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MEMBERSHIP AND KNOWLEDGE. SCIENTIFIC RESEARCH AS A GROUP ACTIVITY

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ABSTRACT

Much scientific research is characterized by a high degree of multidisciplinarity and interdependence between the experts. In these cases research may be described as a group activity, and as such analysed in terms of the intentions of the participants. In this paper I apply Bratman's notion of shared intentionality to explain the relations between social and epistemic elements in groups with a truth-oriented common goal. I argue that in truth-oriented activities the disposition to help – which is a constitutive part of Bratman's notion of shared intentionality – takes the form of a commitment not to lie, and that mutual knowledge of this commitment gives the members an entitlement to rely on other members' testimonies. Thus, in truth-oriented group activities, common knowledge of the disposition toward mutual support gives epistemic relevance to cooperation. Scientific research is shaped by the coexistence of social and epistemic elements: social relations influence knowledge attributions, and the epistemic goal of the activity confers a particular character to these relations.

1. THE SOCIAL AND EPISTEMIC CHARACTER OF SCIENTIFIC RESEARCH

Scientific research differs in many respects from the Cartesian ideal of an individual scientist generating knowledge by herself. Even the metaphor of the dwarfs sitting on the shoulders of giants fails to capture the degree of interdependence and mutual reliance which characterizes the relations between scientists: scientific research requires the coordination of individuals with expertise ranging over a wide variety of subjects, and their cooperation in experiments with a great degree of complexity. This feature is more evident in the experimental sciences, for the design and realization of an experiment often involves a large number of scientists and technicians. As a matter of fact, no individual could ever know all the evidence that justifies the statements expressing the results of big experiments, and in relevant cases no individual could even grasp it.

The problem arises whether there could ever be an appropriate subject for such knowledge, that is, a subject who is capable of having knowledge in the traditional sense of justified true belief. The attribution of individual knowledge of complex scientific achievements is not possible in the traditional sense, since individuals are not in a position to understand and take into account all the evidence that is necessary for justification. Notwithstanding, it is possible to try to capture this social feature of knowledge production by way of a *summative* approach, that is, by explaining social knowledge as the sum of individual propositional attitudes and common knowledge of them. The *locus classicus*

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of the simplest version of summativism is Quinton (1975), but sophisticated versions have subsequently been proposed by other philosophers (e.g. Corlett 2007).

Summativism is generally considered unable to capture the peculiarity of social beliefs, for example because it does not refer to the social mechanisms that allow their production (Bird 2010) or because it does not recognize that social knowledge in some cases is independent from the beliefs of the members of the group (Gilbert 1989). A number of *non-summative* accounts of social beliefs have been developed over the years, therefore, in the attempt to define how collective subjects may have doxastic or epistemic attitudes.

Talking of groups as subjects of propositional attitudes suggests their strong entification, which is typically regarded as ontologically suspect: when people join together in a group, group agency seems to emerge in virtue of some mysterious 'force' (Hager 1989; Runciman 1997; McLean 1999). Yet, in the last twenty years, a lot of work has been devoted to the explanation of collective agency, trying to avoid eliminativism, but also to make philosophical discourse about collectives metaphysically acceptable. The work of Pettit (Pettit 1993, 2007; List and Pettit 2011) is an example of realism about group agents that does not require the presence of mysterious and inaccessible forces. Pettit's account is motivated by the recognition that treating groups as agents is advantageous from an epistemological point of view: the phenomena of group behaviours and of group beliefs are better understood as *supervenient* on the individualistic level; the explanation of group phenomena is better handled without attending at the lower level (List and Pettit 2011: 75).[1]

The pioneering work of Margaret Gilbert (1989, 2000, 2001, 2004, 2009) on *group beliefs* is central in the debate about the non-summative accounts. Gilbert argues that in order to act as a group, and in order to form group beliefs, people have to openly express their joint commitment, that is, they have to openly express to each other their willingness to let a certain view be the view of the group. Thus, a group belief is irreducibly collective in virtue of the attitude required for its formation – the joint commitment of the members.

Gilbert's notion of group belief has generated intense debate, because some elements of her characterization of the notion (especially the *voluntaristic* character of group beliefs formation) suggest that group beliefs in her sense are more similar to acceptances than they are to individual beliefs. *Believers* and *rejectionists*[2] argued for and against the plausibility of attributing beliefs to group agents, and Gilbert (2000) clarified her position on this point, favouring the believers' interpretation.

The main reason why this debate is relevant for the definition of social knowledge is that it seems natural to assume that groups' capacity of having belief is a necessary condition of group knowledge: if groups can accept propositions but cannot properly believe

1 Following Bacharach (2006), it is useful to distinguish between entification 'from the outside' and entification 'from the inside'. Entification from the outside is very common in social science and also in many contexts of everyday life, but is ontologically suspect. Entification from the inside is a psychological phenomenon due to the fact that people think of themselves as members of a collective. According to Bacharach, entification from the inside plays an essential role in the aetiology of behaviour, since being part of a group changes payoff structures in cooperative games. Gilbert's account of group belief formation (1989, 2004) seems to refer to the same phenomenon.

2 The debate includes Gilbert (1989, 2000), Tuomela (1992, 1995, 2000, 2004), Schmitt (1994), Wray (2001, 2003), Giere (2002, 2007), Tollefsen (2002, 2003), Preyer (2003), Hakli (2006, 2007), Corlett (2007), Fallis (2007) and Staley (2007). See also Mathiesen (2007) for a brief but enlightening survey of the debate.

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them, they cannot be knowers. Yet, rejectionists like Wray argue that acceptance can be a base for knowledge (Wray 2007): even if groups do not have beliefs, they can possess knowledge in a proper sense. Thus, it is not necessary to settle the problem of group beliefs before dealing with collective knowledge.

