



Wholes as networks

Touts comme réseaux

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Abstract. In this paper we argue that there are different kinds of collective readings, which require different kinds of explanations. We analyze the case of "collectivity as pure dependence", illustrated by the example: *John and Mary are walking along the beach*. This is characterized by the fact that the collective event is nothing but the coordination of two particular events.

We show in detail that theories of wholes as sums and of wholes as unities fail to grasp this specificity and we propose an alternative account in terms of wholes as networks. We make the hypothesis that two entities can be considered as forming a network if they entail each other via their properties. The notion of property constraint and possible state spaces allow us to distinguish cases of accidental association (distributive interpretation) and non-accidental one: given prior knowledge of the speaker, the first one corresponds to the observation of a given situation, the second, to the predication that the speaker does about its future developments.

This account is semantically based and pragmatically driven: individual-level properties and definitory localization are entailment-proof properties, which resist constraint application. It would be informationless to know one entity in a definitory manner and, at the same time, to epistemically link its properties to the properties of another entity. On the other hand, whenever a property is available for constraint application this is enhanced only by contextual information.

We extend this account to cases of reciprocity and argue that the reciprocal relation can be analyzed into two converse properties which entail each other in such a way that if one entity satisfies one side of the reciprocal relation, there exist another entity which satisfy the converse in a non-accidental way. This underspecified instruction is instantiated into different configurations.

We finally show that the lexical items *together* and *with* differently instantiate the notion of collectivity as pure dependence, and argue that symmetrical-with instantiates it prototypically.

1 Introduction. Collective interpretations and kinds of wholes

In the literature of the last thirty years on pluralities, the abstract notion of group has been explained in the light of two contrasting conceptions of wholes: wholes as sums and

wholes as unities. In this paper we test these two conceptions of wholes on the case of "collectivity as pure dependence", illustrated by the following example:

(1) John and Mary are walking along the beach

For a unique situation - two people following exactly the same trajectory - (1) can be interpreted either distributively (John and Mary are two people walking accidentally side by side along the same trajectory) or collectively (John and Mary are walking together along the same trajectory). The main difference between these two interpretations is that, in the first case, the association is seen as accidental and, in the second, the association is seen as a regular link between the trajectories of John's walk and Mary's walk.

The specificity of this case of collectivity is that both the group and the members have to be held within the representation: each of the members walks, and they also walk collectively. To put it in other terms, the individuals form a group in the very act of walking.

We claim that neither the conception of wholes as sums nor that of wholes as unities properly explain the sources of collectiveness effect for "collectivity as pure dependence", and we elaborate a third notion of whole: whole as network, or "dependency without whole".

Before we demonstrate in detail why the existing theories do not properly account for this particular case of collectivity and we present an alternative explanation, let us provide, in this introduction, a general outline of the argument.

Since Plato and Aristotle¹ there have been two contrasting conceptions of wholes:² wholes as sums and wholes as unities. The last century's renewed interest in the formal relations between parts and wholes has endorsed these two contrasting conceptions,³ which have entered the more recent literature on pluralities, particularly with respect to the sources of the togetherness effect, the collectivity criterion and the distinction between distributive and collective readings⁴.

¹Plato, *Theaetetus* 202e-205e, and particularly 203c-205a; Aristotle, *Metaphysics*, especially book Z Chs. 10,17; book H Ch.6.

²Unless explicitly stated otherwise, we use "whole", "parts" and "components" in pre-theoretical terms: a whole is an entity which comprises parts or components.

³See [Russell, 1903, pages 137ff] for the contrasting distinctions between sums and unities, called, respectively, "aggregates" and "unities"; see [Frege, 1884], [Goodman N., 1951], [Leśniewski, 1916], [Lewis, 1986] for conception of whole as sum; see [Nagel, 1952], [Simons, 1987], among many others, for theories of wholes as unities. The notion of unity is strictly related and largely inspired by that of "organic unity" [Husserl, 1901], and shares its essential features with that of "Gestalt" [Wertheimer, 1925].

⁴For theories of groups as sums, see [Link, 1983], [Schwarzschild, 1996], [Lasersohn, 1995]; for theories of groups as unities, see [Link, 1984], [Landman, 1989b], [Landman, 2000], [Moltmann, 1997].

On the first account, wholes are coextensively identified with their parts⁵ and sum is a necessary and sufficient principle of composition without any additional coherence relation nor any ontological dependency among the parts summed together.

On the second, wholes are seen as monads distinct from their components. There are at least two foundational views of wholes as monads. Under the Aristotelian account, the monad exists by virtue of ontological dependencies among the parts. Under the Platonic account, the monad has an ontological life independent of its parts and their relations. To sum up:

- *Whole as sum (classical mereology)*. The whole is coextensive with its parts. Sum is the necessary and sufficient operation of composition. No coherence relations supervene the sum of the parts.
- *Whole as sum/unity (neo-classical mereology)*⁶. The whole is coextensive with the sum of its parts, but the parts are linked by coherence relations.
- *Whole as unity*. The whole is not coextensive with the sum of its parts but it is an abstract entity *per se*, a primitive.

In this paper we are concerned with the collective interpretation of singular⁷, distributive predicates, which we will be referring to as "collectivity as pure dependence". Let us clarify what cases are at stake.

Unless explicitly established, it seems that, at least on a descriptive level, there are different kinds of collectivity.

(2) a. *Collectivity as collection.*

⁵Under the label "wholes as sum", we comprise here the notions of whole as distributive and whole as a collective class introduced by [Frege, 1895] and reinterpreted by [Leśniewski, 1916]. The major formal difference between Fregean distributive and collective classes lies in that there exist two ways to belong to the first class: as a member or as a subclass, whereas for collective classes components are comprised only as subclasses. What these two kinds of classes have in common is that they are both collections - concrete or abstract - of entities, and are completely coextensively identical with the entities they comprise.

⁶We borrow the labels of "classical mereology" and "neo-classical mereology" from [Meirav, 2003] who provides a very convincing grid of interpretation of ancient and modern theories of wholes.

⁷Predicates are said to be singular if they denote individual, atomic entities [Landman, 2000].

The cards from one to seven and the cards from eight to ten were separated.

- b. *Collectivity as team credit.*
 - i. "Credit as measurement". John and Mary earn 5000\$
 - ii. "Credit as collective responsibility". The gangsters killed their rivals
 - iii. ...
- c. *Collectivity as pure dependence.* (= 1) John and Mary are walking along the beach.

This categorization is certainly not exhaustive, but it allows us to individuate the particular cases we are interested in phenomenologically, and to identify their specificities with respect to the most important concurring cases on which theories of groups generally focus.

In (2a) the cards from one to seven and the cards from eight to ten are seen as two heaps⁸. They form two collections of cards.

In (2b) the individuals are seen as contributing for the benefit of the group ⁹.

Finally, (2c) is different from the others in two respects: on the one hand, it requires that there exist some coherence relations between the walks of the participants (collections do not); on the other hand, it is a case where, even under the collective reading, both of the participants have to necessarily satisfy the property (members of a team do not).

Note, moreover, that each of the sentences in (2b) and (2c) can be interpreted either distributively or collectively: (2bi) can either mean that John earns 5000\$ and so does Mary, or that they earn 5000\$ together; (2bii) can either mean that each of the gangsters has killed one (or more)¹⁰ of the rivals or that some gangsters have killed some rivals, bearing collective responsibility for the group; finally (2c) can either mean that John and Mary walk accidentally side by side, or that they walk "as a group". It is also possible to interpret (2a) in different manners, according to whether every card of every subcollection has been separated from every other card of the same collection or not.

When talking about theories of wholes as sums and wholes as unities, we are by no means suggesting that the notion of sum applies to distributive interpretations and that of unity to the collective one. The notion of sum is used to explain the notion of group¹¹.

⁸This terminology has been introduced for the first time by Aristotle, in the *Metaphysics*, cf. note (1). The term "heap" (*soros*) contrasts with "essence" (*ousia*), referring respectively to collections and monads.

⁹No matter whether John and Mary do form a couple, as far as their salary is concerned, each contributes to the final sum.

¹⁰We consider here only the subject position.

¹¹See note 4.

The classification we have proposed strongly suggests that every case of collectivity calls into play a different notion of group, and that, probably, the notion of sum will fit to cases for which that of unity will be inappropriate, and vice versa.

Our aim, in this paper, is to explain the notion of collectivity as pure dependence ((2c) = (1)), and to find out what notion of whole, and of group, is needed. It is outside the scope of this work to establish what theory of whole fit what cases of collectivity.

Strikingly, in the literature on pluralities, it is often the case that once a particular view of wholes has been chosen, it is used to explain all the possibilities. Indeed, none of them is appropriate to explain the cases of "collectivity as pure dependence". Nevertheless, all contribute some crucial features. Given the variety of collectiveness effect, this is not surprising: "collections", "unities as primitive" and "sum plus dependency relations forming a unity" are distinct but interrelated notions that underlie distinct but interrelated representations of wholes. Our aim is, then, to individuate the components of the mechanism underlying the "collectivity as pure dependence". If none of the existing theories is ready for use, all present some crucial elements.

The first part of this paper (3) is dedicated to showing why the notions of sum (classical mereology account), sum plus dependency relations (neo-classical mereology account) and unit are all inappropriate to explain this particular case (1).

Theories based on the notion of wholes as sums would represent cases of "collectivity as pure dependence" as in (3a). Theories based on the notion of wholes as unity and sum/unity would instead provide representation (3b).

- (3) Collective interpretation for (2c)
- a. Whole as sum : $\text{walk}(\{\{\text{John}\} \sqcup \{\text{Mary}\}\})(\{\{e_1\} \sqcup \{e_2\}\})$
 - b. Whole as unity : $\text{walk}(\{\{\text{John}\}, \{\text{Mary}\}\})(e_3)$

Note that most of the theories are based on a neo-Davidsonian [Parsons, 1990] account of event structure. They assume an homomorphism between the individuals in the scene and the events in which they are involved in such a way that the questions what kind of group and what kind of event are in fact the same¹².

Authors explaining collectivity in terms of sum ([Link, 1983], [Schwarzschild, 1996], [Lasersohn, 1995]) would claim, informally, that an event is collective if it is identical to the sum of its sub-events, or, in other terms, if it is sub-structured into two sub-events which compose it.

