aware of x's affective state. It is worth mentioning that empathy can also occur without y directly perceiving x's emotional expression if y imagines x's affective experience (de Vignemont and Singer 2006), but I will not be discussing that possibility here.

(d) Rapport: y perceives x's positive sentiment toward y and responds by expressing a positive sentiment toward x, to which x responds by expressing a positive sentiment toward y, etc.

It is apparent that the two latter varieties are shared in more robust senses. Empathy is more robust than contagion because it includes contagion as well as y becoming aware of x's affective state. Rapport is also a robust case of shared emotion because it holds mutually. Having distinguished these four kinds of shared emotion, I will now look at each of them a bit more closely and elucidate the roles that each can play as coordinating factors in joint action.

¹⁰ Y may, for example, be unable to guess above chance whether x is in the affective state.

5. Shared emotions and joint action

5.1 Emotion detection

Although emotion detection involves sharing in only a minimal sense, since only one person must actually have the emotion, I would like to suggest that it can have numerous effects that contribute as coordinating factors in joint action.

First, it can facilitate prediction, since emotions are associated with action tendencies. Thus, if x and y are dancing tango together and x expresses disgust or embarrassment about y's performance of a particular move, such as the *colgada*, y may be less inclined to predict that x will initiate another *colgada*. Clearly, a sophisticated understanding of the intentional objects and action tendencies associated with emotions will enhance the usefulness of emotion detection for prediction, but it is not necessary. 18 month-old children are able to form accurate predictions about others' food preferences on the basis of expressions of disgust or positive emotional attitudes (e.g. 'mmm, yummy') (Repacholi and Gopnik 1997).

Secondly, emotion detection can facilitate monitoring, because a person's emotional expressions can transmit information about how she appraises her progress toward the goal of her own task, or the group's progress toward the global goal of a joint action. In fact, if x has access to such information about y's assessment of y's progress, x might under certain conditions not have to directly monitor y's progress. If this is correct, one might expect that interference effects in co-representation studies, and neural responses to others' errors, might *decrease* during the course of a task if the other person is reliably providing information about her own appraisal of her progress by expressing emotion in response to feedback about her results. I know of no evidence bearing upon this question, but it is in principle a testable hypothesis.

Emotion detection may also enable emotional expression to serve a signaling function. For example, a fearful or relieved expression can signal the presence or absence of dangerous objects or events. Such signaling is an efficient way to spread information within a group. Moreover, it does not presuppose the presence of sophisticated conceptual skills, and is therefore applicable to very young children. The phenomenon of social referencing, present in 12 month-olds, provides evidence for this sort of function in early childhood (Vaish and Striano 2004). Emotional expressions can also serve as signals of information about relations within the group. For example, a positive emotional expression such as a smile may signal approval of another participant's action or proposed action, or the continued presence of rapport within the group. Presumably it will generally be conducive to coordination if group members all have the same information about the task at hand and about relations within the group, since it will facilitate prediction of each other's behavior and minimize misunderstandings. In this sense, emotion detection can also be said to function as a coordination smoother.¹¹

Emotion expression and detection may also go some way toward achieving what commitments achieve, e.g. providing participants with an additional, moral motivation¹² to

¹¹ This term is explicated above (in section 3).

¹² cf. Rosati 2008

remain engaged and to resist alternative temptations, and enabling each to be confident that the other will also remain engaged. Thus, if y perceives x's expression of enthusiasm about engaging in a joint action, this would likely give rise to an expectation in y that x will remain engaged. Conceivably, this expectation may influence y's planning and behavior without y being explicitly aware of it. Imagine, for example, that you ask me to participate in a joint action with you, such as writing an article together. On the one hand, I might pause, frown, and respond in a quiet and monotonous voice by saying, 'yes... let's do it'. On the other hand, I might raise my eyebrows in surprised delight at the suggestion and in a loud and gleeful voice say 'yes...let's do it'. In the first case, you will perceive that I am not enthusiastic about the idea, and will assume that I am more likely to abandon the project, to give a half-hearted effort, and to free-ride on your efforts. As a consequence, you are likely to check back with me before you go ahead and devote a month's efforts to the project, to expect less or inferior output from me, and to monitor my progress more closely. In the second case, on the other hand, you will be more inclined to expect me to stick with the project, to do my part – in short, to remain committed. In fact, if you are aware that your perception of my expression contributed to the formation of these expectations, you may justifiably refer to it in asserting that I have obligations associated with the project. If I did not intend to do my part, I should not have misled you.

