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HOW DOES IT FEEL TO ACT TOGETHER?

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Abstract

This paper on the phenomenology of joint agency proposes a foray into a little explored territory at the intersection of two very active domains of research: joint action and sense of agency. I explore two ways in which our experience of joint agency may differ from our experience of individual agency. First, the mechanisms of action specification and control involved in joint action are typically more complex than those present in individual actions, since it is crucial for joint action that people coordinate their plans and actions. I discuss the implications that these coordination requirements might have for the strength of the sense of agency an agent may experience for a joint action. Second, engagement in joint action may involve a transformation of agentive identity and a partial or complete shift from a sense of self-agency to a sense of we-agency. I discuss several factors that may contribute to shaping our sense of agentive identity in joint action.

Keywords: joint action; coordination processes; sense of joint agency; agentive identity;

1. Introduction

In the last decade, there has been an explosion of interest among philosophers and cognitive scientists alike in the topic of joint action. During the same period, the phenomenology of action and the experience of agency for action have also attracted considerable research interest. Yet, the phenomenology of joint action, an important topic that lies at the intersection of these two very active domains of research, remains to this day little explored.

We very often perform actions together with others and these joint actions take a multitude of forms. But how does it feel to act together? What are the similarities and differences in how people experience agency for individual and for joint actions? Could our experience of agency for joint action be not just quantitatively but also qualitatively different from our experience of individual agency? Could it involve a transformation of the experienced unit of agency itself? Suppose, for instance, that Natalie and Günther are cooking a dinner together. Is Günther's sense of agency for this action weaker than if he had been preparing dinner on his own? Does it make a difference whether one is a better cook than the other or whether one is bossing the other around? Does it make a difference whether their actions are perfectly coordinated or whether they keep getting in each other's way? What if the dinner they prepare together is much more sumptuous than what either of them could have achieved on his own? Can their preparing this dinner together foster a kind of team spirit? Does it make a difference whether it was their common plan to invite people for dinner or whether Natalie has simply enlisted Günther's help to prepare dinner for her friends? All these issues concerning the phenomenology of joint action and the factors that may influence it have only very recently started to be addressed (Obhi & Hall, 2011; Pacherie, 2012; van der Wel, Sebanz & Knoblich, 2012; Wiess, Herwig & Schütz-Bosbach, 2011).

The main aim of this paper is to explore two ways in which our experience of joint agency may differ from our experience of individual agency. There is now considerable evidence that the sense of agency we experience for an individual action relies on a multiplicity of cues related to different levels of action specification and control. In joint action, however, people face coordination demands at both the planning and implementation stages that they do not face when acting alone. To get a better grip on the phenomenology of joint action, we need to know how these demands are met – i.e., what further cognitive processes are involved in joint action to ensure coordination – and what implications this has for the sense of agency we may experience over joint outcomes. This first aspect of the phenomenology of joint action is concerned with the strength of the sense of agency for a joint outcome. Let me call it the outcome-related aspect of the phenomenology of joint agency. In addition, the phenomenology of joint agency presents a second challenge. When agents acting on their own are asked whether they experience a sense of agency for an outcome, they are typically either faced with a binary choice (me/not me) or asked to select a value on a scale labeled 'me' at one extremity and 'not me' at the other (or some variation thereof). When agents acting jointly with others are asked the same question, they confront an ambiguity. Is the alternative me/not me or us/not us? When answering 'yes!', do they mean 'I did it!' or 'we did it!'? In other words, when acting together with others, an agent may also undergo a transformation of her agentive identity and experience a sense of we-agency rather than of self-agency. Let us call this the agent-related aspect of the phenomenology of joint action.

In the next section, I offer a brief survey of recent, complementary models of how and where in the cognitive architecture the sense of agency for individual actions is generated, pointing out the relations they draw between action specification and control mechanisms and processes involved in the generation of the sense of agency. In section 3, I discuss the specific

requirements that bear on joint action—in particular, the requirements concerning the coordination of participants' actions with respect to their joint goal—and the coordination mechanisms involved in joint action. In section 4, I discuss the implications of these requirements and of the coordination processes they engage for the outcome-related aspect of our sense of agency for actions. In section 5, I discuss several factors that may modulate the agent-related aspect of experiences of joint agency. I conclude with some remarks on how an investigation of the experience of joint agency can also serve as an entry point into the nature of social reality.

2. The Sense of Agency for Individual Actions: Sources and Mechanisms

Empirical research on agency has explored a variety of potential cues to individual agency, and a number of different models of how the sense of agency for an action is generated have been proposed. These models all rely to a greater or lesser extent on a congruence principle: the sense of agency is produced when there is a match between cues *x* and *y*. The points on which they differ concern the nature of the cues being compared, the nature of the processes involved in the production of the sense of agency, and how closely these processes are related to action production and control processes.

Two theoretical positions define the two ends of the spectrum of possibilities: the motor prediction view and the cognitive reconstruction view. On the motor prediction view, the sense of agency is generated by processes dedicated to action control. On the cognitive reconstruction view, the sense of agency is generated by a general-purpose process of retrospective causal inference.

The motor prediction view is inspired by computational theories of motor control. According to these theories, when the motor system generates a motor command, an efference copy of this command is sent to forward models whose role is to generate predictions about its

sensory consequences in advance of actual execution. The motor prediction view holds that the signals used for motor control also provide cues to agency (Blakemore & Frith, 2003; Frith, Blakemore, & Wolpert, 2000a, 2000b). In particular, it holds (1) that awareness of initiating an action is based on a representation of the predicted consequences of making that action, rather than its actual consequences, and on the congruence between the predicted state and the desired state, and (2) that for this experience of agency to continue, the predicted consequences also have to remain congruent with the sensory reafferences when they become available. The better the fit, the stronger the sense of agency people will experience.