¹²Unless explicitly stated otherwise, the term *entity* will be referring to both *individuals* and *events*.

Authors subscribing to the second option ([Link, 1984], [Landman, 1989b], [Landman, 2000]) would claim that the group is a unity, blind to the composing sub-events. This conclusion is also endorsed by neo-classical theories of sums ([Moltmann, 1997], based on [Simons, 1987]), which consider that parts summed together by virtue of dependency relations do form a unity.

The distinction between theories of wholes as sums and of wholes as groups is, in principle, transversally characterized by that between extensionality and intensionality. Nevertheless it is very often the case that sum - especially when it is seen as free from any dependency relation - is seen as an extensional operation, where monads are seen as appealing to intensional properties. This is due to the fact that the notion of whole as sum is based on principles of coextensiveness and of identity between whole and its parts and that these principles do not hold for wholes seen as unities.

We show that these two models for wholes are inappropriate for the collective interpretation of (2c).

On the one hand, accounts of wholes as sums subscribe to the principle of *universal existence of sums*. Consequently, they cannot establish a clear distinction between the distributive reading in which two persons are *accidentally* walking side by side¹³ and the collective one.

On the other hand, accounts of wholes as unities, being blind to the properties of the parts and their ontological dependencies, compel us to a too strong ontological claim¹⁴. In (1), it is precisely by virtue of the fact that each individual is walking that they walk collectively.

Finally, theories of wholes as sums plus dependency relations are liable to the same conclusions as theories of wholes as pure unities. These accounts have been criticized in depth on a philosophical basis¹⁵. On a linguistic ground, it appears that, when they define distributivity and collectivity, they are compelled to subscribe to the principle of non-accessibility which turns out to be very infelicitous when it is applied to (2c). This principle states that the collective event is ontologically independent of the sub-events which constitute them and these are not kept as independent entities in the representation of the collective event. Indeed, under the collective interpretation for (2c) the collective event-argument (if there is one) is sub-structured into two or more sub-events.

In the second part of the paper (4) we propose a new account for "collectivity as pure dependence" cases and we elaborate the notion of *wholes as (epistemic) networks*. On this view, the whole is nothing but a set of interrelated events, without being itself a unity,

¹³Very likely, in fact, that they can only explain the notion of group as collection.

¹⁴They seem to capture the notion of team credit more accurately.

¹⁵[Meirav, 2003, chapter 7]

or an integrated object hiding the access to its parts. This view allows us to retain two elements which seem to characterize the togetherness effect specific to (2c):

1. there exist strong dependency relations among the parts, and
2. the members are accessible, i.e. the collective event is nothing but the interrelation of sub-events. To put it another way, there is not an ontologically independent collective event. For (1), it is precisely to the extent to which they are involved in an event of walking that they walk collectively.

Crucially, the notion of whole as network is grounded on epistemic constraints that the speaker establishes among descriptions of events. Given an event and a certain property, if, given the previous knowledge of the speaker, this property provides certain information about the properties of another event, then these two events form a network. The network is thus an epistemic construction.

Even more importantly, this epistemic construction takes the form of a valid inference, or a counterfactual reasoning [Lewis, 1973]. The collective / distributive distinction can be formulated as a distinction between a regular vs. accidental association. The notion of regularity is captured by a rule of interpretation which links, in all possible worlds, the descriptions of the events that are seen as interrelated.

We will be arguing that this rule is semantically constrained and contextually driven. On a semantic level, the properties of the entities play a crucial role, constraining and limiting the cases of construction of wholes: contrary to the universal existence of sums, not every property allows to build a "collection as pure dependence". The establishment of a network, on the other hand, is dependent on context and on the speaker's previous knowledge.

Finally, this account has some important consequences. First, the epistemic constraint linking two events via their properties by an entailment reinterprets the distinction between individual-level and episodic-level [Carlson, 1977]. properties as constraint proof properties and non-constraint proof properties. Second, the model sheds new light on the notion of localization, introducing a distinction between processive and non-processive localization. Third, it can be extended to cases of reciprocity, capturing the under-specified notion which seems to underlie every possible configuration of reciprocal statements and which is not based on symmetry. Finally, it is a starting point for a complete lexical semantics of *together* and *with*.

The paper is structured as follows. In section (2) we state the legitimacy of the question, claiming that (i) "collectivity as pure dependence" is compatible with singular predicates, (ii) there is no set of well established descriptive criteria that allow to identify

the conditions for the collective interpretation, (iii) some generalizations are nevertheless possible (in particular, individual-level properties are incompatible with the notion of "collectivity as pure dependence"), (iv) frequency adverbs can improve the acceptabilities with individual-level properties, (v) co-localization is not a necessary nor a sufficient feature for the collective interpretation, and, finally, (vi) definitory localization is incompatible with the collectivity reading.

In section (3) we discuss formal theories of wholes as sums (3.1) and of wholes as unities (3.2) in turn. We begin by considering models of wholes as sums based on classical mereology principles (3.1.1) and then theories (3.1.2) of wholes as sums which integrate a pragmatic component. We conclude that, insofar as they subscribe to the principle of universal existence of sums, these theories cannot grasp the difference between the pure accidental, distributive interpretation of (1) and its collective interpretation. The introduction of pragmatics is certainly a major move which deserves further development. Subsequently, we consider theories of wholes as unities (3.2). Models based on a notion of group as atoms (3.2.1) retain the crucial information that each of the members has to satisfy the property, or in neo-Davidsonian terms, that the collective events are sub-structured into accessible sub-events. The so-called¹⁶ neo-classical accounts ([Simons, 1987], [Moltmann, 1997]) are liable to the same criticism (3.3). We conclude the first part of the paper by summing up the elements of the togetherness effect for "collectivity as pure dependence" (3.4).

In the second part of the paper (4) we develop the notion of whole as network. This notion is loosely inspired by the Nietzschean theory of organic unity and by [Shusterman, 1988] who first introduced this terminology. We begin by providing an informal account (4.2), we argue that the notion of "whole as network" is semantically constrained but pragmatically driven (4.3) and then we develop a formal model for the notion (4.4). The founding notion of informational dependence ([Dretske, 1981]) is instantiated as an entailment between descriptions provided by the agent. The regularity (vs. accidentality) characterizing the "collectivity as pure dependence" cases requires possible world based semantics and strongly relies on counterfactual reasoning ([Lewis, 1973]). The explanation that we provide is pragmatically driven and semantically constrained. It is steadily grounded on the notion of property and descriptions whose material is uniquely provided by the predicate.

We come back to the data in section (5) where we discuss, in turn, cases of definitory and non-definitory co-localization by introducing the notion of "processive localization" (5.1) and the distinction between individual and episodic level predicates that we interpret as constraint proof and non-constraint proof properties (5.2).

¹⁶[Meirav, 2003, chapter 7]

In section (6) we show how the formal definition of "comitativity as dependence" extends to cases of plural, non-conjoined NPs, and to reciprocity. We assume with [Higginbotham, 1980], [Schwarzschild, 1996], [Gillon, 2003] and many others that the semantics of plurality and reciprocity are strictly related, and we show that the model generates an underspecified representation for reciprocal configurations [Langendoen, 1978], [Dalrymple et al., 1998]. We finally consider in section (7) how the general definition of the collectivizing operation is instantiated by the lexical items *together* and *with*.

2 Descriptive criteria for the "collectivity as pure dependence" interpretation

In principle, singular predication is incompatible with collective interpretation, in the same way as some plural predicates apply only to groups (for instance *be numerous*). Let us cite [Lasnik, 1995, p. 142]. With respect to sentence *The children are asleep* the author claims:

"... is not ambiguous between one reading where the individual children are asleep and another reading where the group of children somehow sleeps independently of its members".

This leads us to make the hypothesis that different cases of collectivity behave differently with respect to singular predication.

If one subscribes to the view of "wholes as collections", Lasnik's observation no longer holds. It is correct, however, if one considers groups as monads or groups as a set of dependent elements.

Landman [Landman, 1989a], [Landman, 2000] also states that distributive predicates never take groups in their denotations. He recognizes, however, that there are some cases of collective responsibility which supervene to the distribution of properties. For instance:

(4) The journalists asked the President five questions

can be interpreted collectively even in the case where each journalist asks the President five questions. The journalists are seen as belonging to the body of the press, so that each has a collective responsibility with respect to the body.

The data we are about to present show that distributive predicates are, in some cases, compatible with the interpretation of "collectivity as pure dependence".

It is very clear, then, that the semantic notion of singular and plural predication does not constrain by itself the possibility to interpret the sentences distributively or collec-

tively. Schwarzschild¹⁷ states that plural predicates are not ambiguous, but that their interpretation as distributive or collective is context-dependent. This view can be extended to *some* cases of singular predication. Some distributive predicates provide the necessary material not only for team credit interpretation but also for "collectivity as pure dependence".

This claim immediately requires us to investigate by virtue of what criteria singular predication can give rise to a "collectivity as pure dependence" interpretation. Let us consider some data. For each case, if the *with*-paraphrase is possible, then the "collectivity as pure dependence" interpretation is considered to be available for the particular singular predication¹⁸.

1. Amovibility of the entities seems to be a necessary condition.

- (5) a. The glasses and the decanters are in the cupboard
 → The glasses are in the cupboard with the decanters
 b. The cottage and the lake are on the top of the hill
 → The cottage is on the top of the hill and the lake is on the top of the hill
 ↯ *The cottage is on the top of the hill with the lake¹⁹.