In order to appeal to emotional expression as a justification of claims about obligations, awareness is of course necessary, as are such concepts as 'commitment', 'obligation' and 'entitlement'. But I do not see any reason to think that either awareness or these concepts are necessary in order for your processing of my emotional expression to cause you to have certain expectations about my future behavior or to dispose you to respond with disappointment and/or annoyance if I do not meet your expectations. In short, my emotional expression will have a similar effect upon you to an explicit promise, but without your having to be aware of it or apply the corresponding concepts.

Another way in which emotional expressions may function like commitments is that they can signal mutual interest and investment in the other participants' actions. For example, if I, in the context of a joint action, express positive emotions about positive outcomes of *your* actions and negative emotions about negative outcomes of *your* actions, you will likely expect me to remain emotionally engaged in the joint action. It is an interesting empirical question whether young children might understand such patterns of emotional expression on the part of other parties to signal something like commitment to a joint action. Thus, if an adult expresses appropriate emotions about the outcomes of a child's actions within a joint action, the child might be more surprised and/or distressed by the adult's abandonment of the joint action.

Emotion detection may in fact not only lead the perceiver to expect the expresser to remain committed, but in fact lead the expresser *to feel committed*. Consider again the example of our writing an article together. I am likely to be aware of the expectations I have caused you to form, and thus also of your disposition to be disappointed and/or annoyed if I let you down. If so, I will have an additional motivation to avoid letting you down, since causing you to be disappointed and/or annoyed will cause me to have an unpleasant experience of empathetic distress or concern, or simply embarrassment. Although it clearly requires some degree of cognitive sophistication to bring expectations of others' emotions to bear upon planning one's own actions, it does not require sophisticated concepts like 'obligation' and 'entitlement'. It requires only that my emotional dispositions be influenced by my expectations about your emotional dispositions. And the foundations for this sort of structure are present early in childhood. Soon after birth, infants exhibit crying or distress in response to other infants' crying or distress (Sagi and Hoffman 1976), and by 14-18 months they show empathetic and

sympathetic responses to others' distress (Eisenberg, Spinrad, Sadovsky 2006). It is a testable hypothesis whether young children (or people in general) are less likely to abandon a joint action after they have expressed enthusiasm and thereby led their partner(s) to expect their continued engagement, or more likely to apologize or give excuses if they do abandon the joint action.

This is not to say that emotion detection leads to commitments that are as robust as commitments created by explicit promises, but merely that it provides a minimal analogue of an explicit promise. Indeed, one might speculate that concepts like 'commitment' build upon pre-existing patterns of expectations and dispositions, making them explicit and elaborating them further. If this is right, then shared emotions could be developmentally necessary for commitments. If so, then children who do not experience certain shared emotions, such as feeling hurt or abandoned when someone else abandons a joint action, or empathic concern or guilt when they themselves do so, may have trouble learning such concepts as 'entitlement' and 'obligation'.

5.2 Emotion/Mood Contagion

Another way in which one person's perception of another person's emotional expression can have effects that are relevant to an interaction is if the perceiver thereby enters into an affective state of the same type. This phenomenon, known as emotion (or mood) contagion (Hatfield et al. 2009), is presumably mediated by unconscious mimicry, which is defined as the tendency to automatically synchronize affective expressions, vocalizations, postures, and movements with those of another person (Hatfield et al. 1994).