I follow Wray in distinguishing the possibility of knowledge attribution from the possibility of belief ascription, although my argument is not based on a redefinition of the notion of knowledge, but rather on a reconsideration of the relation between social knowledge and individual attitudes. Thus, the definition of social knowledge of complex scientific results that I wish to articulate is inconsistent neither with believers' nor with rejectionists' accounts of group beliefs. Group beliefs and social knowledge are different phenomena which can coexist and which are connected with individual propositional attitudes in different ways. As List and Pettit (2011) point out, social knowledge is related to individual epistemic states, even though the former cannot be reduced to the latter. I argue that people working on a scientific project cooperate, and the interactions between them are complex phenomena, whose psychological and sociological components should be analysed for a full-blown explanation of the way in which membership influences the possibility of knowing.

In this paper I suggest that it is possible to analyse social knowledge of complex scientific achievements focusing not on collective beliefs, but rather on collective prior intentions and collective intentions-in-action as defined by Searle (1995, 2010). I will argue that if we focus on these forms of collective intentionality, which constitute the most basic level of social life, we are in a position to explain social knowledge and also how individuals can know complex scientific claims and know them as group members.

Scientific research, when directed to the achievement of complex experimental results, is necessarily a *collective activity* and, thus, should be observed through the lens of a theory of collective action.[3] On the other hand, scientific research gains its peculiarity by its goal which is an *epistemic* – or *truth-oriented*[4] – *common goal*. For this reason, epistemological considerations are appropriate, especially social epistemological ones.[5] My focus is the interrelation between these levels, but it should be clear that other questions are central

3 The most influential accounts of collective intentionality are those developed by Gilbert (1989), Searle (1990, 1995, 2010), Bratman (1992, 1993, 2010) and Tuomela (1992, 2000, 2004).

4 By saying that science is an 'epistemic - or "truth-oriented"' goal I want in no way to suggest that truth is the only epistemic virtue (see Fallis (2007) for a discussion of different collective epistemic goals). Although in the rest of the paper I often use 'truth-orientation of the goal' as synonymous of epistemic goal, nothing that I say entails a conception of science as exclusively aimed at discovering truth. I mean to suggest neither that science *always* has the truth as its *unique* goal, nor that science consists in knowledge production only. In the following sections it will become clear that the truth-orientation of scientific research is entirely compatible with the recognition that there are also other epistemic goals (often in conflict) and that scientists have non-epistemic individual goals as well. Truth-orientation in this weak sense is also consistent with instrumentalist conceptions of science. The requirement of truth-orientation captures the idea that science is epistemically distinctive with respect to other social practices: individuals involved in scientific research intend their activity as related to truth (or empirical adequacy), and also laypeople understand science as an activity aimed at discovering *facts* about the world.

5 There are different ways for socializing epistemology. A possible classification is suggested by Goldman (1999: 4–5) who lists three kinds of social epistemology: the first focuses on social routes to knowledge; the second focuses on group entities, although the knowing agents are still individuals; the third one considers collective entities as potential knowing agents. As will be clear in what follows, I am sympathetic with the second version of social epistemology.

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in a complete explanation of the phenomenon – especially, psychological considerations regarding the way in which people try to achieve individual and group goals simultaneously, and how membership shapes individual goals and desires (see Bacharach 2006).

My thesis is that some social relations between the individuals may influence their possibility of knowing. In particular, I focus on *membership in scientific research teams* and explain why there are cases in which the members of a team can know the collectively produced result, while non-members need further evidence in order to be justified in the same belief, and to come to know the result. I will also argue that the epistemic goal of the activity bestows a particular character to such social relations. Thus, membership plays an epistemic role only when combined with an epistemic common goal.

In the next sections, I distinguish three levels of interdependence in scientific knowledge-production, then I turn to a brief summary of Bratman's notion of shared intentionality (1992, 1993, 1999) which I will apply to scientific research teams with some modifications required to account for the epistemic character of the intended common goal. I also explain how truth-orientation may frame the trust relations between the members of the team. In the conclusion, I return briefly to the compatibility between my cooperative sense of social knowledge and non-summative accounts of social knowledge.

2. MEMBERSHIP AND COOPERATION. THREE LEVELS OF INTERDEPENDENCE

The first question we need to address is what makes a collection of individuals a collective to which an epistemic state can be attributed. In an interesting paper, Bird (2010) points out that in most cases the groups to which knowledge is attributed are those in which membership does not arise from an active commitment[6] but rather from division of cognitive labour, from interdependence, and from reliance on others' work. Collectivities formed in such a way are Durkheimian *organic groups* whose cohesion derives from *organic solidarity*: as a cell is part of a particular organism because of its *functional integration* in it, so an individual is a member of a group in virtue of her functional integration, that is, in virtue of her interdependence with the other members. Functional integration is not necessarily cognitive integration: an indirect consumer of knowledge (e.g. through technology) is also part of the society which has knowledge, and this kind of non-cognitive integration is very common. Division of labour only entails that each individual devolves to experts the responsibility for some cognitive activities, so that 'their activities, if of the right kind, suffice for social knowing, whether or not that knowledge is shared explicitly' (Bird 2010: 50).

It is worth observing that Bird attributes to non-epistemic relations, namely to non-cognitive dependence, an epistemic power: laypeople have social knowledge of scientific claims, just in virtue of their being members of a society. But is this sufficient for knowledge? Does membership in such a wide sense support an entitlement to accept anything that is stated by experts? I argue that it does not: although I agree that a particular kind of dependence relation gives such an entitlement, I also maintain that the dependence at issue must be of a special kind. The claim that membership in a community warrants complete reliance and trust has to be justified and not simply assumed: interdependence between the members of

6 The idea of an active commitment is central in Tuomela's and Gilbert's proposals. For example, see Tuomela (1992: 286) and Gilbert (2004: 9).

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a collectivity is a non-epistemic notion, so it is not trivial to say that individuals are allowed to use the propositions that are part of social knowledge *just* in virtue of their being members of the collectivity. Why and how does interdependence matter in knowledge attribution?