The impossibility to interpret (5b) collectively could be ascribed to the underlying zeugma: the cottage is a (relatively) movable entity but the lake is not. Nevertheless:

- (6) a. The forest and the lake are on the top of the hill

¹⁷[Schwarzschild, 1996, p.57]

¹⁸In this section, "→" means: "can be paraphrased by". One should wonder why *with*-paraphrases should be preferred to *together*-paraphrase. There are many reasons that will become clear at section (7). Shortly, we can mention that there is a semantic difference between the adnominal and adverbial *together*. Both might be used to paraphrase different cases, which would lead to confusion. Moreover, even choosing to use only the adverbial (more process-oriented) *together*, one would encounter some difficulties. It seems that *together*-adverbial captures the notion of dependence to a lesser extent than *with*: it tolerates the temporal concomitance provided that the entities occupy a symmetric position with respect to the property. Insofar as we want to capture here a notion of dependence, *with* seems more appropriate insofar as it seems to introduce a notion of influence or, more generally, of causal relation. Nevertheless, one should be careful not to confuse *with*-paraphrases and the lexical item *with*. There are cases of collective interpretation that are allowed by lexical *with*, but not by conjoined *NPs*. We can assert, for instance: *The president is making the declaration with his bodyguards* but we cannot interpret *The president and the bodyguards are making the declaration* as a case of "collectivity as pure dependence". In fact *The president and the bodyguards are making the declaration* cannot be appropriately paraphrased by *The president is making the declaration with his bodyguards*, nor *The president is making the declaration with his bodyguards* entails that *The president and the bodyguards are making the declaration*. *With*-paraphrases simply provide us with an illustration of the notion of "dependence". Note also that *with* and *together* have a different meaning because *The president and the bodyguards make the declaration together* cannot be interpreted in the same way as the *with*-sentence. See section (7).

¹⁹The "↯" signals that the "collectivity as dependence" interpretation is not allowed; "*", "??" and "?" signal, respectively, that *with*-sentence is semantically not acceptable, very odd, and odd.

→ The forest is on the top of hill and the lake is on the top of hill
 ↗ *The forest is on the top of the hill with the lake

Amovibility is not sufficient by itself, however.

- (7) John and Chirac are in Paris
 → ?? John is in Paris with Chirac

(7) cannot be interpreted as a case of "collectivity as pure dependence" if John lives in Paris and Chirac is in Paris as one would normally expect from the President of the French Republic.

2. On the other hand, even though co-localization is generally assumed to be a necessary and a sufficient condition for the collective interpretation, (5) shows that the co-localization does not by itself allow the collective reading. Moreover, it is not even necessary:

- (8) John and Mary are talking on the phone

3. Collectivity as pure dependence, though, does not require that the entities act together (5a). A proper definition of the notion of "collectivity as pure dependence" will have thus to state the conditions according to which two entities occupying the same position at the same time and which do not interact can be seen as associated.

4. Finally, temporal simultaneity is also not necessary.

- (9) The local police and the FBI work to trace the criminal
 → The local police and the FBI collaborate to trace the criminal

Under the collective interpretation - i.e. the local police and the FBI collaborate - (9) does not entail that the local police and the FBI work simultaneously, but only that they work on the same issue, tracing the same criminal.

At this point one could conclude that there are no criteria establishing under what conditions the "collectivity as pure dependence" reading is possible with singular predication.

Nevertheless, there are some generalizations. In particular, it is easier to state under what conditions the "collectivity as pure dependence" is forbidden.

5. This collective interpretation is not compatible with any kind of singular predication.

- (10) a. John and Mary are pop stars
 ↗ a'. *John is a pop star with Mary
 b. John and Mary are sad
 ↗ b'. ??John is sad with Mary

Individual-level properties [Carlson, 1977] are incompatible with "collectivity as pure dependence". (10a) cannot be interpreted as (10a'), and (10b) cannot mean that John is sad, Mary is sad, and that they are sad together. We discard the interpretation under which Mary is the cause of the sadness of John.

Note that in some cases, a frequency adverb can improve the acceptability (e.g. 10b):

(11) [?]Every time that John is sad, he is sad with Mary

Again, there exist two interpretations. Either Mary is the cause of the sadness of John, or every time that they are sad, they are sad together. The interpretation that is totally impossible for (10b') timidly emerges for (11).

7. Co-localization deserves closer attention. If it is correct that amovibility is not sufficient to give rise to a collective eventuality, when two entities are non-movable, the association is clearly impossible. This observation is to be somehow correlated with (10).

One way to rule out this set of data is to admit that there is no event argument for individual-level properties [Kratzer, 1995]. Definitory localization can be considered as lacking an event argument as well, and by consequence, it would not be relevant for any account based on events.²⁰

Nevertheless, the hypothesis that individual-level properties lack an event argument is not enough to discard them as irrelevant.

Firstly, it is true that individual-level properties behave very much like some other predicates which do not lack the event argument, but which are incompatible with "collectivity as pure dependence":

(12) The children are asleep

Collectively, (12) can be interpreted as a case of "collectivity as collection".

Secondly, individual-level properties are only incompatible with "collectivity as pure dependence", but not with the other cases of collectivity. Consequently, whether or not accounts of collectivity do use the event argument, they have to take into account these data²¹. In particular, individual-level properties:

(i) can function as minimal relations among the members of a collection:

(13) The blond and the brown-haired met in different rooms

²⁰Particularly for *with*-sentences, this hypothesis seems to be strengthened by the fact that, as soon as the spatio-temporal parameter is introduced into the situation, the sentences become more felicitous. *John is elegant with Mary* cannot mean that John is elegant, Mary is elegant and that they are elegant together, but only that John *behaves* elegantly in relation to Mary.

²¹These data are in fact considered by the following authors, whether they subscribe to a neo-Davidsonian approach to individual-level properties or not: [Schwarzschild, 1996], [Landman, 2000], [Moltmann, 1997], (among many others).

(ii) can function as the glue which introduces a perspective on individuals as a group behaving as a team (14):

(14) My colleagues, as senior researchers, have been talking the whole day with the Chair of the department

Finally, it is not really clear why non-movability should entail a lack of event argument. Insofar as the behaviors of individual-level properties and non-movability with respect to "collectivity as dependence" seem to be similar, they probably appeal to a unique reason.

Crucially, we have to explain why these are incompatible with only one species of togetherness effect, the cases of "collectivity as pure dependence", but not with the others. The definition we will provide for this notion will have to generate only the acceptable cases.

Nevertheless, before we present our account in section (4), let us consider whether the existing models of wholes as sums and wholes as unities properly explain the data we have presented here and whether they capture the phenomenological specificity of the cases of "collectivity as dependence", namely that *a group exists by virtue of some coherence relation among the parts*.

3 The elements of "collectivity as pure dependence"

In this section we consider theories of wholes as sums (3.1), theories of wholes as unities (3.2) and theories of wholes as sums and unities (3.3). We show that none of these can be used to explain the "collectivity as pure dependence" cases, but all present some elements that we will integrate into our model. As we stated in the overview, this is not surprising: it turns out that theories are appropriate for a certain conception of wholes, but not necessarily for all the cases of collectivity. We conclude this section by summing up the features that seem to be needed to explain cases such as (1).

3.1 Wholes as sums

Algebraic approaches subscribing to the conception of wholes as sums use operations of mereological sum or set union over a domain of eventualities or individuals. They do recognize the axioms of *closure* (15a) and *uniqueness* (15b).

- (15) a. Closure: A is closed under the operation \circ , i.e. for any $a, b \in A$ there is an element $c \in A$ such that $a \circ b = c$
- b. Uniqueness: If $a = a'$ and $b = b'$ then $a \circ b = a' \circ b'$

On this view, groups are not considered as being of a different nature from the members which compose them and, very importantly, sum and composition are the very same operation²².

(16) u is a sum of $x_1, x_2, \dots, x_n =_{def}$ for all y , y overlaps u if and only if y overlaps one of the x s

(17) x_1, x_2, \dots, x_n compose $u =_{def}$ u is a sum of x_1, x_2, \dots, x_n

This means that there are no extra relations other than sum of the parts which compose a whole. It follows that wholes as sums are perfectly coextensive with their parts²³:

(18) *Coextensive determination.* Wholes are coextensively determined if and only if for all u , for all v , for any x , for any y , if u is a whole which corresponds to the x , v is a whole which corresponds to the y , then u is identical to v only if the x s are coextensive with the y s.

Finally, the notion of sums brings with it the principle of universal existence of sums:

(19) Whenever we specify individuals, some individual exists which is a sum of those individuals.

In the following subsections, we discuss two theories. The first (3.1.1) interprets the set theoretic notion of sum in classical mereology terms ([Goodman N., 1951], [Leśniewski, 1916]). This view has been carefully reconsidered in philosophical terms ([Simons, 1987], [Moltmann, 1997], [Meirav, 2003]). We add some other elements to the discussion, showing that such a view cannot grasp the crucial difference between accidental association and collective interpretation.

The second theory (3.1.2) sticks to the set theoretic notion of sum and crucially integrates the extensional algebra with a pragmatic component. The basic idea is that, once the semantic operation of union has generated the possible candidates for denotation - individuals or their sums - contextual information selects the appropriate *cover*. This move does not entail that the group be of a different ontological nature from sums. In fact groups do not exist as such, but only as collections of individuals.

We argue, sticking to the principle of universal existence of sums, that these approaches do not account for the distinction between an accidental association - which characterizes the walk of two people moving side by side, but not as a group - and the collective reading.

²²[Meirav, 2003, p.40]

²³[Meirav, 2003, p.224]

If coherence relations are the burden of pragmatics, then general criteria have to be stated explaining why any kind of distributive predicate does not allow the "collectivity as pure dependence" reading, avoiding tautological explanations.

In the end, if coherence relations are needed, and not only sums, one can wonder whether sums have to be retained into the representation of "collectivity as pure dependence".

3.1.1 Eventualities, part-whole relation, overlapping

Assuming that the "collectivity as pure dependence" reading of distributive predicates is obtained by a collectivizing operation, we investigate whether Lasersohn's definition of *together*, based on mereological relations among sub-events, can be extended to such cases. We reinterpret two conditions provided for lexical *together* ([Lasersohn, 1995, pages 192-193 and 223 respectively]) in (20) and (26) below, and we consider them as the rules defining the conditions for collectivization without an overt marker. This move is not explicitly undertaken by the author, so the extension and the criticism of conditions (20) and (26) below are entirely my responsibility. Even though the first condition has been revisited into the second one, for the purpose of understanding the reasons which do not allow these conditions to explain "collectivity as pure dependence", we reconsider both of them.

First condition: strong identity. Let e, g, P , be, respectively, event, group and property variables. $\ll x_1, x_2, \dots x_n \gg$ denotes the group consisting of $x_1, x_2, \dots x_n$.

$$(20) \quad \text{First condition for group formation } \lambda P, e, g. g \in P(e) \& \forall e' \sqsubseteq e (\exists x (x \in P(e') \implies P(e') = P(e)))$$

Condition (20) states that a group g is the set of people that satisfies a property in each proper and improper part of the collective event. No other entity can be added in any subpart of e . So a group g is the minimal set satisfying property P .