One important way in which contagion can function as a coordination smoother¹³ within joint action is by means of alignment. One simple benefit of alignment is that it is likely to increase participants' motivation to act jointly with each other, since people tend to find other people with similar moods to be warmer and more cooperative, and prefer to interact with them, even if the mood in question is a negative mood (Locke and Horowitz 1990). Apart from this simple motivational benefit, alignment can facilitate coordination in joint actions in other ways as well. Given that emotions and moods influence cognitive and bodily processes in various ways, two or more people with congruent emotions will tend to be influenced in the same ways and will therefore tend to converge, or align, with each other. This would make it easier to predict each other's actions and to coordinate movements.

It is well known that emotions and moods have characteristic effects upon attention and memory. With regard to attention, people are better at processing stimuli that are congruent with their emotional dispositions (Öhman et al. 2001), and current mood (Wells and Matthews 1994). With regard to memory, people are better at recalling information if they are in the same mood that they were in when they learned the information (Bower 1981). Bower speculates that the explanation of this tendency may be that information that was relevant in previous instances when one experienced a given emotion is likely to be relevant in subsequent instances when one experiences that emotion, and the part of the function of the emotion is to facilitate access to such relevant information.

Through their effects upon attention and memory, then, emotions and mood tend to make particular objects and features of the environment more salient, and some stored information more easily accessible. If two people are emotionally aligned, it will increase the likelihood of

¹³ This term is explicated above, in section 3.

noticing the same objects in the context of a joint action. This would facilitate prediction of each other's behavior, since knowing what people are attending to provides clues about the actions they are likely to initiate. It would also facilitate communication by enhancing the overlap in objects, features, and events that they are likely to refer to.

Emotions in the sense of gut reactions are also widely held to have important functions in decision-making. According to Damasio's (1994) somatic marker theory, quick and automatic affect responses guide decision-making, as revealed in experimental situations such as the Iowa Gambling Task, where various measurable signs of affective response are correlated with changes in decision patterns prior to subjects' awareness of those changes in their own decision patterns. Some theorists (De Sousa 1987, see also Evans 2002) speculate that emotions have an important function in simplifying the frame problem. The frame problem implies that deciding among alternative options in any simple case potentially involves intractable complexity if one takes into account all possible consequences of each option. Emotions might simplify the problem insofar as decisions are guided by immediate affective responses, or gut reactions, to quick consideration of a few immediate consequences of each option. Emotions, in this sense, would serve as quick and dirty heuristics for simplifying the decision space, i.e. they would abbreviate potentially complex cognitive processes. Insofar as moods and emotions influence the affective responses that people are disposed to exhibit (Kelly and Barsade 2002), they may influence their gut reactions and thus also their decision-making. There is support for this speculation from studies showing that emotions, moods and emotional disorders have specific, predictable effects upon subjective probability assessments and other aspects of economic decision-making (Wright and Bower 1992; Loewenstein and Lerner 2003).

With respect to the bodily effects of affective states, one might speculate that different emotions and moods have specific effects upon people's movements, particularly on their tempo, but perhaps also on other aspects such as their smoothness as opposed to abruptness, the size and frequency of gestures, etc. If this is correct, then having roughly the same emotion could help to facilitate synchronization of movements in joint action. There is some preliminary support for this speculation from studies using video displays (Michalak et al. 2009) or point-light displays (Troje 2002) of bodies in motion, which reveal that experimentally induced or clinical states of depression and anxiety have specific, identifiable effects upon gait patterns. Additionally, De Gelder (2006, 2009) has emphasized the specific effects that different emotions have upon bodily posture and other aspects of bodily movement, which can be distinguished even by observers with blindsight (Tamietto and De Gelder 2008).

Some empirical support for the suggestion that emotion and/or mood contagion facilitates joint action is provided by a study conducted by Barsade (2001). Participants engaged in negotiation within groups of three to five members, including one confederate, whose task it was to express and thereby spread a cheery or a grumpy mood. Various measures confirmed that the mood had been contagious, and also that the contagion had specific effects upon participants' level of cooperativeness. Contagion of positive moods even enhanced participants' performance, as measured by subjective perception of their performance and also by the others' assessment of their performance.