Claim (1) – and therefore the possibility that the sense of agency can emerge in advance of actual sensory effect and be based on premotor processes alone – is supported by evidence that awareness of initiating a movement in healthy subjects is reported by the agent between 80-200 milliseconds before the movement actually occurs (Libet et al., 1983; Libet, 1985; Haggard & Eimer, 1999). It is also supported by evidence that this awareness is absent or delayed when the brain areas responsible for these predictions are temporarily disturbed using transcranial magnetic stimulation methods or are damaged (Haggard and Magno, 1999; Desmurget & Sirigu, 2009). Evidence for claim (2) – that the sense of agency also depends on the congruence between predictions and sensory reafferences – comes from studies showing that gradually disrupting the consequences of actions by introducing temporal delays or spatial inconsistencies gradually reduces the sense of agency (Fourneret & Jeannerod, 1998; Knoblich & Kircher, 2004; Knoblich, Stottmeister, & Kircher, 2004; Leube et al., 2003; Sato & Yasuda, 2005; Sato, 2009).

The results of some of these studies also suggest that the motor system generates predictions at several levels of grain and that we need to distinguish between low-level sensorimotor predictions and reafferences and higher-level perceptual predictions and feedback (Gallagher, 2007; Jeannerod, 2009; Knoblich & Repp, 2009; Pacherie, 2008, 2010). There are several

reasons to think that perceptual predictions may play a greater role than sensorimotor predictions in establishing agency for an action. First, the vast majority of our actions aim at producing effects in the environment and we normally attend to the perceptual effects of actions rather than to the exact movements we produce to achieve those effects. Second, experimental evidence suggest that people can make sizeable adjustments of their movements without being aware of doing so as long as the perceptual consequences of their movements are consistent with their goal (Fourneret and Jeannerod, 1998). Finally, several clinical populations present severe impairments of their sense of agency while retaining an intact capacity to make automatic online corrections of their movements (Jeannerod, 2009; Fletcher & Frith, 2009). It may therefore be that perceptual cues rather than sensorimotor cues are crucial to the sense of agency. Or, alternatively, it may be that our awareness of what we are doing relies essentially on perceptual cues, while our awareness that we are acting is influenced by both kinds of cues.

In contrast to the motor prediction view, the cognitive reconstruction view downplays the contribution of the motor system to the sense of agency and proposes that it is inferred retrospectively from the existence of a match between a prior thought and an observed action rather than predictively. Thus, on Wegner's theory of apparent mental causation (Wegner, 2002), a general-purpose causal inference process is at play. If an action is consistent with a prior thought of the agent and other potential causes of the action are not present or salient, a sense of agency for the action will be induced.

There is also empirical evidence that high-level inferential processes play a role in determining the sense of agency for an action. Studies of Wegner and colleagues have demonstrated that cognitive cues can alter the sense of agency for an action independently of changes in sensorimotor and perceptual cues. For instance, consciously or subliminally priming an outcome can enhance the sense of agency for that outcome or even induce an

illusory sense of agency for an outcome one had no control over (Wegner & Wheatley, 1999; Wegner, Sparrow, & Winerman, 2004; Aarts, Custers, & Wegner, 2005; Aarts, Custer, & Marien, 2009).

There is now a growing consensus that the motor prediction view and the cognitive reconstruction view are not mutually exclusive but complementary and that intrinsic cues (cues provided by the motor system) and extrinsic cues (such as cognitive primes) both contribute to the sense of agency (Bayne & Pacherie, 2007; Gallagher, 2007; Knoblich & Repp, 2009; Pacherie, 2008; Sato, 2009; Synofzik, Vosgerau, & Newen, 2008; Moore, Wegner and Haggard; 2009; Moore & Fletcher, 2012).

One way to try and combine the two approaches is to appeal to the distinction between pre-reflective experiences or feelings of agency and reflective judgments of agency proposed by several authors (Bayne & Pacherie, 2007; Gallagher, 2007; Haggard & Tsakiris, 2009; Synofzik, Vosgerau, & Newen, 2008) and to argue that while motor processes contribute mainly to feelings of agency, interpretive processes contribute mainly to judgments of agency. This conceptual distinction is echoed methodologically in the ways agency is measured in experimental studies. Some studies (Farrer et al., 2003; Metcalfe & Greene, 2007; Sato & Yasuda, 2005; Wegner & Wheatley, 1999) investigate agency by asking participants to explicitly judge whether they caused a particular sensory event (e.g., by answering questions such as "Did you produce the movement you saw?" or "Did you produce the sound you heard?"). Other studies use implicit agency measures such as intentional binding and sensory suppression. Intentional binding is a phenomenon, first reported by Patrick Haggard and his colleagues (Haggard, Clark & Kalogeras, 2002), whereby a voluntary action and its external sensory consequences are compressed together in subjective time. As intentional binding occurs only in situations in which the participant is an agent (Engbert, Wohlschlaeger, & Haggard, 2008; Tsakiris & Haggard, 2003) and is furthermore modulated by the statistical

relation between events (Moore & Haggard, 2008; Moore *et al*., 2009), it is considered to provide an implicit measure of agency. Sensory attenuation of self-produced action effects has also been used as an implicit measure of agency. Sensory attenuation has been suggested to result from a comparison of the internally generated motor predictions about the sensory consequences of one's ongoing actions with their actual sensory consequences. When they are congruent, the sensory percept is attenuated, thereby enabling a differentiation between self-generated and externally generated sensory events (Blakemore, Wolpert & Frith, 2002; Cullen, 2004). Several studies have confirmed the existence of sensory attenuation effects in the tactile, visual and auditory domains (e.g., Blakemore, Wolpert, & Frith, 2000; Bays & Wolpert, 2007; Cardoso-Leite, Mamassian, Schütz-Bosbach & Waszak, 2010, Aliu, Houdé & Nagarajan, 2011). However, recent studies showing that prior authorships beliefs, or even monetary gains and losses (Takahata *et al*., 2012), can modulate both sensory attenuation and intentional binding (Desantis, Roussel & Waszak, 2011; Desantis et al., 2012), suggest that drawing a sharp distinction between feelings of agency supported by motor processes and judgments of agency supported by interpretive processes may be over-simplistic.