Consider a situation in which John and Mary walk in e . If Paul walks separately in $e' \sqsubseteq e$ and if no other individual or group walks in any part of e , there exist two possibilities.

(i) Assuming $e' \sqsubseteq e$, then $walk(e) = \{\ll j, m \gg\}$ and $walk(e') = \{p\}$. So (20) is not satisfied.

(ii) Assuming $e = e'$, then $walk(e) = \{\ll j, m \gg, p\} = walk(e')$. But if e' is the event of walking of Paul then $walk(e') = \{p\}$ and $\neq walk(e)$ (as reinterpreted under the assumption that $e = e'$, i.e. considering the spatio-temporal slice in which the three people

walk along the same sub-trajectory). Again (20) is not satisfied as expected: John, Mary and Paul do not walk as a group.

Conditions (i) and (ii) above show that two entities acting collectively are the minimal set satisfying the property - in our example, only John and Mary can be said to walk collectively in e -. Condition (20) reflects the basic intuition according to which one cannot freely join a group of walking persons for a subpart of the trajectory and be said to walk collectively with them.

A corollary requirement is that the property does not have to be redistributed down to the members constituting the group ([Lasersohn, 1995, p.190]).

- (21) **Principle of no redistribution.** A group g has a property P *together* in eventuality e iff e has a smaller eventuality e' as a part, such that g has P in e' , and e' does not have parts such that the members of g have P in those parts.

Consider (22) interpreted as in (23):

- (22) John and Mary are carrying the piano upstairs

- (23) $\exists E, \exists e_1 \sqsubseteq E[\text{carry}(\{j, m\}, e_1)]$

According to the Davidsonian view of events endorsed by Lasersohn ([Lasersohn, 1995, p.191]), the assertion of the sentence involves demonstrative reference to a particular eventuality (the collective Davidsonian event (E)). This eventuality, in the situation we have described, consists in one sub-event, e_1 , in which John and Mary are carrying the piano together.

Principle (21) guarantees that the eventuality is collective because there is a sub-event (e_1) in which the individuals do not satisfy the property separately.

In spite of conforming to the intuition of what a collective action is, this account presents two major hurdles when one tries to extend it to the cases of "collectivity as pure dependence".

On the one hand, with respect to the principle of no redistribution, it is not clear how we can get the collective reading with singular predication (24).

- (24) $\exists E, \exists e_1, e_2, e_3 \sqsubseteq E[\text{walk}(\ll \{j\}, \{m\} \gg, e_1), \text{walk}(\{j\}, e_2), \text{walk}(\{m\}, e_3)]$

Where necessarily $e_1 = \ll \{e_2\}, \{e_3\} \gg$. By the nature of the predicate, the property has to be distributed down to the individuals. As we have suggested earlier, in section (2), Lasersohn does not recognize that sentences with singular predication can be interpreted

collectively. More precisely, Lasersohn makes reference, in our terms, to collectivity as unity. It is in fact correct that the "group" does not walk (see section (3.2)).

Yet the collective reading is possible if one considers that John and Mary are not accidentally walking side by side.

It follows that (20) cannot capture the difference between accidental and non-accidental association. Consider the case where John and Mary are two persons walking *accidentally* side by side, going exactly from point A to point B . This set of people satisfies the definition of group given in (20) because it is the minimal set which satisfies the property of walking in every proper and improper part of the event of going from A to B .

This observation is directly related to the principle of universal existence of sums to which classical extensional mereology subscribes (19). Even in the case of purely accidental association the individuals can be summed up in such a way that there is no criterion to distinguish the accidental/distributive reading from the collective/regular interpretation.

Condition (20) has been reconsidered by Lasersohn in the light of the analysis of downward entailing cases. Sentence (25) can be interpreted in the situation where John lifts two pianos in e_1 and Mary lifts two other pianos in e_2 and $e = e_1 \sqcup e_2$. This is predicted to be false by (20) because the entities that satisfy the property in e and all its subparts are not necessarily the same (25).

- (25) John and Mary lifted between two and four pianos, inclusive
- lift-between-two-and-four-pianos*(e') = $\ll j \gg$ (and in particular two pianos)
- lift-between-two-and-four-pianos*(e'') = $\ll m \gg$ (and in particular two other different pianos)
- lift-between-two-and-four-pianos*(e) = $\ll j, m \gg$

Condition (26) is designed to solve this problem.

Second condition: partial identity. The new condition (26) relaxes the identity condition $P(e') = P(e)$ and states that the group g satisfies P collectively in e if and only if (i) g satisfies P in e and, (ii) for any two sub-eventualities e' and e'' where P is satisfied by an individual and/or a group, the subgroups which satisfy P in e' and the subgroups that satisfy P in e'' overlap.

- (26) **Second condition for group formation** $\lambda P, e, g. g \in P(e) \ \& \ \forall e', e'' \sqsubseteq e (\exists x(x \in P(e') \ \& \ (\exists y(y \in P(e'')))) \Rightarrow P_g(e') \cap P_g(e'') \neq \emptyset)$

This relaxation solves the problem related to downward entailing cases (25). In the situation where John lifts two pianos in e_1 and Mary lifts two other pianos in e_2 and $e = e_1 \sqcup e_2$:

- (i) $\ll j, m \gg$ satisfies P in e ,
- (ii) j satisfies P in e and e'
- (iii) m satisfies P in e and e''
- (iv) $\ll j, m \gg$ satisfies P in e' (according to [Lasersohn, 1995, pages 223-224]),
- (v) $\ll j, m \gg$ satisfies P in e'' (according to [Lasersohn, 1995, pages 223-224]).

If (iv) and (v) are taken for granted, the set of subgroups of $\ll j, m \gg$ which satisfies P in e' and the set of subgroups which satisfy P in e'' overlap, their common element being the original group $\ll j, m \gg$.

This condition seems to avoid the first of the criticisms addressed above, because it does not entail the principle of no redistribution of properties. Properties can be distributed ((i) and (ii)), yet the collective interpretation is possible.

Nevertheless (iv) and (v) above are infelicitously based on principle (27):

- (27) If x satisfies property P in e and if $y \neq x$, the group $\ll x, y \gg$ satisfies property P in e

It is the case that a group is seen as satisfying a property even if only a certain part of its members satisfies that property. Nevertheless it does not follow that any time an individual satisfies any property, another individual and/or group can be joined so as to form a group. In a situation where I am writing a paper, it is not true that my colleague and I we are writing a paper collectively, unless it has been previously established that my colleague and I, we are co-authors. This is also the case for (1). An appropriate condition should define the conditions for group formation without presupposing it.

On the one hand, this leads us to conclude that clear-cut criteria are still needed to state the difference between an accidental juxtaposition and a collective event. In fact, even in the case where y satisfies the property, it is not necessary, as (27) entails, that x and y form a group. Now, two people accidentally walking side by side can, under (27), be considered to be walking "as a group".

On the other hand, if it is true that the "group" does not walk, two people walking side by side can be seen as walking "together". The notion of collection (juxtaposed entities) which mereological accounts seem to grasp, is not strong enough to capture "collectivity as pure dependence". This inconvenient is very likely due to the notion of sums upon which the theory is built.

3.1.2 Algebraic approaches and pragmatic criteria

[Schwarzschild, 1996] elaborates a model theoretic theory based on the extensional operation of union over individuals. The major innovation is the introduction of pragmatics into the theory. Distributivity and collectivity are not relegated to semantics but are a matter of interpretation in context. This is a major advance that cannot be ignored. It is certainly the first move toward an analysis which considers properties of entities in the reference situation, partly overriding the shortcomings presented, at the semantic level, by a pure extensional approach of wholes as sums.

The basic idea is that a plural *NPs* denotes a set generated by union. This operation generates any possible cover of the domain. The distributive interpretation of a plural *NP* will select only atomic elements, whereas under the collective interpretation the *NP* will denote the maximal set generated by union. Under intermediate readings, any other possible cover will be chosen.

Pragmatic criteria influence the choice of the appropriate cover. For instance, the plural *NP* in (1) will denote the individuals John and Mary under the distributive interpretation, and, the set formed by the union operation $\{\text{John}\} \sqcup \{\text{Mary}\}$ under the collective reading. At any time, any possible cover is available. This easily explains that a collective predicate can be conjoined to a distributive one, without multiplying the interpretations of the plural NP. In (28)

(28) The boys met in the park, and each carried the piano

the first predicate "meet" denotes the cover made up of the sum of the individual boys, the second predicate denotes each individual boy in the domain. Semantic union makes all the possible covers available and contextual or lexical information is ascribed to select the appropriate one.

It is clear that this kind of account considers groups as *collections* that are coextensively identical with their members. When pragmatics intervenes, it only contributes to the selection of a particular level of grouping.

There is no coherence relation or any notion of group as unity independent of its parts, neither at the semantic level of wholes as sum formation, nor at the pragmatic one.

Singular predication and *ad hoc* pragmatic constraints. According to this view of wholes, when (1) is interpreted collectively, it would denote the cover $\{j\} \sqcup \{m\}$ ($= \{j,m\}$ [Schwarzschild, 1996, p.1]), the whole coextensively coinciding with the sum of its parts.

One might prefer $\{\{j,m\}\}$, or $\{\{j\} \sqcup \{m\}\}$ because the collective walk is not only the union of two separated walks, but a "common walk". Nevertheless, unless one admits that

the whole is of a different nature from its components, this multiplication of bracketing would not really add any information, and the whole would still be considered as the sum of its parts. Because the theory subscribes to the axioms of uniqueness and of closure, wholes are of the very same nature as sums.

This is not necessarily an inconvenience, if we take for granted that the "group" does not walk, but that, even under the collective reading each of the members is understood as being involved in a specific event of walking.

One could reasonably require, though, that *two* facts be retained within the representation of (1):

- each of the people walk, and,
- there are some coherence relations which allow to distinguish accidental (distributive) from non-accidental (collective) association (i.e. which trigger the appropriate level of grouping).

The notion of whole as sum can satisfy the first observation but not the second. Sum is the only principle of composition without any additional dependence or coherence relation among the parts.