5.3 Empathy

Contagion can also lead to empathetic understanding of the other's affective state, if the

perceiver is aware that the other person is the source of her acquired affective state (Sonnyby-Borgstrom 2002, de Vignemont and Singer 2006, Singer and Lamm 2009). In this case, the conditions for perceived emotions as well as those for contagion are fulfilled, so one would expect empathy to facilitate joint action in all the ways that perceived emotions and contagion do. In addition, since empathy involves perspective-taking, it should have a facilitating effect upon representing others' tasks and monitoring their behavior. One would therefore expect that highly empathic people would co-represent other people's tasks and monitor others' errors to an even greater extent than other people. De Bruijn et al. (2008) found individual differences in interference of co-representations, and speculated that empathetic people may be more prone to co-representation, but this has not been specifically investigated.

5.4 Rapport

The same kind of unconscious behavioral mimicry that can lead to emotion and/or mood contagion is also one way of creating another kind of shared emotion, namely rapport. In fact, the functional explanation that Lakin et al. (2003) give of behavioral mimicry is that it expresses a positive sentiment toward other people, and thereby increases rapport with them. The idea is that x's expression of a positive sentiment toward y causes y to form and to express a positive sentiment toward x. Interestingly, the causal relationship between behavioral mimicry and rapport is bi-directional (Chartrand and Bargh 1999, Jefferis, van Baaren, and Chartrand 2003). Thus, the relationship between rapport and mimicry can be regarded as a positive feedback loop:

This is a never-ending cycle that would allow members to be successful with their group interactions. An individual mimics to create rapport and be included in the group. The interpersonal closeness that inevitably develops between group members then perpetuates the cycle, as it causes group members to continue to mimic each other, which creates more rapport (Lakin et al 2003).

When one considers this characterization of rapport, one may see an analogy to the kinds of embedded recursive structures associated with common knowledge or, indeed, with joint attention. In those cases, two (or more) individuals each believe that p or attend to p in part because the other believes that p or attends to p. This interconnectedness can facilitate joint action by ensuring that individual participants have the same beliefs about their joint task and about how their individual contributions to the task mesh together, and/or that they are attending to the same thing. In the case of rapport, there is a similar kind of interconnectedness, but what is interconnected is not beliefs or perceptions but affective states directed at the other members of the group. It is probably more basic than both of these analogous phenomena, as it can occur unconsciously. Moreover, it is conceptually simpler, since it is a dyadic relation between two people rather than a triadic relation among two people and a third object. Children engage in dyadic proto-conversations (Trevvarthen 1979) and exchanges of emotional expression (Stern 1985) months before there is evidence for the triadic engagement characteristic of joint attention. If rapport plays a coordinating role in joint action, then, it could be an important part of a minimal architecture that does not require participants to have mutual knowledge of each other's intentions, beliefs or other mental states. I would now like to look at some evidence that it does indeed play such a coordinating role.

For the purposes of joint action, rapport would be especially useful if it increases not only behavioral mimicry but also movement synchrony in more general ways. This would be

important, for example, whenever the tasks of two participants in a joint action are not strictly congruent, i.e. whenever they do not have to do exactly the same thing. In such cases, such aspects of movement synchrony as temporal similarity, abruptness versus smoothness, and simultaneity of movement may be useful for the purpose of precisely coordinating movements.

Tentative support for a positive answer to this question can be found in a study reported by Bernieri et al (1988), in which rapport was found to be predictive of movement synchrony, as rated by judges observing tapes of the interactions. These results are especially interesting since the authors specifically distinguished between behavior matching and three other parameters of synchrony, namely simultaneous movements, smoothness, and similarity of tempo, and found that the effect held for all four parameters. These findings support the prediction that rapport is likely to facilitate coordination of movements in joint action in several ways. First, it is presumably easier to predict movements that are similar to one's own, and if rapport leads to synchronization, it will thereby also make participants' more similar to each other. Secondly, synchronizing movements is likely to be associated with increased attention to each other's movements, which would increase the amount of information taken in about other participants' movements, and thereby facilitate prediction and monitoring.