A promising approach is to appeal to a Bayesian integrative framework involving a hierarchy of prediction and model building (Fletcher & Frith, 2009; Pacherie, 2008; Moore & Fletcher, 2012). Thus, Fletcher and Frith (2009) propose that the sense of agency is determined by a Bayesian process of cue integration, where the predictions generated a higher levels of the hierarchy provide the priors for the lower levels; i.e. constrain the interpretation of cues available at lower levels. In this model, cue integration is itself the product of both the strength of the priors and the weights attached to the available cues.[1] These weights are themselves a function of the reliability of these different cues, which may vary from context to context (Synofzik, Vosgerau, and Newen, 2008; Hendricks, Wiggers, Jonker, & Haselager, 2007;

[1] See, for instance, Moore and Fletcher (2012) for accessible examples of how Bayesian cue integration works.

Lau, Rogers, & Passingham, 2007; Moore, Wegner, and Haggard, 2009; Moore & Fletcher, 2012). When priors are weak – for, instance I am quite unsure what the effects of my pressing down this button will be –, I may still have a strong sense of agency for the ensuing consequence, provided that perceptual reafferences carrying information about it are very reliable. Conversely, if my priors are very robust, I may have a strong sense that I produced a certain effect in the world, even though the feedback I get is weak or ambiguous. When both priors and reafferent cues are weak, my sense of agency may be correspondingly weakened. While this Bayesian approach does not allow for a sharp distinction between agentive experiences and agentive judgments, it can accommodate the idea that priors exert more influence on agentive judgments than on agentive experiences.

3. Joint actions: coordination requirements and how to meet them

For joint actions to be performed successfully, it is not enough that agents control their own actions; i.e., correctly predict their effects and make adjustments if needed (*self-predictions* and *self-adjustments*). They must also coordinate their actions with those of their co-agents so as to achieve their joint goal. For that they must represent their partner's actions and predict their expected consequences (*other-predictions*) and use these predictions to adjust what they are doing to what others are doing (*dyadic adjustments*). While dyadic adjustments are necessary for joint action, they are not yet sufficient. For example, the film *Enemy at the Gates*, where a Russian sniper and a German sniper play a game of cat-and-mouse during the Battle of Stalingrad, provides a vivid illustration of a sophisticated mutual adjustment of intentions and actions. Obviously, the two snipers in the film are not cooperating; theirs is a deadly competition. What is furthermore required in the case of joint action is that participating agents share a goal and understand the combined impact of their respective

intentions and actions on their joint goal and adjust them accordingly. To do that, they must be able to represent the combined effects of their actions and those of their partners (*joint-predictions*) and use their predictions of these joint effects to monitor progress towards the joint goal and decide on their next moves (*triadic adjustments*).

Philosophical accounts of joint action (Bratman, 1992, 2009; Gilbert, 1992, 2009; Tuomela, 2007) are typically concerned with the processes involved in making decisions about whether or not to act together and in long-range planning. Their focus is on the coordination of agent's intentions prior to acting, but they pay little heed to the perceptual, cognitive, and motor mechanisms enabling people to coordinate online. In contrast, during the last decade, cognitive scientists have investigated joint action by focusing on online coordination processes in relatively simple joint tasks and on the factors that affect these coordination processes. These two sets of processes are not completely independent, however. For instance, whether people decide to act together often depends at least in part on the nature of the coordination to be achieved and on their expectations regarding their capacity to coordinate online. Conversely, there is evidence that low-level coordination (e.g., in the form of bodily synchronization) has an effect on how people perceive social interactions and those they interact with (Chartrand and van Baaren, 2009; Farmer & Tsakiris, 2012; Hove & Risen, 2009; Miles et al., 2009; van Baaren et al., 2009) and can foster cooperation within groups by strengthening feelings of social affiliation and group cohesion (Wiltermuth & Heath, 2009). In addition, it seems likely that our sense of agency for a joint action may depend to a large extent on how well co-agents coordinate online. For instance, although we may have formed a shared intention to spend the afternoon rowing on the Thames and have meshing subplans for our joint goal, our sense of agency for the joint action will probably be quite weak if we are

unable to coordinate our movements precisely when rowing. It is therefore important to understand what kind of processes may support online coordination.

In recent years, cognitive psychologists and neuroscientists have made much progress in understanding the perceptual, cognitive, and motor mechanisms and processes that enable individuals to coordinate their actions with others online as well as the neural basis of these mechanisms. In a recent review of psychological research on joint action, Knoblich, Butterfill and Sebanz (2011) distinguish between two types of coordination, emergent coordination and planned coordination.[2] In emergent coordination, coordinated behavior occurs due to perception-action couplings that make multiple individuals act in a similar way. In planned coordination, agents plan their own actions in relation to the joint goal and to their partners' actions.

While emergent coordination can occur between individuals who have no plans to act jointly, it is also a key facilitator of joint action. Emergent coordination processes include interpersonal entrainment, affordances, perception-action matching and action simulation.

Entrainment is a process whereby two people involuntarily synchronize their behavior, even in the absence of direct mechanical coupling. Thus, two people sitting next to each other in rocking chairs will unconsciously synchronize their rocking frequency and do so even when they have chairs with different eigenfrequencies (Richardson et al., 2007b). Similarly, two individuals who are asked to tap at a confortable tempo strongly tend to spontaneously fall into synchrony (Oullier et al., 2008).

The perception of common or joint affordances may also be one process through which emergent coordination can be achieved (Richardson et al., 2007a). For instance, if it starts

[2] For an excellent survey of recent developments in the empirical study of joint action, see also the papers in the special issue on joint action, guest-edited by Sukhvinder S. Obhi and Natalie Sebanz, in *Experimental Brain Research*, vol. 211, issues 3-4, June 2011.

raining, the people in a park may spontaneously converge on the kiosk that affords protection from the rain. The kiosk that can shelter many people would constitute a common affordance. A joint affordance is a case where an object affords action to two people that it may not afford to each of them individually. Thus, a seesaw may provide great fun to two kids riding it, but not to a single child.