Again, as soon as one adopts a sum-based model, one also subscribes to the fact that, for any two entities, whatever their properties, there exists a sum, i.e. a possible candidate for group denotation. Pragmatics should then play a major role being responsible for blocking the selection of a non-appropriate cover. Let us develop this point by comparing (1) and (10).

If one admits that $\{a \sqcup b\}$ is compatible with the fact that each entity satisfies the property, and, at the same time, that this is the right representation of a group as a whole, one cannot see why individual-level properties couldn't be represented in this way, i.e. be interpreted collectively.

If two separated walks can be joined under union giving rise to a collective walk, one cannot see why two individual-level properties cannot be joined under union too. In other words, if two walks can be joined without coherence relation making up a whole, individual level properties could be treated in the same way. And in fact they are, given the notion of whole as sum and principle (19).

If one aims to explain the notion of wholes seen as collection, this model is totally appropriate.

One can assert (29):

(29) The blond and the brown-haired have been separated

where the group is seen as the sum of blond and of brown-haired people. They cannot, of course, be blond "as a group". A collection of individuals does not entail the members "behaving" as a group.

Nevertheless, this is not enough for (1). There is another principle of composition for the collective interpretation of (1), which pure sum cannot express.

With regard to "collectivity as pure dependence", pragmatics, at this stage at least, can only say that an individual-level predicate cannot be interpreted as (collectively) dependent, which is purely tautological. On the other hand, nothing has been said by pragmatics of what a common walk is, apart from that it is a sum of two separated walks.

More generally, if pragmatics has to introduce the notion of coherence relation, given that this is a very general notion triggering the appropriate level of grouping, it has to provide general criteria, avoiding *ad hoc* explanations. We are quite convinced that this is the right direction to explore, and that a general account of what a contextual dependency relation actually is still needed.²⁴

3.1.3 Conclusion concerning the notion of groups as sums

To explain the notion of "collectivity as pure dependence" illustrated in (1) one could try to apply the notion of group as sum. Nevertheless this conception is bound to the principle of coextensive determination of whole with respect to its parts, and to the principle of universal existence of sums. By virtue of these principles, conceiving wholes as sums, one misses two major features of "collectivity as pure dependence":

- the association is non-accidental (but regular),
- the group exists neither as a whole (recall Laserson's like claim: "groups do not walk") neither as a collection (because two people accidentally walking side by side coextensively coincide with their collection).

One response would consist in ascribing the responsibility to introduce dependency relations to pragmatics. In this case, because "collectivity as pure dependence" seems

²⁴A very similar approach has been developed by Gillon [Gillon, 1987]. The foundational idea that distributivity and collectivity are not a matter of semantics but of pragmatics and interpretation-in-context is very appealing, and has to be taken into account as the data lead us to do. Nevertheless, the algebraic structure of the complete join semi-lattice, which serves as the background for the application of contextual selection in Gillon's theory, is susceptible to the same criticism as Schwarzschild's approach.

For a plural NP whose denotation is $\{a,b,c\}$, the collective interpretation is taken to correspond to the aggregation $\{abc\}$ and the distributive reading to the aggregation $\{a,b,c\}$.

On the one hand, admitting that $\{abc\}$ is compatible with singular predicates, individual-level properties can be represented in this way, under "collectivity as collection" interpretation (*The blond and the brown-haired have been separated* (29)). If two separated walks can be summed and each of the individuals still keeping walking, one cannot see why two individual-level properties cannot be joined to one another, each of the individual being permanently characterized by it.

Again, because the difference between distribution and collectiveness is explained by the abstract operation of sum, one cannot avoid the principle of universal existence of sums. Blond people form a group and this is a correct prediction if one considers wholes as collections. Yet, they form a different kind of group from people walking "as a group". Blond or brown-haired people can form a group in much the same way as two people following by chance the same trajectory form a group: they all satisfy the same property. This is nevertheless a group of a very different nature from that formed by two people walking together.

to comprehend a general phenomenon, general principles are needed in order to explain what dependence is. This is certainly an important direction to explore and it is heavily integrated in the notion of whole as integrated situated unity [Moltmann, 1997]. But before we come to theories of wholes as sum and unity, let us consider a formal model based on the notion of whole as unity *tout court*.

3.2 Groups as unities

An alternative way of conceiving wholes is in terms of unity.

The basic assumption is that a whole is a primitive, which has parts, without being dependent on the existence of each of them. The principle of composition to which theories of wholes as unit subscribe is not that of sum, but that of *making up*²⁵:

(30) for any xs , for all ys , if the xs make up the ys then each of the xs is a part of y

Very importantly, the notion of *making up* is such that the converse of (30) does not hold: if some xs are part of y they do not necessarily make up y .

The major distinction between theories of wholes as sums and of wholes as unit is that on the first account, the whole has a distributive relation to each of its parts: it is identical to their sum and thus it is a whole *with respect to each* of them. On the second account, the whole bears a relation to the parts altogether, and it *collectively corresponds to* the parts that - technically - make up the whole.

It follows that the members of a whole as unit are not distributively accessible. Their specificities count only as far as they contribute to the existence of the whole, and not *per se*. Consider a class, for instance. When one asserts (31):

(31) The class is calm

one focuses on the behavior of the class as a unit, no matter which particular student is calm. It is enough that a relevant part of the students be calm.

Indeed, some basic principles grounding the notion of whole as sum are not obeyed by theories of wholes as unities.

(32) Wholes as unities do not obey the principle of universal existence of sums. Whenever some elements exist, a sum of these elements does not necessarily make up a whole.

(33) Wholes as unities do not obey the principle of uniqueness. This is because some elements can be put together in such a way that more than a whole can result.

²⁵According to [Meirav, 2003] the notion of *making up* is to be understood in contrast with that of "coextensiveness". Parts contribute to the existence of the whole, but this is not coextensive with them.

- (34) Wholes as unities do not obey the principle of coextensive determination. Wholes are not identical with the sum of their parts.

Collective responsibility illustrates the notion of whole as unit in the domain of abstract objects. Consider the famous example²⁶ of a band of gangsters killing their rivals (35):

- (35) The gangsters killed their rivals

The collective interpretation does not necessarily require that each of the gangsters killed each or some of the rivals. The gangsters form a group or whole even though each has not directly contributed to the killing of the rivals.

Landman's approach to the notion of group reflects this particular notion of whole as unit.

3.2.1 Groups as (plural) atoms

From the ontological point of view, [Landman, 1989b] and [Landman, 2000] claim that groups are plural entities seen under a certain perspective, that is to say, monadic entities of a different nature from the plural entity which underlies them. In this respect, Landman's theory is an intensional theory of wholes. Groups are *plural atoms*: a plurality of individuals seen and behaving as one. The explanation is model theoretic: there is a domain of individuals and an operation of pluralization. The theory is augmented with a type-shifting rule which transforms plural entities into groups.

Even though Landman seems to keep the notion of sum when considering that of pluralization, the definition of wholes as group atoms forces him into accepting the ontological commitment that wholes are unities of a particular intensional nature. Once the unit has come into existence, the accessibility to each of the members is blocked, i.e. the internal structure of the unit becomes completely opaque.

In Landman's ontology only atoms count as entities. Predicates differ with respect to whether they take group atoms or individual atoms in their denotation.

Singular predicates (36) never denote group atoms but only individual atoms. They can be pluralized (the "*" indicates the pluralization of the predicate).

- (36) John and Mary walk
 $John \sqcup Mary \in *WALK$
 $John \in WALK \ \& \ Mary \in WALK$
 $\rightarrow \forall a \in John \sqcup Mary \ a \in WALK$

²⁶This example is discussed by [Landman, 2000, p.167].

Collective predicates take group atoms and do not distribute the property down to the members (37)

- (37) John and Mary meet
 $\uparrow(\text{John} \sqcup \text{Mary}) \in \text{MEET}$
 $\not\vdash \forall a \in \text{John} \sqcup \text{Mary} \ a \in \text{MEET}$

Some other predicates are ambiguous, and a type shifting operation allows one to switch from the distributive to the collective reading (38):

- (38) The boys carry the piano individually \longrightarrow The boys carry the piano together
 $\sigma(*\text{BOYS}) \in *CARRY \longrightarrow \uparrow(\sigma(*\text{BOYS}) \in CARRY)$

On an ontological level, the type shifting operation corresponds to a change in perspective and can be translated by "as a group". The bunch predicate introduces a perspective on sums, in the same way as *as a teacher*, in *John as a teacher*, introduces a perspective on John. In this way, the new entity *John as a teacher* is created.

It is of major importance to state under what criteria one can shift the interpretation from a sum reading to a group reading. Landman provides a collectivity criterion (39), [Landman, 2000, p.169]:

- (39) **Collectivity criterion.** The predication of a predicate to a plural argument is collective iff the predication is a predication of a thematic basic predicate to that plural argument, i.e. is a predication where the plural argument fills a thematic role of the predicate.

In order to keep the theory coherent, Landman assumes that distributive predication is not thematic. For, in (40):

- (40) The boys sing
each individual boy sings, so it is not the *group* that fills the thematic role "agent" but *each* individual boy²⁷.

In some cases, the property can be distributed down to each singular entity of the group, with the collectivity criterion still satisfied. Recall (4) repeated here as (41):

- (41) The journalists asked the president five questions

Landman [Landman, 2000, pages 171-172] uses the notion of collective responsibility or team credit, guaranteeing that, even if each singular journalist asks the president five questions, each question is attributed to the press body to which each journalist belongs. Taking this into account, either one has to subscribe to the principle of group holism (27), or to presuppose the existence of a group.

²⁷Landman, implicitly, does not recognize that collections are wholes.

Applicability of Landman's account to cases of "collectivity as pure dependence". This account avoids the shortcomings presented by classical extensional mereology approaches and, in particular, the problems related to transitivity. Because it introduces the notion of whole as a separate entity, transitivity is blocked when needed. This is certainly a major advantage of the theory, which avoids the infelicitous conclusion (42c) from (42a) through (42b):

- (42)
- a. a. The pages are part of the book
 - b. b. The books are part of the library
 - c. c. #The pages are part of the library

The foundational insight of this account is that sums and groups are not the same extensional entity, but that groups present their own specific properties which they do not inherit from their parts.

Nevertheless, some difficulties remain when one tries to apply this representation to cases of "collectivity as pure dependence" as in (1).