I suggest that a *shared intention* maintained by the members of a group with an epistemic common goal makes interdependence function properly in influencing knowledge attributions. Roughly, the idea is that there are cases in which the members of a research team are justified in believing the result they have produced collectively, even if they do not individually know the details of the project; in contrast, non-members need further evidence for being justified in believing the same conclusion. The reason is that membership in the team grounds the *trust relations* between the members, providing each of them with an entitlement to accept others' testimonies as true. Thus, membership matters in knowledge attributions when the group has a common epistemic goal.

Since cooperation in a scientific project and membership in a research team have this epistemic function, the issue of social knowledge of scientific claims has to be analysed considering differences in membership, i.e. differences in the degree of active cooperation of the individuals and in the degree of interdependence between them.

Membership may hold at different levels: scientists are members of society, but they are also members of the scientific community, and some of them participate in specific research projects, e.g. in the Large Hadron Collider project or the Human Genome project. Since being part of a research team with a specific goal – such as mapping the human genome – entails that certain interactions between the members are going to take place, the kind of interdependence that holds between the members of a team differs from the looser interdependence that is detectable in general between scientists that are experts in different fields, or in particular areas of the same field. Scientists typically do not work just as members of a research team, with the aim of realizing a common goal. They also have individual goals, which are often non-epistemic (e.g. earning reputation and money). An explanation of the way in which researchers interact cannot ignore this aspect.

The notion of social knowledge that my account tries to capture has scientific achievements as objects. Its subjects are individuals but – and this is the central point – only individuals considered as parts of a group, a collectivity, interdependent at the epistemic level. Knowledge is social as long as cooperation in its production and fruition is involved. For this reason, my approach is a cooperation-based account of social scientific knowledge and not a reductivist one.

Within the scientific community broadly considered, there is interdependence between members at the epistemic level, but the absence of a specific common goal makes reliance function differently. A complete analysis of interdependence at this level should also account for the presence of research teams working in competition: although they have the same goal, they do not work together, and their interactions are driven by extra-epistemic motives as well. In many cases, the competing teams differ in the strategies they adopt rather than in the goal they intend to reach, as for example in the competition between the government-funded team and Craig Venter's Celera for the sequencing of the human genome.[7] This aspect should also be accounted for, and contrary to what Wray (2002) maintains, I will suggest that social knowledge is present at this level as well.

7 www.ornl.gov/sci/techresources/Human_Genome/home.shtml. In particular, see the section 'The Human Genome Project and the Private Sector'.

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Finally, the issue of knowledge of complex scientific claims in society at large deserves a separate treatment, since most people lack the background knowledge that is necessary to understand a scientific result, and so one should also explain in what sense society knows things like 'The human genome has been mapped', or other statements describing complex scientific achievements and whose implications people cannot grasp. In this case, arguably, there is no epistemic interdependence between society and scientists, but rather laypeople are epistemically dependent on scientists.

These different levels of interdependence correspond to three distinct problems for a cooperation-based account of social scientific knowledge: (A) the *internal problem*, or how to explain social knowledge of a scientific claim within the research team that produced it; (B) the *intermediate problem*, or how to account for social knowledge of scientific claims within the scientific community; and (C) the *external problem*, or how to deal with knowledge of scientific claims in the society broadly understood. I will tackle each of these problems in the rest of this article.

2.1 A. *The internal problem*

I have already observed that scientific knowledge is produced via a collective activity, namely scientific research, which is characterized by cooperation between expert individuals – scientists and technicians – who collectively pursue an epistemic goal. Membership in a research group influences knowledge attributions in virtue of a *shared intention* maintained by the individuals involved in cooperative scientific research. When experts work together on a project, each of them does her part using her individual background knowledge and her expertise. The cooperation between them depends on shared intentionality.

The concept of cooperation can be grasped quite simply. Intuitively, people cooperate in a joint activity when they not only give their individual contribution to the common goal, but they also have a degree of awareness of the collective character of the goal and plan their actions taking into account the presence and the activity of the other individuals involved. A number of philosophers have provided accounts of cooperative activities, trying to explain how it is possible for people to cooperate and what kind of intentionality is involved in people doing things together. Bratman (1992, 1993, 1999) proposes an account of cooperative joint activities particularly apt to be applied to scientific research, although he has not addressed the issue directly until now.[8]

Bratman argues that a joint activity is cooperative if and only if it is performed by participants who have a *shared intention* and who are mutually responsive. According to Bratman, a shared intention is a state of affairs consisting primarily in attitudes of the participants and interrelations between such attitudes (1993: 104). We have a shared intention to the effect that we *J* if and only if:

(1)(a)(i) I intend that we *J*;
(1)(a)(ii) I Intend that we *J* in accordance with and because of meshing subplans of (1)(a)(i) and (1)(b)(i);

8 The relation between collective knowledge and science has been analysed by Gilbert (2000). Wray (2010) introduces a special issue of *Episteme* entirely devoted to this relation.

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(1)(b)(i) You intend that we *J*;
(1)(b)(ii) You intend that we *J* in accordance with and because of meshing subplans of (1)(a)(i) and (1)(b)(i);
(1)(c) The intentions in (1)(a) and (1)(b) are not coerced by the other participant;
(1)(d) The intentions in (1)(a) and (1)(b) are minimally cooperative stable;
(2) It is common knowledge between us that (1).

I will not engage in a detailed analysis of Bratman's conditions, but some considerations are in order. First, a shared intention involves *mutual responsiveness*. This means that I cannot treat my partner in the activity as an object in the world, but rather I have to consider him as an intentional agent. Moreover, cooperation can arise just in case the commitment toward the joint activity is common knowledge between us. According to Bratman, mutual responsiveness also involves a commitment to mutual support. The commitment to mutual support takes the form of a disposition to help. Since I intend a joint activity, the efficacy of your action is part of my intention and I have a rational pressure to help you do your part if the need arises. The intentions of the participants in the cooperative activity are thus *interlocked* (Bratman 1992: 335).