A third process than can induce emergent coordination is perception-action matching. A number of recent theories—the common coding theory (Prinz, 1997), the motor simulation theory (Jeannerod, 1997, 2006), and the motor resonance theory (Rizzolatti & Craighero, 2004) postulate an interface between perception and action such that the perception of an action leads to the activation of a corresponding action representation in the observer's action system. These theoretical insights are supported by a wealth of empirical findings, from single-cell studies in monkeys (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996) to brain imaging studies in humans (Decety & Grezes, 1999, 2006; Calvo-Merino et al., 2005).

A fourth related process of emergent coordination is action simulation, where, when watching someone else acting, an observer can use the predictive models in his own motor system to anticipate the timing and outcomes of the observed actions (Knoblich & Sebanz, 2008). Both perception-action matching and action simulation can lead to emergent coordination by inducing the same action tendencies in agents who observe one another's action.

In planned coordination, agents plan their own actions in relation to the joint goal and to a greater or lesser extent their partners' actions. The extent to which one represents and take into account one's partner's intentions and actions may vary greatly according to the task. For instance, to prepare a meal together, we must first decide what the menu will be and who will prepare what, but while preparing the dinner it may be unnecessary to form detailed

representations of what the other is doing. It is enough that we coordinate our actions so as to avoid needing the same kitchen utensils at the same time and avoid bumping into one another while moving around in the kitchen. In other cases, where the precise coordination of the agent's respective actions is required for successful performance, it may be important to form detailed representations of others' actions and their consequences. For example, two people moving furniture together or playing doubles in tennis had better form precise representations of their partner's actions and their consequences.

As emphasized by Knoblich, Butterfill and Sebanz (2011), shared task representations play an important role in planned coordination. Shared task representations do not only specify in advance what the respective tasks of each of the co-agents are, they also provide control structures that allow agents to monitor and predict what their partners are doing, thus enabling interpersonal coordination in real time. Empirical evidence shows that having shared task representations influences perceptual information processing, action monitoring, control and prediction during the ensuing interaction (Heed et al., 2010; Schuch & Tipper, 2007; Sebanz et al., 2006b; Tsai et al., 2006). Furthermore, several studies (Sebanz et al., 2005; Sebanz et al., 2006b, 2007) have shown that actors may form shared representations of tasks quasi-automatically, even when it is more effective to ignore one another.

Several researchers have also suggested that joint attention provides a basic mechanism for sharing representations of objects and events and thus for creating a "perceptual common ground" in joint action (Tomasello, 1995, 1999; Tomasello & Carpenter, 2007; Tollefsen, 2005; Sebanz et al., 2006a). To act jointly, it is often necessary not only that the co-agents identify the objects to be acted upon, their location as well as the location of possible obstacles, but also be mutually aware that they do. The phenomenon of joint attention involves more than just two people attending to the same object or event. In

addition, there must be some causal connection between the two subjects' acts of attending (causal coordination) and each subject must be aware, in some sense, of the object as an object that is present to both; in other words the fact that both are attending to the same object or event should be open or mutually manifest (mutual manifestness). Joint attention may thus play an important role in ensuring that coagents track the same objects and features of the situation and be mutually aware that they do. In a recent study, Böckler et al. (2011) showed that attending to objects together from opposite perspectives makes people adopt an allocentric rather than the default egocentric frame of reference. These authors suggest that taking an allocentric reference frame facilitates object processing for objects that are turned towards the other and may support the efficiency of joint actions from different spatial orientations.

Independently of mutual manifestness, being able to assess what others are perceiving, or can or cannot perceive at a given moment in time may also facilitate coordination. For instance, a study by Brennan and colleagues (Brennan et al., 2007) demonstrated that co-agents in joint visual search space were able to distribute a common space between them by directing their attention depending on where the other was looking and that their joint search performance was thus much more efficient than their performance in an individual version of the search task.

As pointed out by Knoblich, Butterfill and Sebanz (2011), to enable efficient joint action, emergent and planned coordination must work together, as there are complementary limits on what each can achieve. A series of recent studies provides evidence that planned coordination modulates emergent coordination, with top-down modulation of entrainment through joint action plans (Kirschner & Tomasello, 2009) and the activation of simulation for co-actors but not for agents acting independently (Kourtis, Sebanz, & Knoblich, 2010). Conversely, emergent coordination can also modulate planned coordination either directly as

when the presence of a joint affordance causes people to switch from individual to joint action or indirectly as when entrainment and motor synchronization fosters cooperation within groups by strengthening group cohesion. Thus, Wiltermuth & Heath (2009) had participants in an experiment play a public goods game – the Weak Link Coordination Exercise, where different amounts of cooperation and free riding are possible –, after taking them on walks around campus, either in a synchronous condition, where they had to walk in step or in an asynchronous condition, where they walked normally. Participants who had walked in step cooperated more than those in the asynchronous condition. They also indicated stronger feelings of connection with and trust in their counterparts than did those in the asynchronous condition.

Although an important research effort is still needed to understand in detail how various coordination processes interact and what factors modulate the activation of these processes, we now already know enough about these processes to start asking the question how they might also contribute to the phenomenology of joint agency. To this issue I now turn.

4. Strength of the sense of agency for joint action

The discussion that follows is premised on the idea that, as is the case with individual actions, the sense of agency we experience for joint action relies on a multiplicity of cues related to different levels of action specification and control. However, the mechanisms of action specification and control involved in joint action are typically more complex than those present in individual actions. Thus, to understand how the phenomenology of joint action might differ from the phenomenology of individual actions, we need to take into account the specific coordination requirements that bear on joint actions. In the previous section, I

discussed these requirements as well as a range of cognitive processes that may help us meet them.

In an investigation of the phenomenology of joint agency, we should consider the issue of what factors influence the strength or intensity of the sense of agency one experiences when engaged in joint action. However, a second issue also arises: what form does the sense of agency take and why? That is, to what extent is agency experienced as self-agency or as we-agency? In the remainder of this section, I concentrate on the first issue. The second issue is discussed in the next section.