The first difficulty is a consequence of the strength of the ontological statement. [Moltmann, 1997, pp. 75sqq.] criticizes this account with respect to its ontological consequences. Let there be an individual called "John" who is a teacher and father. If *John as a teacher* and *John as a father* are two distinct entities as this ontological accounts leads us to assume, the plural could be applied:

- (43) ??John as a teacher and John as father are very calm

Second, the strong ontological assessment has an infelicitous consequence, even with respect to the interpretation of collective predicates. (37), according to Landmann's account, is to be interpreted in such a way that it is the plural atom formed by John and Mary which "meets". On an ontological basis, according to the distinction object / non-object, [Moltmann, 2002] claims that, in this case, the plurality $\ll John + Mary \gg$ satisfies the property as an object, because it is an argument of a collective predication. Nevertheless, she recognizes that there is a derived property of *addition* such that each individual of the group contributes to the meeting of the group. It follows that, even in the interpretation of a pure collective predicate, one has to retain the contribution of each singular member of the group into the representation.²⁸

²⁸As we will be discussing in section (3.3), [Moltmann, 1997] does not exploit this observation in order to state that even under the collective reading one needs to keep an *access* to the members of the group, i.e. to retain the events in which each member is involved, within the representation.

Thus, even though *perspective* can be considered as an element of the collectiveness effect, the ontological consequence seems too strong to be kept.

Third, according to the collectivity criterion, two options are possible:

1. either one assumes that individuals forming the group must not satisfy the property separately, i.e. singular predication can never be interpreted collectively, as Landman assumes at one point in his argument [Landman, 2000, p.148];
2. or one has to retrieve the existence of a group in which the individuals are supposed to be involved from the context or from the lexical information.

The first statement cannot be accepted if one recognizes that there is a collective interpretation for (1):

(44) John and Mary are walking (as a group)

$\uparrow(\text{John} \sqcup \text{Mary}) \in \text{WALK}$

and $\rightarrow \forall a \in \text{John} \sqcup \text{Mary} \ a \in \text{WALK}$

The second statement would force the speaker and the hearer to assume that John and Mary form a couple, for instance. This is, however, not mandatory at all. The group does not necessarily pre-exist the eventuality described in the scene. *It is precisely "in walking" that John and Mary do form a group.*

So either we have to admit that the collective interpretation is incompatible with singular predicates, or we have to abandon the collectivity criterion.

We assume that singular predication is compatible with the collective reading even in cases where a group does not pre-exist the scene described by the sentence and thus it cannot be grounded on the collectivity criterion. Instead, we agree, and we develop it in detail, that the notion of group is strictly related to that of "perspective".

We agree that But it cannot be grounded on the collectivity criterion.

3.2.2 Groups as unities: conclusion

When one tries to apply the notion of whole as unity to cases of "collectivity as pure dependence", one does not succeed in capturing all the aspects of this particular way of grouping.

On the one hand, one needs to consider the event in which every individual is involved. The notion of unity is completely blind to the sub-parts of the whole.

On the other hand, one needs to introduce some coherence relations into the representation, because it is *in* the scene described by the sentence that the entities form a group without the group necessarily existing otherwise. Landman's approach, when it integrates

singular predication into the picture of collectivity [Landman, 2000, pp. 164 sqq.], does so under the labels of "team credit" and "collective responsibility", which seem to call into play different features from those of "collectivity as pure dependence".

3.3 Wholes as sums plus dependency relations

A third account of wholes is based on the hypothesis that wholes are, simultaneously, sums and unities. [Simons, 1987], refusing the principle of universal existence of sums, claims that some entities can be summed up as a whole only if they are related by dependency relations. Granted that there are some dependency relations, the whole is then the sums of its members.

Moreover, by virtue of these dependency relations, the whole is also seen as an independent entity, or a unity. It is said to be *integrated*, that is to say, its parts are no longer accessible. Once the whole exists, then, it exists as an independent entity with certain properties.

There are different levels of integration according to which members are more or less accessible. Technically, integration and accessibility are interdefined [Moltmann, 1997, p.66]:

- (45) *Accessibility*; An entity x has an *accessible part structure* in a situation s (ACC-PART(x, s)) iff $\neg INT - WH(x, s)$

Definition (45) states that if x is an integrated whole, its parts are not accessible. As argued at length in [Moltmann, 1997] accessibility and integration come in degrees and they are not binary notions.

The details of the theory certainly deserve closer attention, but this would lead us too far away from the discussion of the notion of "collectivity as pure dependence". For our purpose, let us simply mention the difference between strongly integrated wholes and weakly integrated wholes. The first notion applies to cases where there are some dependence relations among the parts which constitute a unity. The second refers to collections of similar entities. Only in this second case are the members accessible; strongly integrated-wholes have non-accessible parts.²⁹

²⁹This view of sums plus dependency relation has been criticized by [Meirav, 2003], as it requires that one subscribe an ontological commitment, namely that for the adjunction of a over-zealous microscopic part, the whole has to stop existing or to change its own nature. Let us return to two people walking collectively side by side. Under a strict interpretation of the theories of wholes as sums and unities, because wholes rests on the very notion of sums, if one of these two people loses her hat during the walk, she cannot be said to participate any longer in the common walk.

A very straightforward response, from a neo-classicist, would be that only the loss or the gain of immediate components is to be considered. For instance, if one of the two persons stops walking, the walk can no longer be seen as common. This is a suitable conclusion, and one could stop here, considering

Moltmann [Moltmann, 1997] elaborates a model for distributivity and collectivity, based on the notion of strongly / weakly integrated-wholes. In the case of the collective interpretation of (1), insofar as the walks of John and Mary depend on each other, they form an integrated whole, so that the events in which each member is involved is not accessible.

In this framework, then, both distributivity and collectivity make reference to a group Davidsonian argument [Moltmann, 1997, p.56], with the parts being *accessible* only under the distributive interpretation. Given the operation of sum $<_s$, and s and s' the described situation and the reference situation respectively, the definitions of distributive and collective interpretation are the following [Moltmann, 1997, p.56]:

- (46) *Distributive interpretation.* For entities e and x , a verb f , and situations s and s' , f is interpreted distributively in s with respect to e , x , s and s' iff $[f]^S(e, < x, s' >) = 1$, and for every x' , $x' <_s x$, there is an event e' , $e' <_s e$ and $[f]^S(e', < x', s' >) = 1$
- (47) *(Strict) Collective interpretation.* For entities e and x , a verb f , and situations s and s' , f is interpreted collectively in s with respect to e , x , s and s' iff $[f]^S(e, < x, s' >) = 1$, and there is no e' , $e' <_s$, such that for some x' , $x' <_s x$ and $[f]^S(e', < x', s' >) = 1$

The author states that a predicate can be ambiguous and the distributivity / collectivity interpretation has to do with a question of perspective and of accessibility of parts [Moltmann, 1997, p.56].

These definitions raise two problems.

Firstly, the notion of group Davidsonian argument and the accessibility of the parts can be questioned in respect of both of these definitions. With respect to (46), following [Link, 1983], [Landman, 2000], and many others, we will be assuming that distributivity, as well as cumulativity, entails that there exist as many events as participants, without a heading group event sub-structured into many sub-events as Moltmann's definition of distributivity leads one to conclude.

We can also add, with respect to (47), that collectivity when it is instantiated as a case of "collectivity as pure dependence" (1) requires an access to the members: each of the participants is involved in an eventuality of walking and it is in this action of walking

that a common walk is the sum of two separated walks, plus some dependency relations.

Moreover, this view crucially excludes any possibility of considering wholes as evolving over time, losing or gaining parts. Leaving aside the details of the philosophical quarrel, theories of sum plus dependency relation that take the whole to be determinatively determined by its parts cannot integrate the notion of change into the theory since they are unable to deal with the transitional period neither discretizing the steps of the change nor fluidifying it [Meirav, 2003, Ch. 7]. The discussion of such details is outside the scope of this paper and it has no bearing on the matter under discussion here.

that they do form a group. There is a dependence between their walks, yet there is no unity.

This leads us to abandon two criteria generally taken for granted by theories of wholes as sums plus dependency relations:

(i) that the collective reading requires a closure under sum formation via a Davidsonian collective by default argument, and that

(ii) only distributive interpretation requires an access to the members.

The notions of integrated whole and non-accessibility, then, when applied to the collective interpretation of singular predicates, are too compelling ontologically.

The second problem is related to the lack of temporal and modal dimensions in the neo-classical notion of integrated whole. Properties of wholes are temporally and modally *blinkered*, i.e. their instantiation at time t at world w does not entail their instantiation at another time t' or at another world w' . This, as we will argue in detail, is a crucial feature characterizing the collective interpretation of purely distributive predicates.

Let us just reformulate here the basic intuition founding the distinction between an accidental or a distributive association and a collective interpretation: only in the second case, one can *foresee* that the dependency will be retained during the time of the walk, and this in accordance with every possible evolution. Under the distributive reading, two people are seen as walking close to each other accidentally, so no prediction can be made about the future of the whole.

Moltmann (ibid.) argues that time is somehow taken into account insofar as wholes are considered to be situation dependent. Indeed situation dependency *per se* neither guarantees (i) taking the situation as durative - that a whole can evolve within the situation that persists in spite of its own evolution, nor (ii) taking the situation as a punctual one - that it can persist in situations accessible from the actual one. In other words, situation dependency does not guarantee that the property is persistent at other times and or in other accessible worlds, or situations if one prefers.

Nevertheless, to integrate time into the neo-classical picture would not be particularly difficult. One could easily assume that dependency relations persist through time.

This move is not easy with regard to modal properties, and, more precisely, with regard to epistemic ones, without reconsidering the whole theory. Let us consider again the basic intuition we have just introduced: it is only under the collective interpretation, that one (the cognitive agent) can *foresee* that the dependency will be retained during the time of the walk, and this in accordance with every possible evolution and with respect to every accessible possible world.

The notion of perspective, when introduced by Moltmann, only serves to switch from

the distributive to the collective interpretation. It is by no means part of the meaning of collectivity. Evoking possible worlds and the speaker's point of view, perspective becomes the very glue between two entities seen as acting collectively.