In most cases, the individuals involved in a joint activity also have individual goals that they intend to reach through the realization of the joint activity (*subplans*). Commitment to mutual support also means commitment to mesh our individual subplans. It is worth observing that in Bratman's account a cooperative joint action does not require to start or to end the activity with an agreement in the agents' subplans. All that is required is the possibility for the subplans to mesh, in the sense of their being co-realizable: 'our subplans concerning our *J*-ing mesh just in case there is some way we could *J* that would not violate either of our subplans but would, rather, involve the successful execution of those subplans' (1992: 332). The commitment toward meshing subplans ensures that each group member is committed and appropriately responsive to the coherent and effective interweaving of the planning agencies.

It is not particularly controversial to say that scientific research performed by teams is a cooperative activity in Bratman's sense, since this means that the members of the research team intend to perform the joint activity *J*, e.g. the particular research or experiment for which the team was formed. Individuals involved in the activity of a research team are aware of the existence of a common goal. Arguably, this awareness comes in degrees: principal investigators are probably more aware than the technicians who fix the apparatus. Yet, it is sufficient for the members to be aware of the fact that they are not simply acting individually to realize an individual intention but rather playing their part in the performance of a joint activity. It is not necessary for each member to know the details of the project: they just have to have an intention toward the realization of a joint activity whose goal is truth-oriented.

Although the definition of scientific research as a cooperative activity is uncontroversial, it is not sufficient either. There is, indeed, a feature of scientific research that differentiates it from other kinds of joint activities and which has to be taken into account for a complete explanation of social knowledge. This feature is the goal of scientific research, for it is a distinctive epistemic goal.

In order to appreciate the relevance of having an epistemic goal, let us consider Gilbert's example of a poetry discussion group, whose goal consists in expressing an interpretation of a poem (1989: 288–92). According to the original description of the example,

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the common goal pursued by the group is a doxastic one, since the interpretation of a poem is not strictly related to the discovery of an objective truth. Gilbert, indeed, maintains that whatever the decision of the group (in her words, whatever the *group belief*), each member can still have a personal belief about the issue that is inconsistent with the belief that she maintains as members of the discussion group. Group beliefs are not the sum of individual beliefs, and individual attitudes toward the proposition are not even necessary in the formation and in the maintenance of group views. If someone belongs to a group that accepts *p*, she is not required personally to believe *p*, but only to behave consistently with the belief that *p* in relevant contexts. For this reason, it is logically possible that individuals have individual beliefs that are inconsistent with the group belief that they accept as members of the group (Gilbert 1989: 288–94). The reason why Gilbert argues for the possibility of this inconsistency is that group beliefs depend on the mechanisms of their formation, that is, on the decision procedures endorsed by the group. In these procedures, individual beliefs are unimportant, because what matters are the public expressions of the group members (their votes). Their personal opinions and reasons cannot play a role – at least, not an explicit one. As a consequence, one may express a disagreement between personal and group beliefs by way of declaring that one is speaking *in propria persona*.

Let us now turn to the case of a scientific research team. By assumption, the group's goal is epistemic, and the group view resulting from the team's work is not intended to be a mere opinion, but rather it aspires to qualify as knowledge. Social knowledge differs from group belief because the legitimate expression of disagreement differs between the two cases. Although a member of the research team might say: 'We know that *p*, but I do not know *p*', such a statement could not express a genuine disagreement. Rather, the member would refer to the evidential support needed for the justification of *p*: the individual knows that the evidence that she possesses is not sufficient to justify *p*, while she also knows that the team – as a whole – is justified in believing *p*.[9]

There are more interesting cases of disagreement between individual beliefs and social knowledge when, for example, an individual believes that the group does not have enough evidence for justification (because the data are insufficient or have been misinterpreted, or the group has used inappropriate procedures to collect them). Such cases are expressed in a form like 'the team *believes* that we know *p*, but I do not believe that we know *p*'. In addition the individual may also hold 'I believe that non-*p*, but I know that I do not know non-*p*'. This formulation of the disagreement suggests that, when social knowledge is involved, interesting cases of disagreement must be expressed by weakening the social knowledge claim. In other words, the disagreement is moved to the realm of beliefs.

Although the above considerations do not imply that disagreement is impossible in the case of knowledge, they suggest that the application of Gilbert's account to social knowledge is not as straightforward as it might seem. Moreover, the analysis suggests that in order to distinguish social knowledge from mere group beliefs one should stress its *factivity* which, as in the case of individual epistemic concepts, is part of the distinction between knowledge and belief; moreover, the match between world and mind(s) is part of the

9 It is worth observing that, in the case of scientific research, if an individual could have a justified belief about *p* all by herself, then the group would be redundant. In the poetry discussion group this is not the case, since the group belief differs by individual beliefs in its content and in its psychological consequences.

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explanation of why we value (social) knowledge (see Williamson 2000 for a complete defence of this claim). The mere reference to the psychological attitudes and decision procedures that are operative in the formation of a group view cannot account for this aspect.

In what follows, I suggest that in defining social knowledge we can capture the central role of factivity by analysing how the truth-orientation of the common goal modifies the relation between individual and group beliefs. I include this aspect in the definition by modifying some conditions of Bratman's shared intentionality. In particular, I modify the commitment to mutual support and the disposition to help requirement.