In individual actions, the strength of the sense of agency one has for an action depends on how good the matches are between the predictions we make about the consequences of our actions at the cognitive, perceptual and sensorimotor levels and their actual consequences. The same principle of congruence presumably applies for joint actions. However, as we saw in the previous section, in joint actions, prediction becomes a much more complex task. Agents must not just predict the consequences of their own actions at all three levels of action specification (*self-predictions*), they must also do the same for the actions of their co-agents (*other-predictions*), and finally integrate both self- and other-predictions to build predictions about the joint consequences of their combined actions (*joint predictions*). The strength of the sense of agency for the joint outcome will depend on how accurately one is able to make joint predictions, which in turn depends on the extent and accuracy of self- and other-predictions and on the manner of their integration.

One's success at making joint predictions depends on a range of cognitive processes described in the previous section but also on the accessibility of relevant information. This accessibility in turn depends on the nature of the joint action. Factors such as the structure of the joint action, its scale, the degrees of specialization of agents' roles, and the longevity or transience of the collective all affect the accessibility of relevant information.

The structure of joint actions can range from the strictly egalitarian, where all participating agents contribute more or less equally to the joint action and are equally responsible for planning it and controlling its successful execution, to the highly hierarchical, where planning, monitoring, and control are responsibilities assigned to agents high in the hierarchy. In egalitarian joint actions, the choice of the joint goal and the planning for this joint goal are all negotiated among the co-agents, thus ensuring that they all have a relatively good knowledge of what the tasks of others are and of how they jointly contribute to the total outcome. This shared knowledge makes them well prepared to make reasonably accurate other- and joint predictions at least at the cognitive level. In contrast, in hierarchical joint actions, the choice of joint goals and the planning of the joint action are the concern of agents high in the hierarchy. Agents down the hierarchy typically lack detailed knowledge of the overall plans of the tasks of their co-workers. As a result of this knowledge asymmetry, agents at the top of the hierarchy, but not agents lower down, will be in a good position to make accurate other- and joint predictions.

A second important factor is scale. In small-scale joint actions, typically taking place in a shared physical environment, agents are in a position to monitor what all or most of their co-agents are doing or about to do and what the consequences of their actions are, and they thus have access to the perceptual information needed to make accurate online other- and joint predictions. In larger scale actions, in contrast, there may be too many participants for such a comprehensive monitoring to be feasible. Co-agents have only partial access to what others are doing and to what the joint outcomes of their actions are. To take an extreme example, think of the Allied landing in Normandy in June 1944. The individual soldier crawling on Omaha Beach in the midst of gunfire probably had very little inkling of what was going on at a broader scale and wasn't in a position to assess whether the landing as a whole was progressing satisfactorily.

A third factor to consider is the distribution of roles. In joint actions where participants have near-identical or interchangeable roles, they may have a motor repertoire allowing them to engage in perception-action matching and motor simulation as well as the knowledge needed to form task-representations; they would thus be in a position to precisely represent the goals and actions of their co-agents and make accurate other- and joint predictions. In joint actions where roles are specialized and highly differentiated, this knowledge may be missing.

Finally, a fourth factor that may mitigate the effects of highly differentiated roles is the stability of the association among co-agents. Agents forming a long-term collective and used to acting together will have had the opportunity to form shared-task representations and will typically be better able to predict the actions of their co-agents and their consequences, even when roles are highly differentiated, than members of a newly formed collective.

In a nutshell, then, if the strength of the sense of agency for a joint action depends not just on self-prediction but also on other-predictions and on the joint predictions resulting from the integration of both self- and other-predictions, then participation in small-scale, egalitarian actions, with little specialization of roles and a stable group of co-agents, is likely to yield a stronger sense of agency than first-time participation in a large-scale, hierarchical joint action with highly differentiated roles. Furthermore, for joint actions of the latter kind, the strength of the sense of agency experienced would depend on the position one occupies in the hierarchy. The higher up one stands in the hierarchy, typically the better one knows how roles are distributed and how the co-agents contributions fit together to yield a joint outcome. The stronger therefore, one's sense of agency for this joint outcome should be. Whether the greater sense of agency enjoyed by agents higher up in the hierarchy takes the form of stronger agency judgments, stronger feelings of agency or both may depend on the mode of involvement of these agents in the action and on the more or less direct ways in which they

can monitor and control the joint action. For instance, one may want to contrast the case of the orchestra conductor on his podium who directly issues his commands to the musicians and gets immediate feedback from them from the case of the modern general in his headquarters whose access to what is going on in the battle field is much more indirect. In the conductor's case, the monitoring and control loop remains strongly embodied as his commands are issued through the medium of gestures and his monitoring of the joint action operates through visual and auditory channels. His increased sense of agency may thus not just take the form of stronger agentive judgments than the musicians sitting in the orchestra but also of an enhanced agentive experience. In contrast, the general commanding and monitoring operations from afar will probably form stronger judgments of agency for the battle and its outcome than the mere private but it is unclear whether this increase will be echoed at the level of his agentive experience.

One should note, in addition, that whereas in individual actions prediction and control tend to go hand in hand, in joint actions their relationship is much less linear. In individual action, agents' predictions concern the consequences of their actions and are used to select actions, control their course, and make adjustments to them if needed. The fit between prediction and control is not perfect, and experiences of illusionary control can still arise as shown by some of the experiments discussed in section 2, but on the whole accurate predictions tend to be reliable indicators that the agent controls the action. Thus, the more accurate they are, the stronger the sense of self-agency should be. In joint actions, however, the predictions agents need to make pertain not just to the consequences of their own actions but also to the consequences of others' actions and to their combined effects. The extent to which one might be able to predict the consequences of others' actions need not always parallel the extent to which one might be able to control their actions. While we can exert direct motor and executive control over our own actions, control over the actions of others is

perforce indirect and limited. If co-actors are part of a hierarchy and one has authority over the other, she can control his actions through verbal commands or gestures (e.g., the orchestra conductor) but not the other way round. Even outside hierarchical settings, one may to some extent be able to steer the behavior of one's co-actor(s) either verbally or though action. If we are taking a walk together and I arrive first to the street corner, I may control the direction we take, right or left. If we are carrying together a heavy peace of furniture and you are walking faster than I expected, I may force you to slow down by slowing down myself.