We will argue in detail that perspective is the principle that holds parts together. Two disjointed events are brought together through the intervention of a cognitive agent who relates them. Crucially, this epistemic constraint will have to be compatible with every possible evolution of the system in time, and with respect to accessible possible worlds. We will be claiming, then, that to "see entities as forming an integrated whole" means that "the dependence as epistemic constraint will be kept for every possible evolution of the system".

3.3.1 Wholes as sums and unity: conclusion

Considering dependency and wholes as situated notions, theories of wholes as sums plus dependency relations capture two essential features of cases of "collectivity as pure dependence".

Nevertheless they cannot capture the phenomenon entirely, for two reasons.

On the one hand, the notion of strongly integrated whole, which applies to cases where the parts are held together by dependence relations, forces one to subscribe to the principle of non-accessibility to the sub-events.

On the other hand, perspective is not exploited enough. Perspective, hiding or revealing the parts of the whole, only serves to switch from the distributive to the collective interpretation and vice versa. Under the view we will be developing here, with respect to abstract objects, dependence as epistemic constraint is the glue that holds together the events that compose a complex event through possible worlds. The knowledge of the cognitive agent, then, plays a crucial role in the new definition of a whole that is emerging, namely that of whole as network.

3.4 Conclusion: toward the notion of whole as network

On a phenomenological basis, there are different cases of collectivity. In this paper we are concerned with cases that we have placed under the heading of "collectivity as pure dependence", as illustrated in (1): *John and Mary are walking along the beach*. Two interpretations are possible: a distributive one (John and Mary are accidentally walking side by side along the same trajectory) and a collective one (John and Mary are walking together along the same trajectory). In this particular case, the togetherness effect, or the specific notion of "collectivity as pure dependence", is characterized by two features: (i) there are coherence relations linking the parts (ii) the non-accidental association does

not presuppose the existence of a group but this group exists by virtue of the properties that the individuals satisfy *in the scene described by the sentence*.

The notion of collectivity is generally explained in the light of the notions of wholes: wholes as sums, wholes as unities, or wholes as sums plus dependency relations.

We have shown that none of these models captures the features which characterize cases of "collectivity as pure dependence", and, at this point, one seems to come to a certain impasse.

On the one hand, theories subscribing to the view of wholes as sums cannot make a distinction between two extensionally identical situations. Following the principle of universal existence of sums (19), they miss the difference between accidental and regular association, or, in other terms, between groups as mere collections and groups existing by virtue of coherence relations.

In order not to ignore the possibility that wholes can be compositionally more than simply the sum of their parts, one might prefer to see wholes - and groups - as unities.

Nevertheless this ontological claim seems overly constraining. The whole having a life that is independent of its components and their relation, the more it is integrated, the more the parts are dependent on one another and the less they are accessible.

Theories of wholes as sums are thus too weak to catch the first of the specificities of "collectivity as pure dependence" cases; theories of wholes as unities miss the second. We can conclude, then, that none of the interpretations in (3) properly accounts for the collective interpretation of (48).

(48) John and Mary are walking along the beach

- a. Whole as sum : $\text{walk}(\{\{\text{John}\} \sqcup \{\text{Mary}\}\})(\{\{e_1\} \sqcup \{e_2\}\})$
- b. Whole as unity : $\text{walk}(\{\{\text{John}\}, \{\text{Mary}\}\})(e_3)$

It is clear now that for the case of "collectivity as pure dependence", which somehow remains between "collectivity as collection" and "collectivity as unity", we are looking for a notion of whole that is stronger than sum and weaker than monadicity and which requires to retain the following elements into the representation:

(49) **Elements for the togetherness effect in the case of "collectivity as pure dependence"**

- a. a coherence relation to state the difference between a purely accidental association and the collective interpretation, or an intensional notion to state the distinction between two extensionally identical situations,
- b. an access to the group members even under the collective reading.

To explain the phenomenological notion of "collectivity as pure dependence", we claim that coherence relations are necessary and sufficient. Coherence relations or ontological dependency relations guarantee that the collectivity reading is possible by virtue of the existence of a *network*. There is, then, a third way of looking at wholes: as networks. Individuals functioning together make up a complex object without this abstract object existing *per se*. This is precisely the case for a collective walk.

The notion of a network will enable us to keep both of the elements of the collectiveness effect, namely the fact that each member is accessible even under the collective interpretation, and the existence of coherence relations which distinguish it from purely accidental association.

The data lead us to believe that the nature of the property is partly responsible for the possibility of establishing a network among some entities. We will be assuming that properties exist *per se* and not that they exist only by virtue of interrelations, as [Shusterman, 1988].

Crucially, as it will be developed in the rest of the paper, non-accidental association is strictly bound to cognitive agent's perspective and knowledge, and, even more importantly, to counterfactual reasoning.

Finally, our account, following [Schwarzschild, 1996] and [Moltmann, 1997], relies heavily on situation and contextual information.

4 Whole as network

The notion of whole as network that we will be using to explain the sources of the collectiveness effect for (1) crucially relies on that of dependence. We have concluded from the discussion in the previous sections that this notion remains somewhere in between that of sum and that of unity. In the next subsection (4.2) we discuss this notion at length and clarify whether our account is semantic or pragmatic in nature (4.3). We present then the formal apparatus for the interpretation of cases of "collectivity as pure dependence" (4.4).

The notion of whole as network is nowadays largely developed in computer science, particularly by theories of distributed systems and communicating agents. The model we are about to present is partly inspired by Dretske's theory of information flow [Dretske, 1981]. However, it was first introduced in a very provocative way by Nietzsche³⁰ His purpose was moral, ethic and pragmatic and, as such, it cannot in any way be implemented. Insofar as this was the first overt appearance of the notion of "wholes as network" let us consider

³⁰See, in particular, F. Nietzsche, *The Gay Science*, trans. Walter Kaufmann, New York: Vintage Press, 1966.

it very briefly, through the interpretation of [Nehamas, 1985] and [Shusterman, 1988].

4.1 Wholes as interrelations of inter-defined properties

In the *Poetics*,³¹ Aristotle asserts that an organic unity is such that its parts are so integrally inter-related that if any one of them is displaced or removed the whole will be affected and modified: Aristotle's view of wholes relies on the very notion of parts and property. In his interpretation of Nietzsche, [Nehamas, 1985] presents a notion of organic unity that goes far beyond Aristotle, claiming that the very notion of organic unity is such that the existence and the identity of each part is equally necessary for the identity and the existence of the other parts and not only of the whole. In short, his claims are the following: (i) the whole is nothing but the network of dependent parts whose identity depends on this net of relations, (ii) nothing has neither essential nor accidental properties. Every property of every part is essential to it and depends on that of the other parts in the network at a certain time, (iii) any identification of any part depends on what other part it is interpreted as being related to and distinguished from: the network is the result of an interpretation of facts, and not of their nature, (iv) the unity of a part is nothing but the genealogical account that connects one set of phenomena to the others.

This account, in spite of its novelty, does not only lead to some still unsolved paradoxes³², but clearly does not reflect the ontology with which the language provides us. Properties are either seen (and expressed) as generic or accidental, and this distinction certainly influences the way we establish dependency relations among parts. The provocative force of this account clearly exceeds the limits of the domain within which the data force us to remain. It provides some inspiring idea, however.

First of all, it does not require a view according to which dependence entails integration and unity, as in [Moltmann, 1997]. Moreover, things are seen in their *divenire*, with an history, past and future evolutions. Finally, things are seen as related in those cases where the relation is a matter of interpretation.

These concepts, which are too vague to be used as such, and too extreme to provide a reasonable account of wholes as networks, nevertheless provide us with new directions to explore.

³¹Aristotle, *Poetics*, Ch. VIII.

³²See [Shusterman, 1988] for details.

4.2 Informal presentation

4.2.1 Network as epistemic constraint on properties

At this point, we can informally present the basic insight of the notion of whole as network we will be using from now on to explain the cases of "collectivity as pure dependence"³³.

- (50) **Whole as Network: definition I.** To a person with prior knowledge k , if f having property p carries the information that f' has property p' , (and/or if f' having property p' carries the information that f has property p)³⁴, then f and f' are seen as entering a network.

This definition requires some comments. Consider (1), in which John and Mary are walking "as a group". This definition of "whole as network", based on entailment between properties, states that John's walk and Mary's walk are seen as contributing to a collective walk, if the properties of the walk of John entail that the walk of Mary has certain properties and/or vice versa. This is verified when two people walk "together": if one turns the other will turn too, and, in general, they will *co-ordinate* their trajectories (or make their trajectories *co-vary* [Lewis, 1973]). The properties of their walks entail each other.

Let us emphasize two aspects of this preliminary definition of wholes as networks.

- *Properties.* Properties play a crucial role in the establishment of the network. Concrete and abstract objects³⁵, individuals and events, have properties that we, as cognitive agents, classify as definitory or as episodic. These properties have to be retained within the ontology. On the one hand, they do play a crucial role in the establishment of the dependency relation and, on the other hand, they are not dependent, for their existence, on the network. Note that not every property can enter a dependency relation. This inability is due to the very essence of the properties. What, in the very essence of the property, enables it to enter into a dependence relation or not will become clear in the development which follows, and, in particular, with definition (52), and in sections (4.2.2), (4.4.4) and (5) where, respectively, we clarify the notion of dependence, implement it, and apply it to concrete cases.
- *Knowledge, entailment and inference.* Given some entities, their reciprocal dependence is not only a worldly one, but crucially rests on speaker perspective and

³³The following definitions are inspired by the theory of [Dretske, 1981] and its implementation by [Barwise & Seligman, 1987] for distributed systems. They are nonetheless re-interpreted in a completely new framework.

³⁴For the sake of clarity, in informal definitions, from now on we will omit the part related to possible symmetry.

³⁵By "entity" and "object" we refer both to individuals and events.

knowledge. Properties of events can worldly entail each other. This entailment has to be recognized by the speaker who can make inferences concerning the behavior of the events that she "sees as dependent", in a given situation.

To put it slightly differently, the knowledge relative to a certain entity having a certain property allows the speaker to make an inference about another entity as having a certain property. In other terms, the property, as it is seen by the speaker, entails that another entity has a related property.

Consider again the collective interpretation of ((2c) = (1)). The property of walking along a certain trajectory of John is such that the speaker can infer that Mary satisfies the property of walking along this same trajectory too. If this inference cannot be made, then two (or more) entities cannot be seen as forming a network.