In Bratman's analysis, the realization of a joint activity requires a disposition to help others since the intentional content of each participant also includes the efficacy of others' actions. Once one recognizes that scientific research has as its proper goal the production of knowledge, it follows that if the common goal is truth-oriented then members have *a rational pressure to tell the truth informatively to the other members* in order to facilitate the achievement of the common goal. If we pursue a truth-oriented common goal, and I deliberately lie to you when you ask for some information concerning our research project, I compromise the efficacy of your action. Thus, in the case of scientific research, when it comes to issues pertaining to the research activity, participants are committed to tell the truth – the whole truth – to the other members as part of the disposition to help others. If the participants in the activity do not have such a disposition to help others, the activity is not cooperative in Bratman's sense. If a participant in a scientific research project lies to other members, she is not cooperating and, therefore, she is not a proper member of the team. I name this condition *commitment not to lie.*[10] The commitment not to lie is mutual and is part of a network of commitments. There is also common knowledge of this network within the team, in virtue of common knowledge of the truth-orientation of the common goal. In other words, there is common knowledge of a general commitment not to lie to the other members – on issues pertaining to the research.

Common knowledge of this commitment has an interesting consequence on the role of testimony as a source of knowledge within the research team. If there is common knowledge of a net of commitments not to lie, than each member has a strong reason to accept other members' testimonies. In other words, she is entitled to accept the testimonies of other members, unless she has strong reasons not to believe them. This relaxes the requirement of independent epistemic reasons for accepting testimony advanced by reductive theories of testimony. At the same time, it weakens the non-reductivist claim that there is a general entitlement to accept testimony, which parallels the entitlement to accept perception.[11]

Testimony can be accepted as a source of knowledge in presence of a certain kind of trust between the audience and the speaker, as in Faulkner's hybrid theory of testimony. Faulkner (2000, 2011) maintains that the internalization of norms of trust and trustworthiness are sufficient to explain the rationality of trust. I propose a narrower claim, which is consistent with Faulkner's theory: if between audience and speaker there is interdependence and cooperation toward the realization of an epistemic common goal, then there is a complete entitlement to trust. Membership in a research team is a sufficient reason for members to trust each other; it gives an entitlement to each member to believe

10 'To lie' is intended broadly, to include the commitment to avoid omitting information: the members of the team are committed not only to tell the truth, but to tell the *whole* truth.

11 For a survey of epistemological theories of testimony, see Faulkner (2011) and Adler (2012).

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other members, to use their testimonies as evidence and to gain knowledge by way of accepting other members' testimony. In a scientific research team, the members have an entitlement to trust other members' testimony (regarding their areas of expertise) in virtue of their participation in a collective activity whose goal is truth-oriented.

One could object that the truth-orientation of the common goal is not sufficient for the entitlement to accept testimony because sometimes individual scientists pursue individual goals, rather than a common goal. Often individual goals have little or nothing to do with a disinterested love for the truth and are driven by incentives such as monetary reward and reputation. This fact certainly has to be accounted for when one tries to explain the functioning of a research team. It may seem that what I have said so far gives an excessive – and optimistic – emphasis on the common goal to the detriment of individual non-epistemic interests. But the notion of *meshing subplans* is central in accounting for this aspect. As Bratman observes, in a cooperative joint action it is not required that the subgoals of the participants agree, neither with each other nor with the common goal. The idea of subplans merely meshing may be applied in this context as well. It does not matter whether in participating in a research team I intend to gain reputation *as long as* this personal goal is not in contrast with the common goal. For example, my subplan of gaining reputation through a scientific discovery and the common goal of the research team I am a part of can mesh if I recognize that working in a team is better than working alone, with respect to my personal goal, and I am aware of the truth-orientation of the common goal. Since I know that liars are not accepted in the team, I may decide to cooperate and I may also decide to negotiate the amount of my personal gain (the degree in which my personal goal is achieved) in order to continue to be a member of the team. Achieving a mesh between the subplans might require bargaining and such bargaining involves the negotiation of individuals' benefits to some extent.[12] The possibility of a bargaining agreement allows accounting for those situations in which personal and collective goals are not directly co-realizable. A group might successfully pursue social knowledge also if some of its members are indifferent to truth – it is sufficient that they recognize the group's epistemic goal and decide to behave in light of this goal. It is not important that they make the epistemic goal their own goal: for example, they may adhere to scientific methods simply because they think that this is the best means to pursue their personal goals.

Let us attempt a formal presentation of the cooperation-based account of social knowledge of a complex scientific claim within the research team that discovered it.

Let $M = \{m_i\}$ be the research team, p a statement expressing a complex experimental result, J the collective activity of scientific research, and $E = \{e_i\}$ a set of true propositions such that their conjunction gives sufficient inductive support to p.

Given the respect of scientific procedures and an appropriate aggregation function,[13] there is social knowledge that p in M if and only if the following conditions occur:

12 Discussing completion and levels of mesh, Bratman (1992) uses the example of the game of chess. He argues that a competitive action is not cooperative in his sense; yet, he says, we can use the notion of meshing subplans to capture the idea that we are playing a competitive game in a cooperative framework: although we do not intend that our subplans mesh all the way down, we intend them to mesh at the level of relevant rules and practices. The same seems to apply to competitive research teams, and to strategic behaviour in general.

13 List and Pettit demonstrate the possibility for groups to track the truth reliably. In particular they show that, when the group members are specialists, the judgement aggregation function can satisfy this

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1. *Truth condition*: p is true.
2. *Interdependence*: (i) each m_i knows at least some e_i and (ii) it may be the case that no m_i knows E.
3. *Completeness*: every e_i is known at least by a m_i.
4. *Shared intention*: each m_i has the following attitudes:

   (A)(1)$_i$ m_i intends that M performs the truth-oriented joint activity J;
   (A)(2)$_i$ m_i intends that M does J in accordance with and because of meshing subplans of the other members;
   (B) The intentions in (A) are not coerced.
   (C) Each m_i has an intention toward meshing subplans and a disposition to help other members do their part.

5. *Common knowledge*: in M there is common knowledge at least (i) of condition (2)(i); (ii) of the shared intention and (iii) of the truth-orientation of the common goal.

Condition (1), the *truth condition*, is part of the definition of knowledge describing factivity: if p is false, it cannot be known – neither individually nor socially, whatever interpretation of social knowledge one endorses.