As a result of the loosening of the link between prediction and control, joint actions leave much more room for spurious experiences of control. I may have the impression that I control your behavior, not because I actually control it, but simply because I am able to accurately predict it. At the same time, this tendency to experience spurious control over a joint action, may, to some extent, be counterbalanced by the knowledge we normally have that we are not acting alone.

Second, and pulling in the other direction, matches between our predictions of the outcomes of others' actions and their actual outcomes may not be as good as matches between our predictions of the consequences of our own actions and their outcomes. To the extent that the sense of agency relies on the goodness of the match between predicted and actual consequences of actions as specified at the sensorimotor level, then, as pointed out by van der Wel, Sebanz and Knoblich (2012), the sense of agency should be weaker for joint action, since, on the one hand, the link between one's motor commands and their sensory consequences is less clear as a result of the perturbations that may be introduced by what the co-actor does, and, on the other hand, we have no direct access to the sensorimotor reafferences others get when acting and thus no way to make precise comparisons between predictions we make about the sensory consequences of their actions and their actual sensory consequences. However, as we saw in section 2, there are reasons to think that perceptual

predictions may play a greater role than sensorimotor predictions in establishing agency for an action. With respect to predictions made at the perceptual level, agents normally have access to information about the perceptual consequences of others' actions and are in a position to compare them with what they had expected these perceptual consequences to be. The goodness of the match, hence the strength of the sense of agency one would experience, would depend on how well others perform, as the perceptual consequences of actions are easier to predict the better people perform.[3] In addition to the intrinsic quality of the performance, another important factor would be its timing, since, as we saw in section 2, temporal distortions between predicted and actual outcome tend to reduce the sense of agency. Different individuals often have different temporal signatures. For instance, the spontaneous walking pace of people can present important inter-individual variations. These idiosyncratic differences could contribute to reduce the accuracy of predictions. However, they may be compensated in turn by emergent forms of coordination. Thus, synchronization through motor entrainment may induce temporal interpersonal alignment and thus improve the temporal accuracy of predictions.

5. Agentive identity: Self-Agency vs. We-Agency

What actions one can perform and what effects one can voluntarily bring about define what we may call the scope of one's agency. This scope can vary from agent to agent or vary within the same agent according to age, acquired skills, available instruments, and institutional empowerments. Some agents can perform actions and bring about effects that others can't. For instance, some people can do a cartwheel or play the violin while others

[3] Models of motor control are typically based on optimality principles (For a review, see Todorov, 2004). Very roughly, skilled performance on a certain task is performance that minimizes the total energy cost to the system. It has been proposed that optimality is also what guides our assessment of actions performed by others. Thus, according to the teleological stance advocated by Csibra and Gergely (2007), our evaluation of the quality of actions is based on an assessment of the relative efficiency of the action performed to achieve the goal within the situational constraints given.

can’t. Learning new skills is a way of enlarging the scope of one's agency and thus agents may be able to do things at some stage of their life that they couldn't do before they had mastered the relevant skills. Agents may be able to do things with the help of instruments that they couldn’t do without. Agents may also be able to do things when empowered by relevant institutions that they couldn’t do if not so empowered, like marrying couples or hiring new employees. The widening of the scope of one’s agency appears as a form of self-enlargement involving boundary expansion and, indeed, in some instances quite literally so. For example, many human and monkey studies have shown that brain representations of peripersonal space, that is, the surrounding space encompassing objects within reach, are quite plastic and that the use of tools allowing one to reach further in space results in a recoding of far space as near (Iriki *et al.*, 1996; Farné & Làdavas, 2000).

In many cases, acting jointly allows us to bring about outcomes that a single agent could not—or could not easily—bring about on his or her own. For instance, two people may be able to lift together a heavy object that neither could lift alone, or a team of construction workers may build a house much more efficiently than a single individual. Acting jointly is thus one way of increasing agency scope. But is increased agency then experienced as self-agency, an expansion of the boundaries of one's self-agency, or as we-agency, a merging of one's agency in the collective agency of the group? We may call this the question of agentive identity in joint action.

What form agentive identity takes depends on the extent to which the conditions needed for self-other discrimination obtain. These conditions themselves may be roughly distinguished into, on the one hand, structural conditions, i.e., factors relating to the structural properties of the joint action, such as its more or less pronounced hierarchical organization and division of labor among agents, and, on the other hand, motivational conditions, the latter

encompassing both the reasons that motivated the agent to engage in a given joint action in the first place and the motivational effects of the action itself.

In section 2, we have seen that in individual actions one's sense of self-agency depends to a large extent on the degree of match between one's predictions about the effects of our actions and their actual effects. In joint action, however, it is also important that we make predictions about the effects of other actions to facilitate coordination and yet differentiate between self and other to avoid interference effects and conflicts (Sebanz, Bekkering & Knoblich, 2006; Wenke *et al.*, 2011). Thus, in joint action contexts, agents may be confronted with increased self-other discrimination demands while, at the same time, some of the main cues used in individual action contexts, namely matches between predicted and actual consequences, become much less reliable indicators of self-agency. However, the severity of the challenge may well depend on the structural properties of the action.

It seems that the less differentiated the respective contributions of co-agents, the greater the challenge of self-other discrimination and hence the more likely that a sense of we-agency could arise. In joint action, agents make their own contribution to the joint goal but must also coordinate with others (dyadic adjustments) and coordinate with others with respect to the joint goal (triadic adjustments). Contributions to the joint outcome may be important or marginal and coordination relations may be symmetrical or asymmetrical. The more commensurate the respective contributions of the co-agents and the more symmetrical the coordination relations among them are (or are perceived to be), the more likely it is that the sense of agency they will experience will involve a shift towards a sense of we-agency.