There is also some research that suggests that rapport fosters a sense of commitment and influences behavior within joint actions in much the same way that one would expect commitments to influence behavior. It has been shown, for example, that members of interpersonally cohesive groups are less likely to loaf and more likely to compensate for the poorer performance of other group members (Karau and Williams, 1997). Furthermore, groups with greater rapport are more likely to put pressure on individual members to conform to group norms (Back, 1951) and are more likely to react to dissenters with punishment and exclusion (Schachter, 1951).

Some empirical support for the prediction that rapport facilitates coordinating processes in joint action and thus leads to better outcomes on group tasks can be found in a meta-analysis conducted by Mullen and Copper (1994). The authors confirmed a significant relationship between interpersonal affective ties and group performance of sports teams. Presumably, it would be possible to investigate this connection further in experimental settings by comparing the outcomes on various kinds of joint tasks in experimental settings for groups with rapport to groups without rapport. It would also be interesting to investigate the specific contributions of the various variables I have mentioned. Does rapport facilitate representation of partners' tasks and/or monitoring of their actions? If so, one would expect to find more pronounced effects in co-representation and error-monitoring tasks. Does rapport facilitate mutual openness to assistance, or perhaps compensation for and/or correction of each other's errors?

6. Conclusion

The present proposal aims to enrich a minimalist framework by showing how shared emotions can be among the basic coordinating factors in joint action without presupposing common knowledge of complex, interconnected structures of intentions. I have discussed several ways in which various kinds of shared emotion can facilitate processes that are central to the coordination of participants' individual actions within joint actions, such as representing other participants' tasks, predicting their behavior, detecting prediction errors and correcting accordingly, monitoring their progress, synchronizing movements and

signaling. I have also suggested that shared emotions can instantiate a minimal analogue of commitments, which does not rest upon sophisticated concepts such as ‘obligation’ and ‘entitlement’.

Minimalist approaches, as I have argued, are more readily applicable than classical approaches to cases in which the participants lack the requisite cognitive capacities for shared intentions, such as the capacity to represent recursively embedded belief states. This does not undermine the appropriateness of classical accounts for more sophisticated cases of joint action, especially for those requiring long-term planning. But minimalist accounts may have a broader scope. And if the components of joint actions picked out by minimalist accounts are also present in more sophisticated cases, minimalist accounts may complement classical accounts by telling us something new about sophisticated cases. In fact, some of the components of joint actions picked out by minimalist accounts may not only be present in more sophisticated cases alongside the features picked out by classical accounts, but may be developmentally necessary for some of the latter features. To illustrate this possibility, I have speculated that shared emotions may be developmentally necessary for understanding commitments and concomitant concepts such as ‘obligation’ and ‘entitlement’.

Whether or not these more speculative suggestions are correct, it is one of the virtues of minimalist approaches that they raise such questions by highlighting the continuity between joint actions in adult humans and in less sophisticated creatures. Surely, the more sophisticated coordinating factors that classical accounts focus upon, such as interlocking intentions and commitments, emerge within a space that is already structured by more basic coordinating factors, which they build upon, make explicit, and elaborate further. Such further elaboration clearly enables conceptually more sophisticated coordination and better long-term planning, but a minimalist framework denies that this is necessary for all kinds of joint action.

Acknowledgements I would like to thank everyone involved with the workshop “Shared emotions, joint attention, joint action” (Aarhus, 26th October 2010), without which this paper would not have been written – especially Anika Fiebich, Albert Newen, Andreas Roepstorff and Lars-Henrik Schmidt for making that event possible. I would also like to thank Steve Butterfill and one anonymous reviewer for very helpful comments, which greatly improved the paper.

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