Condition (2), *interdependence*, specifies some features of the epistemic interdependence between the members of the research team. The first part of the condition, (2.i), states that each member of the team knows something (potentially) relevant to the research. This fact justifies each member's inclusion in the team: although we cannot know a priori what will be relevant, background knowledge and the specialization field are useful criteria for inclusion. If one did not know anything useful for the project, she would not have been included. Obviously, not everyone knowing (or, capable of discovering) an e_i or a proper subset of E is included in the team. There may also be overlaps in the subsets of E known by the members, for in many cases there are overlaps in background knowledge. If m_i and m_j knew exactly the same subset of E they would have the same background knowledge and arguably they would not be both included in the programme. In fact, while a certain degree of overlap is useful – e.g. overlap regarding some elements of scientific method, or overlap regarding some notions to facilitate discussion between members with similar background knowledge – a complete or too high degree of overlap is inefficient. In forming a research team one should avoid including an individual who does not know anything relevant to the research, and also avoid including in the team two members who know exactly the same subset of E.

The second part of the condition, (2.ii), is more a descriptive assessment than a prescriptive one. For one thing, if there is an individual capable of doing by herself all the work of a group (both in terms of background knowledge and of know-how), it would seem preferable not to form a team at all. Yet, this condition expresses a characteristic of cooperation: for cooperation to be genuine, interdependence is required. If there is someone who individually has enough evidence to justify p, teamwork loses its rationale. The knowledgeable individual would not be in an interdependence relation with the other

'epistemic desideratum' if the group's organizational structure satisfies three principles, namely 'democratization', 'decomposition' and 'decentralization' (see List and Pettit 2011: 97–103).

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members. Rather, the other individuals would simply rely on her. The result *p* would continue to qualify as knowledge, but not as knowledge collectively produced by a team. Yet, it is perfectly possible that in some circumstances someone might come to possess enough knowledge about the collected evidence and might also derive theoretical conclusions from it. Such a case would not disqualify the social element constitutive of knowledge.

The *completeness* condition (3) states that for *p* to be social knowledge the team, as a whole, has to possess sufficient evidential support to justify *p*.

Condition (4) has the structure of Bratman's analysis of shared intentionality, slightly modified to account for the number of participants (Bratman always refers to the case of a pair of agents) and for the truth-orientation of the goal. The intention toward meshing subplans allows accounting for individual non-epistemic subplans, and the truth-orientation of the common goal turns the disposition to help into a disposition to tell the truth informatively to the other members. For these reasons, the truth-orientation of the common goal frames the trust relations between the members, modifying the role of testimony-based knowledge in the team's context. The members of the team individually know the statement in question since membership gives them the entitlement to use other members' testimonies as evidence.

Condition (5) specifies the elements that have to be common knowledge in *M*. Common knowledge of (2.1) – the first part of the interdependence condition – entails that each member knows that every other member has been chosen to work in the team because of her competence; knowing that one's colleagues are competent in their fields is a precondition for trust. Common knowledge of the shared intention, (5.ii), is discussed by Bratman (1993). Common knowledge of the truth-orientation of the common goal (5.iii) is important because it specifies that it is not required for each member to know the details of the research in terms of goal and strategies adopted. All that is required is that each of them knows to be part of a team and that such a team pursues a goal which is truth-oriented. Knowing to be part of the team also entails that one knows how to communicate with others. Communication of pieces of evidence, processes of judgement aggregation and, finally, the assembling of an argument establishing *p* are necessary in turning the mere possession of evidence into proper knowledge.

The account of social knowledge developed in this section is individualistic, and avoids reductionism. Furthermore, the proposal overcomes the contraposition between believers and rejectionists, since group beliefs are no more part of the definition of social knowledge. Individual knowledge of parts of a scientific result, individual beliefs about the common goal (and common knowledge of these beliefs), attitudes toward cooperation (in the sense of having shared intentionality): these are the necessary elements for social knowledge. Since the social elements are necessary, the analysis is not reductivist, although it entails that group beliefs are not implied by social knowledge.

An individual who participates in the production of social knowledge can properly be said to have that knowledge. One might ask, quite reasonably, what happens in the case that a member leaves the group: why should we deny that people still have knowledge of the achievements? There are two different scenarios, determined by the kind of reasons that led to abandonment of the research team. In the first scenario, the motivation is non-epistemic, 'political' in a broad sense (e.g. transfer to other research centres, attainment of funds for other projects that are considered more interesting, etc.). When someone leaves a research team for non-epistemic reasons, our intuition is that she still has social knowledge. The present account accords with this intuition, justifying knowledge

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attributions in these situations. The reason for the correctness of such attributions is that in this scenario epistemic trust is still there, and epistemic trust is precisely what makes cooperation function properly. Only when this trust vanishes are we entitled to say that there is no more membership. This consideration brings us to the second scenario, that is, people leaving the research project because of epistemic reason, in particular because of disagreement regarding methodological issues in the work of the team. Only in this scenario is cooperation affected, and the activity ceases to be one of full cooperation within a research team; these cases may be better described in terms of cooperation and competition between different teams, where the degree and the possibility of cooperation depends on the severity of the disagreement.

2.2 *B. The intermediate problem. Cooperation within the scientific community and the role of competition*

Large research teams often tolerate a certain degree of disagreement between members, for example regarding the interpretation of experimental results or the appropriateness of certain methods. A research team is not necessarily a compact unit. Because of the heuristic potential of mutual criticism, disagreement is a powerful means to reach the truth. Nonetheless, a group can support only a limited amount of disagreement. Indeed, a condition for a group continuing to count and properly function as a group is that a sufficient level of agreement between the members holds.

The difference between being a group or not, thus, comes in degrees, and arguably it is not possible to quantify the threshold of disagreement precisely. Yet, it may be possible to identify it empirically: for example, if the participants accept to appear as the authors of a multi-authored paper published by the team, we can infer that the level of disagreement is not significant and that they are still part of the research team in question[14].