Other things being equal, participation in egalitarian joint actions is more likely to give rise to a sense of we-agency than participation in a hierarchically structured action. In hierarchical actions, agents high in the hierarchy can have more influence on the joint outcome than agents lower down the hierarchy, and coordination relations are highly

asymmetrical with agents at the top of the hierarchy coordinating while agents down the hierarchy are being coordinated. High-ranking agents, on the one hand, are likely to experience a sense of personal enlargement, understood as an enhanced sense of self-agency rather than a sense of we-agency and to regard other participants as social tools rather than co-agents. Low-ranking agents, on the other hand, may well experience a shrinking sense of self-agency without the compensation of a robust sense of we-agency.

There are many intermediate situations, however, where one's experienced sense of agency can be a mix of self-agency and we-agency, and there are several factors that may further modulate the experience. A group of agents may contribute equally to a joint goal and yet have specialized roles that allow them to keep a strong sense of self-agency at the same time they experience a sense of we agency. Think, for instance, of the goalkeeper in a soccer team, who may experience a strong sense of we-agency for the team's victory, while retaining a strong sense of self-agency for stopping a penalty and thus contributing to this victory.

In addition, very small perturbations in the relative salience of co-agents can influence our perception of the importance of their contribution to the joint action. Wegner and Sparrow (2007) discuss results from social psychology experiments showing such effects. Thus, a person wearing a brightly colored shirt is more likely to be held responsible for the direction of a group discussion than someone dressed so as to blend in, even if these individuals' contributions are the same (McArthur & Post, 1977). Similarly, the physical perspective from which co-actors are seen influences the perceived importance of their contribution. Looking at someone face-on rather than looking over the person's shoulder will incline us to attribute to that person a greater responsibility for the action (Taylor & Fiske, 1978). Wegner and Sparrow (2007) also report findings from their own experiments showing that small variations in the timing of action and gaze appear to influence judgments of authorship for the joint action. Thus, when two people are acting together, the person who moves first, be it by a split

second, will tend to be seen as the leader of this segment of their action and will experience greater authorship of it.

A recent study by Obhi and Hall (2011) suggests that this mix of self-agency and we-agency can also take the form of a dissociation between explicit and implicit measures of agency. In their experiment, they determined intentional binding, used as an implicit measure of agency, and compared it to explicit judgments of agency for effects following from jointly produced actions that were initiated by one of two co-actors. While only the initiator of the action explicitly judged that he or she was causally responsible for the production of the effect, both agents demonstrated significant and indistinguishable intentional binding. The authors tentatively suggest that the presence of intentional binding in both agents might constitute evidence that when two individuals are involved in a joint action context, they automatically form a new agentive identity, a 'we' identity, at the pre-reflective level. In contrast, at the reflective level they would retain a sense of their identity qua independent entities and this would be reflected in their agency judgments.

In another recent study, Weiss, Herwig & Schütz-Bosbach (2011) investigated the influence of social interactions on sensory attenuation of action effects, a phenomenon that has also been used as an implicit measure of agency. They compared the attenuation of the perceived loudness intensity of auditory action effects (i.e. tones generated by a button press) performed either by oneself or another person in an individual, non-interactive action context or in an interactive action context. In the individual conditions, the participants either performed a tone-eliciting button press or observed the experimenter doing this. In the interactive conditions, the participants either performed a tone-eliciting button press whenever the experimenter requested them to do so by touching their right forearm or, conversely, the experimenter performed the tone-eliciting button press whenever the participants requested him to do so by touching his right forearm. Consistent with previous evidence, the perceived

loudness of self-generated sounds was attenuated compared to sounds generated by another person. However, sensory attenuation of both self- and other-generated sounds was also significantly increased in interactive conditions, as compared to the respective individual action contexts. In contrast to Obhi and Hall (2011), the authors of this study do not interpret their results as evidence for the formation of a new implicit 'we' agentive identity. Rather, they interpret increased sensory attenuation in the participants when the other person was acting on their request as a marker of increased self-agency and enlarged agency scope, where the other person becomes an integral part of the participant's own internal sensorimotor loop. Similarly, they suggest that the stronger attenuation of sounds resulting from the participant's own button press when acting on request rather than of his own accord might be due to a form of contrastive enhancement of self-agency.

Given the very limited number of studies on the sense of agency in joint action, it is certainly premature to draw strong conclusions. While both studies demonstrate an effect of interactive or joint action contexts on implicit measures of agency, it is unclear whether this effect is best interpreted as a shift towards we-agency or as an enhancement of self-agency, either by proxy or in contrastive fashion. It is also unclear whether the dissociation found by Obhi and Hall (2011) between pre-reflective and reflective sense of agency should be taken as evidence that they rely on largely independent processes or that the processes determining pre-reflective agency are immune to top-down influence. On the contrary, it may be that knowledge that one is acting together with someone else exerts a top-down effect on how the agency cues used in implicit agency registration are weighted. Finally, we should not necessarily assume that when pre-reflective and reflective sense of agency dissociate, we-agency will always be found at the pre-reflective rather than at the reflective level.

It is important to note, for instance, that the participants in the study by Obhi and Hall (2011) had asymmetric roles, initiator and follower, and clear perceptual information about

who had been the initiator and who the follower. It may be therefore that in joint action contexts where no such disambiguating information is present, explicit agency judgments reflect a mixed agentive identity. To my knowledge, this possibility has not yet been empirically tested. When asking subjects to report their sense of agency for a joint action, typically experimenters tacitly assume that they are measuring self-agency. Yet, their results may be open to other interpretations. For instance, in a recent study where two agents had to coordinate their actions to rotate a pole that moved along a fixed axis, van der Wel, Sebanz and Knoblich (2012) found that the sum of the agency ratings participants provided after joint performance on average exceeded a value of 100, on a scale from 0 to 100. If these ratings are thought to reflect the sense of self-agency of the participants, then one may conclude, as the authors of this study tentatively do, that participants had a general bias to claim more control over the joint action than they objectively had. Alternatively, however, the sense of agency reported by the participants may have reflected a mix of self- and we-agency.

A complete shift towards pure we-agency may perhaps only be observed in very specific forms of joint activity such as military drill and communal dancing, that are explored by the military historian William H. McNeill in his 1995 book *Keeping Together in Time: Dance and Drill in Human History*. McNeill describes the experience of participants in traditional communal dancing and his own experience when subjected to endless military drill in the army as involving a shift in agentive identity:

> "Boundary loss" is the individual and "feeling they are one" is the collective way of looking at the same thing: a blurring of self-awareness and the heightening of fellow-feeling with all who share in the dance. It matches my own recollection of what close-order drill felt like… (1995: 8)

The more similar the actions co-agents perform, the more similar their effects and the more synchronous their timing, the greater the similarity of self- and other-predictions will be

and thus the harder the differentiation of self- and other-agency and the preservation of self-boundaries. If, in addition, social identity is made very salient at the expense of individual identity, all the conditions are met for a merging of the individual into the collective. McNeil's description of military drilling presents all these ingredients. The point of drilling is to get the soldiers to perform the very same actions at exactly the same time. To make self-differentiation even more difficult, the military also imposes uniform dress and hair grooming standards on their soldiers. The soldiers are also constantly reminded that qua individuals they are nothing outside of their status as members of the US army. The military does not do all of this inadvertently of course. Its aim is to instill *esprit de corps* into the recruits and, for better or worse, it seems to have found a very effective recipe: maximize predictability and minimize differentiability by maximizing similarity at all levels.

In addition to structural factors, but also in interaction with them, motivational factors can also contribute to shaping the form agentive identity takes in joint action. On the one hand, the very motivations that lead an agent to engage in joint action may influence the way agency will be experienced. We sometimes engage in joint action because acting jointly with others is a more efficient way of promoting our own individual interests, but we also engage in joint action on the basis of pro-social motivations, i.e. for the benefit of the group rather than for our own individual benefit. In the classical stag hunt scenario, a group of hunters who decide to hunt a stag together rather than each hunt a hare on his own are motivated by self-interest: each will get more food from his share of the stag than from a hare. Contrast this with the case where these hunters are members of the same clan and are hunting the stag to provide meat for a banquet the clan is organizing. In the latter case, the hunters are acting on behalf of the clan and the ultimate goal pursued is a group goal. A form of social or group identity is thus salient from the outset and may influence the way agency is experienced.

In addition, there is also an increasing body of evidence showing a bi-directional relationship between shared social identity and motor synchrony, action-co-representation and cooperativeness. On the one hand, there considerable evidence from social psychology that people are more willing to trust and cooperate with in-group members than with out-group members (Brewer, 2007; Brewer & Kramer, 1986; Taifel, 1970; Wit & Kerr, 2002); there is also evidence that actions are co-represented less when one's co-actor is an out-group member than when he or she is an in-group member (Müller *et al.*, 2011) and that group membership modulates nonconscious behavioral mimicry (Lakin *et al.*; 2003; Yabar *et al*., 2006). On the other hand, there is also strong empirical evidence that nonconscious behavioral mimicry and motor synchrony promote positive relationships (Chartrand & Bargh, 1999), increase affiliation (Lakin & Chartrand, 2003), and lead to more pro-social behavior (van Baaren *et al.* 2004) and cooperation (Wiltermuth & Heath, 2009). This is the recipe the military seem to be following when they submit recruits to close-order drill in order to promote *esprit de corps* among them. In addition, the two sets of processes appear to be mutually reinforcing and could therefore create a snowball effect. The identification with the group that may initially motivate agents to engage in a joint action would lead to more co-representation and motor synchrony, which would in turn increase affiliation and social bonding, thus making it even more likely that agency is experienced as we-agency. If, in contrast, one's initial motivations to engage in joint action are of a more selfish nature and the joint action is only seen as an efficient mean to promote one's self-interests and if, in addition, the structure of the joint action is not such that close motor synchrony or co-representation of one's partners actions are essential to its successful performance, than a sense of self-agency is more likely to prevail.

6. Conclusion

This paper on the phenomenology of joint agency proposed a foray into a little explored territory at the intersection of two very active domains of research: joint action and sense of agency. This exploration of the phenomenology of joint action was guided by the assumption that the principle of congruence between predicted and actual outcomes which is central to the sense of agency for individual actions is also at work in generating the sense of agency for joint actions. However, an investigation of the phenomenology of joint action must take into account two sets of complications.

First, the mechanisms of action specification and control involved in joint action are typically more complex than those present in individual actions, since it is crucial for joint action that people coordinate their plans and actions. To do so, they must be able to predict not just the effects of their own actions, but also the effects of their co-agents actions and the way these effects will combine. I explored the implications that these coordination requirements bearing on joint actions might have for the strength of the sense of agency an agent may have for a joint outcome. In particular, I argued that the strength of the sense of agency one may experience for a joint action is a function of the accuracy not just of self-predictions but also of other-predictions and joint predictions and that this accuracy may vary according to the type of joint action and to the role one plays in a joint action.

A second set of complications is linked to the possibility that engagement in joint action may involve a transformation of agentive identity and a partial or complete shift from a sense of self-agency to a sense of we-agency. I suggested that one's agentive identity when engaged in a joint action is a function of both predictability and differentiability: the more accurate other-predictions are and the less distinguishable self-predictions are from other-predictions, the greater the shift towards a sense of we-agency.

Let me conclude with some general remarks on how this bears on our understanding of social reality. Up to now, philosophical debates concerning the ontological commitments of theories of joint action have been mostly pitched at the level of intentions, with disputes over whether shared intentions can or not be analyzed in terms of individual intentions and over whether the subjects of shared intention are interrelated individuals or collective agents. Consideration of the phenomenology of joint action and of the processes that underlie it suggest a different way of approaching these issues, challenging what Schmid (2005) calls the 'atomistic conception of the individual'. Engaging in joint action appears to involve a transformation of agentive identity, traceable both through the psychological processes that support joint action, some of which are neither required nor operating in individual actions, and through the impact they have on agentive experience. Understanding under what conditions individuals come to think of themselves, act, and feel *qua* members of a team may be an essential entry point into the nature of social reality.

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