A significant decrease in the level of agreement has consequences for the entitlement to trust other members. Eventually, the problem ceases to be one of cooperation and interdependence *within* a research team and becomes more likely an example of interdependence between different, perhaps competing, research teams.[15]

The existence of a common goal shared by the participants in an experimental team marks the difference between knowledge held by the members of the team and knowledge held by other researchers. The reason is that, during the work of the team, the individual pieces of background knowledge are acquired and coordinated in an organized system. This practical cooperation has the consequence of changing the trust relations between the members, producing a special entitlement to accept other members' testimonies as true.

The functioning of science entails the publication of the results and also the possibility for other individuals (or groups) to rely on such results for the development of their work. Clearly, knowledge of scientific results also can be conveyed outside the team: scientists

14 This inference is clearly tentative, especially when applied to young researchers, because it ignores additional factors, such as the strong non-epistemic incentives to publish. Moreover, the level of agreement which one can infer from co-authorship is strictly related to factors such as the norms regulating authorship in different disciplines.

15 On the issue of the consistency of group beliefs, see List and Pettit (2002, 2011).

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who are not involved in a particular experiment and laypeople can come to know the result. What mechanisms make this transmission possible?[16]

Let us consider first the transmission of knowledge *within* the scientific community. The members of the scientific community are experts. Being members of the scientific community for the present purposes means having enough background knowledge to understand the result in its proper (technical) formulation and to be able to judge the reliability of the methods applied in the research. Moreover, being members at this level also entails sharing an intention toward a general common goal, that is, science's truth-orientation. Even in the absence of a particular common goal resulting in a collective action, there is a shared intention toward a general goal at this level, and membership plays its role in orienting individuals' actions.

The degree of cooperation is clearly higher in a group of people working together to perform an experiment than the degree of cooperation that holds in general within the scientific community. Nevertheless, there are clear signs of this second level of cooperation: for example, deciding to publish a result through 'normal' channels – instead of keeping it secret or using unaccepted methods – is a form of cooperation at the scientific community level, for it allows other scientists to use it as a basis for further work.

The interdependence condition is different from the case of a research team, for it is not required that each individual that is part of the scientific community plays an operative role. One must not necessarily know something relevant for the justification of each statement she knows, since one can simply rely on other members who know the justification, as long as she is justified in believing them. Not every member has an active role, and so interdependence functions differently; the resulting cooperation is looser than in a research team.

Yet, the truth-orientation condition is also present at this level and it shapes the trust relations. The shared intentionality scheme, then, might be used as part of the explication of the fact that while a biologist may accept a physicist's explanation without understanding the details, she would probably reject an astrologer's, or a creationist's testimony.

The general shared intention toward the truth-orientation of science has the structure of Bratman's shared intention. The difference from the case of membership within a research team lies in the *degree of mesh* between the subplans.

A scientist who does not participate in the activity of a particular research team is entitled to accept the final result as true, unless she has strong reasons to believe that the result has been achieved violating the truth-orientation condition of scientific method. The difference from the previous case is that she lacks a specific entitlement in trusting each member of the discovering team; she can rely on the group as a whole because of the truth-filtering mechanisms governing science and also because of the fear of sanctions for those who break the rules, such as the loss of reputation. The evidential justification of knowledge has as its part a social relation – membership in the scientific community.

A second aspect of the problem of knowledge transmission within the scientific community consists in the presence of competing research teams, simultaneously pursuing the same goal. Each team has its shared intention: although the shared intentions may have common goals with the same content, they differ in the individuals that are part of the team and, in most cases, in the strategies employed.

16 On the question whether groups are proper sources of testimony, see Tollefsen (2007).

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Contrary to Wray's (2002) claim, research teams are not the only possible collective subjects of knowledge and the reason is that science as a whole is a cooperative enterprise. The degree of cooperation due to membership in the scientific community allows for some forms of cooperation between the teams, in spite of competition. Cooperation usually concerns the use of common resources (such as data or apparatus), the swift publication of accurate reports in public repositories or journals, fairness in refereeing papers, and similar issues. The main evidence of such forms of cooperation comes from the fact that scientists agree to follow rules of scientific conduct, and are reproached if they transgress them.[17]

Obviously, cooperation at this level does not have to be complete. For example, a member of a team may know that the other team is using an inappropriate apparatus or method, and cooperation at this level does not entail that she should inform the competitors of this fact.

The notion of meshing subplans is useful to understand the reasons why cooperation and interdependence hold up to a certain degree; here the mesh holds at a different level, and allows teams to cooperate (by not lying), without impelling them to be entirely cooperative with the competitors at other levels.

2.2 C. *The external problem. Scientific knowledge in society*

The public understanding of science differs from proper scientific knowledge. The main reason is that, typically, laypeople lack the background knowledge which is required in order to be considered a scientist, or an expert, in a scientific field. As Hardwig (1985) observes, we must face the implications of the fact that laypeople do not fully understand what constitutes a good reason in the domain of expert opinion. In most cases a layperson reading a scientific publication would not even understand what it means exactly. For this reason, there are ways to contribute to the public understanding of science by way of *translating* the result in an accessible form. As has been argued by Goldman, laypeople

17 As an example, consider the case of Human Genome sequencing. Two research teams worked at the same time on this project; one of them was publicly funded, while the other was privately funded by Celera Genomics. According to an earlier agreement, the 'Bermuda Accord' (full text at www.sciencemag.org/content/291/5507/1192.full), each group should have pooled its data in a publicly accessible database within 24 hours of generation. Celera refused to deposit its data – even though they kept incorporating the public data into their map of the genome. This decision allowed Celera to publish the complete genome almost at the same time as the publicly funded team (in fact, a few days later), but also raised a debate about its fairness. The Bermuda Accord expressed some conditions to which teams working on the human genome sequencing should comply with, and this open statement is useful to understand a general feature of the competition/cooperation relation between research teams. The Accord stated some conditions for the data pooling in terms of time and accessibility, thus expressing the level of cooperation required in order to be considered part of the larger group of scientists working on the sequencing. Being part of this large group would confer the entitlement to use the data produced by other teams. When Celera decided not to publish its data in the required time, it should also have announced that it would not use the public database: by refusing to be part of the larger team, Celera lost the entitlement to rely on other members' testimonies. One might ask why they were still entitled to believe in the data published by their rivals. The reason is that their rivals were playing simultaneously another game with the rest of the scientific community that implied the publication of 'honest' data. Celera did not reject the common goal, but rather behaved like a free-rider. The rebuke that followed its behaviour suggests that a degree of cooperation consisting in the acceptance of common rules is normally assumed to hold between competing teams.

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epistemically depend on scientists for knowledge: 'even if laypersons also believe, e.g., that a certain type of vaccine will prevent polio, their knowledge obviously derives from science' (1999: 250).

I add that laypeople epistemically depend on scientists for knowledge of *simplified* claims, describing the main features of complex results in an accessible fashion. Even after the result has been made accessible to the non-expert audience, however, there remains a problem concerning public knowledge. Knowledge, indeed, requires justification and laypeople can neither acquire evidence in favour of a scientific result, nor in favour of the reliability of the source.

Bird's suggestion is that the non-cognitive integration within the collectivity justifies laypeople's reliance on experts' testimonies. How can non-cognitive integration play a role in knowledge justification? Society epistemically depends on scientists' work, and this dependence is justified by the public recognition of the truth-orientation of science. Even if laypeople cannot judge the reliability of the results, they know that there is a scientific community, a group of expert individuals committed to knowledge production. The *external* recognition of the general shared intention of science justifies laypeople's trust in science.

Formally, we may say that laypeople cannot really know the original, complex statement p. Rather, they know a simpler statement, p_S, which is entailed by p and which (i) can be grasped by them, (ii) expresses the main features of p and (iii) doesn't need experimental evidence for justification. The complete evidence for p_S is the fact that the scientific community states that p_S is true: laypeople's knowledge that p_S is not directly committed to the possession of evidence for p – although the first depends on the latter – but it is committed to scientific disclosure. Laypeople's knowledge of p_S depends on experts' knowledge that p.

The belief of the layperson is justified because she believes that science is veridically superior to other practices, and because she believes that scientists share a collective intention to achieve the truth. Thus, when a result is disseminated in a popularized form, laypeople are justified to believe this simplified claim because its complete justification is 'Scientists maintain that things are so and so'. Knowledge of the simplified version of the result depends on the original claim, for laypeople are justified in their knowledge just in case the original claim is true and justified. The recognition of a shared intention toward a truth-oriented goal allows one to build an epistemic characterization of dependence and trust.

The cooperation-based account of social knowledge of scientific claims within society is consistent with Goldman's observation that 'the existence of expertise can be inferred although the novice remains ignorant of the substantive ground of that expertise' (1999: 271).

3. CONCLUSION

The main aim of this paper has been to account for social knowledge of scientific achievements attributing a central role to cooperation in epistemic group activities. My proposal overcomes the dichotomy between summative and non-summative accounts of group beliefs, because it rejects the premise that Gilbertean group beliefs are a necessary element of social knowledge. In contrast with this premise, I have argued that we can explain the

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social character of knowledge in terms of shared intentionality toward an activity with an epistemic common goal. Social knowledge of scientific achievements can be explained by the cooperation-based account that I developed in the central sections of this paper. As a first step, I have distinguished cooperation within a research team from cooperation between different teams and from laypeople's fruition of scientific results. Then, I have analysed the intentional structure which characterizes this activity, using Bratman's definition of cooperative activity. The truth-orientation of the common goal turned out to be central in accounting for the activity and also in framing the relations between the individuals involved in the activity, in a manner which differs in the three cases of cooperation/interdependence analysed: in a scientific research team and in the scientific community, the pursuit of a common goal justifies each member's trust in the other members; in society, common recognition of the common goal is part of the explication of laypeople's epistemic dependence on the experts.

A central element of the shared intention is the notion of meshing subplans: by way of it, the degree of disagreement within and outside the research team can be accounted for, while continuing to consider the team or the community as unities whose members pursue common goals.

Cooperation is a crucial element in my proposal, since it allows distinguishing a mere collection of individual pieces of knowledge from proper social knowledge: there is social knowledge just in case there is cooperation between the individuals whose background knowledge is coordinated in a system. Absence of cooperation is explicated by the absence of a shared intention.

My approach to group knowledge is not reductivist. The phenomenon that we call 'social knowledge' is real rather than metaphorical, and its existence depends on cooperation between people. An individual, intended as an agent in her singularity, cannot have social knowledge. Yet, I think that social scientific knowledge is better explained as held by individuals cooperating in a research team. Social knowledge understood as a mere group view cannot do all the work we expect knowledge to do. Group belief formation is an interesting phenomenon of our life as social beings, yet it has little to do with social knowledge.

When we attribute knowledge to groups or societies we refer to a feature which grounds the possibility of knowledge and which determines which individuals are entitled to knowledge. Social relations have *epistemic power*, in the sense that they may be part of the warrant of certain beliefs and knowledge. Trusting a colleague gives a scientist the very possibility to know certain statements. The social mechanisms that govern the production and the fruition of knowledge are crucial to understand the functioning of contemporary science.

The social production of knowledge influences the attributions of individual knowledge, and grounding in the social structure of team work is essential: without such a grounding, a lot of claims could never be known. Scientific research, as a truth-oriented group activity, is shaped by the coexistence of social and epistemic elements, and its analysis reveals the connection of epistemological and sociological issues. A complex analysis – one drawing from each of these disciplines – is desirable.

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