We can then reformulate the condition in inferential terms:

- (51) **Whole as Network: definition II.** To a person with prior knowledge k , f having property p carries the information that f' has property p' , if the person could legitimately infer that f' has property p' from f having property p . f and f' will be then seen as entering a network.

This is not the whole story, though. Given two people who are accidentally walking side by side, the speaker could mistakenly infer that their walks are related. The network, then, is not constructed on the basis of the observation at a given point in time, but via *counterfactual* reasoning, which calls into play possible worlds.

The cognitive agent has to be able to make *predictions* regarding the possible evolutions of the whole. For two people to be seen as walking collectively, one has to make the prediction that for any possible accessible world the dependency would hold.

Epistemic dependency amounts to counterfactual reasoning. In order to see two people as walking collectively as a group, one has to endorse the prediction that, if one turns, the other will necessarily turn too. For any accessible possible world, if the first does not turn, the other will not turn either.

The informal definition of wholes as networks can then be further elaborated:

- (52) **Whole as Network: definition III.** To a person with prior knowledge k , f having property p carries the information that f' has property p' , in all possible worlds compatible with k , if the person could legitimately infer that f' has property p' from f having property p . f and f' are seen then as entering a network.

Finally, considering time and possible worlds, we will be looking at individuals with respect to the *eventuality*³⁶ in which they are involved.

To sum up: we are not only concerned with analyzing the structuring relations among the parts of a situated whole, but also, and most importantly, with stating the criteria that allow a cognitive agent to recognize the existence of a whole out of two events. In other terms, by pushing the question of the very sources of the notion of "collectivity as pure dependence" further, we want to explain what a dependency relation is and under what conditions it can be established.

We have presented a picture in which objects have properties, accidental or essential. The cognitive agent links these properties and thus obtains a network. This network is an abstract object - for instance a "common walk" - which is based on an epistemic hypothesis.

This hypothesis consists in (i) recognizing the possibility of inferring that an entity has some properties given the properties of another entity, and (ii) foreseeing the possible evolutions of the network. The prediction concerning the evolutions and the elimination of the possibilities via a counterfactual reasoning is the basic criterion upon which the cognitive agent relies to interpret a certain situation as involving a collective event.

4.2.2 Juxtaposition, causality and dependence

There are many different uses of the notion of dependency. To further clarify in what sense it is to be understood here, and what role it plays in the theory of "collectivity as pure dependence" we now compare it to two related notions of juxtaposition and causality.

Among the numerous questions that the notion of dependence raises, two are crucial. The first is to know whether this kind of relation is general or specific. The second is to state whether it belongs to a set of finite relations that *entities* or *properties* can entertain. A positive answer to the second question would lead one to make the hypothesis that there is a general relation of dependence. Note that we shall consider here these questions only humbly and briefly, in relation to the data on plurality that the natural language provides us with and in particular with respect to cases of "collectivity as pure dependence".

- *Dependency and juxtaposition.* On the one hand, dependency has to be distinguished from juxtaposition. Two juxtaposed entities can form a collection, but not a unity or a coherent whole.

Juxtaposition is an extensional relation which links entities that belong to a collection. This relation may rely on the fact that entities share some common properties³⁷. Nevertheless, the properties of each entity exist totally independently of the

³⁶By *eventuality* we mean any kind of temporal entity, static or dynamic.

³⁷Cf. [Simons, 1987] and the notion of *FF*-relation.

properties of every other element in the same collection, or, at least, this is what appears to be the case.

- *Dependency and cause.* On the other hand, dependency is weaker than cause. Entities functioning together are generally said to be causally linked. When talking about dependency, though, one does not want to claim that the very existence (of the properties) of one entity is necessarily causally dependent on the existence (of the properties) of another entity, as it would be the case when talking about causality. In the case under investigation, for instance, the walk of one of the two individuals exists independently of the walk of the other. Instead, these two walks *co-vary* [Lewis, 1973]. For two people to be seen as walking collectively, the property of the walk of one of them has to provide certain information about the walk of the other. Dependency is more closely related to *counterfactual reasoning* than to the causal one.

Like causality, dependence relies on types. It is not the occurrence of an event with the occurrence of another event that is linked, but their descriptions. Causality is not random, but can be foreseen by virtue of the types of the events involved. This is also the case for dependency. In a weaker way, though: types are called into play when the cognitive agent epistemically links the occurrences of two events. *If the knowledge that one has about the properties of one event entails the knowledge of the properties of another event, then these two events are epistemically dependent.* Nevertheless, this does not mean that they are causally related.

Let us sum up. On a phenomenological level, we have identified at least three different kinds of collectivity: "collectivity as collection", "collectivity as team credit" and "collectivity as pure dependence". These three types of collectivity appeal to three different notions of groups, collective event, and, in more general terms, wholes. We have been using the term "whole" with reference to both groups and collective events, having recognized that, by virtue of the homomorphism between individuals and the eventualities in which they are involved, the questions "what kind of group" and "what kind of event" are in fact the same.

On an ontological basis, we have settled a distinction between different kinds of wholes: wholes as sums, wholes as unities and wholes as sums plus dependency relations. We have by no means showed that there is a one to one correspondence between these three notions of wholes and the three cases of collectivity. Instead, we have analyzed these three conceptions of wholes in the light of the case of "collectivity as pure dependence", and showed that none of them grasps this particular configuration properly.

As the label we have chosen suggests, we have identified the key to explaining these

cases of collectivity in the notion of dependence. Dependence has entered ontological accounts of wholes since Aristotle. In particular, it has been used largely to explain the notion of integrated whole in very recent studies.

These accounts, though, are based heavily on the notion of unity, which is too ontologically compelling.

In this section, we have reinterpreted the notion of dependency in a different framework. Given definition (52) of wholes as networks, dependence is understood as being an epistemic constraint, based on speaker's knowledge, linking the properties of two events.

To put it another way, the difference between accidental (distributive) association and collective interpretation is stated in counterfactual terms.

Given a unique situation, the collective interpretation rests on an epistemic hypothesis that the speaker makes concerning the future developments of two events whose properties are seen as entailing each other.

In section (4.4) we present an implementation of the notion of dependence and of wholes as networks and leave aside the other kinds of relations which do not fit this kind of collectivity as dependence. But before doing this, let us briefly conclude this informal presentation by speculating as to the nature of the account we are proposing.

4.3 A semantic or a pragmatic account?

The notion of "collectivity as pure dependence" appears as pragmatically driven but semantically constrained.

As will be developed in formal details in the following section, the world in which the "collectivity as pure dependence" interpretation is possible is such that there exist objects on the one hand and descriptions on the other (descriptions as states or actions). The ontology comprehends only **singular entities** and **descriptions** assigned to these singular entities. When a predicate is combined with a plural argument, it is pluralized in such a way that there are as many events as individuals.

In the light of this ontology, we follow Lasersohn [Lasersohn, 1995, p.142] and Landman [Landman, 2000, p.148] recognizing that singular predicates do not denote groups but only singular entities. The collective interpretation is pragmatically driven and not semantically encoded in the grammar of the elements that the sentence provides us with.

It follows that we cannot by any means accept that the sentence denotes a unique collective event. If one wishes to claim that the collective reading compels us to recognize the existence of a collective Davidsonian argument, in order to avoid treating it purely descriptively (namely as if collectivity meant collective event), one has to explain by virtue of what general mechanism such a collective Davidsonian argument is reconstructed out of singular events.

On the one hand, the mechanism of this reconstruction is semantically constrained. The data presented in section (2) have suggested that not every property is compatible with the "collectivity as pure dependence reading". The nature of the property constrains and limits the cases of interpretability. Insofar as an appropriate model has to generate all of and only the possible interpretations, it has to explain why some properties are not compatible with cases of "collectivity as pure dependence".

Only the predicate furnishes the material for the descriptions assigned to the individuals. These descriptions will be used to establish a link, in the described situation, among these individuals.

On the other hand, the mechanism of reconstruction of non-accidental association is context driven. It is a general mechanism which rests on a principle of information flow and counterfactual reasoning. It is crucially enhanced by the way in which the agent perceives and conceptualizes the relations among descriptions of abstract objects, and among descriptions of complex abstract objects in particular.

Given a unique situation, both the distributive and the collective reading are possible. For two persons following exactly the same trajectory, this association can be seen either as accidental or not. The construction of the complex abstract object "common walk" is the result of the conceptualization of the speaker, which makes an hypothesis on the possible evolutions of the walk on the basis of a counterfactual reasoning. The description assigned to the event of walking furnishes the material in order to retrieve the dependence. Whether it is the case that this dependence is retrieved is up to the speaker. In any case, this is a cognitive mechanism which supplements pure denotation.

One important development of this work will consist in analyzing the lexical items *together* and *with*, to find out how this general rule of non-accidental association is instantiated. In section (7) we present a brief analysis of the difference between *together* and *with*, but the development of a model for these two items is outside the scope of this paper. It is now time to turn to the formal implementation of the notion of "collectivity as pure dependence".

4.4 Types, constraints and possible state spaces

In this section we work out in detail the formal model that we have introduced informally. Let us first of all recall that eventualities do play a crucial role. Inferences link the properties - descriptions - of the eventualities and not of the individuals involved. These allow us to take into account past and future developments of the reference situation, and to introduce modal notions related to the content of their descriptions.

4.4.1 Objects and descriptions

The ontology upon which the model is based is structured in two sub-domains, that of *objects* (or *entities* or *token*) and that of *properties* (or *descriptions*, or *types*).

Let individuals and events be objects (53):

$$(53) \quad \begin{aligned} D &\text{ be the domain of individuals;} \\ E &\text{ the domain of eventualities.} \end{aligned}$$

Plural *NPs* always denote a set of plural entities, without requiring any particular relations or structure on this set.

$$(54) \quad \| NP^{plural} \| = \{E \subset D \mid \#E > 1\}$$

Let I , for a predicate f , be the set of entities that fill a thematic role in the eventuality denoted by the predicate.

$$(55) \quad I = \{d^R \mid \exists(e)(\| f \| (e) \ \& \ \text{Role}(e) = d)\}$$

Following [Link, 1983] and [Landman, 2000, p.149], we assume that when a singular predicate is combined with a plural argument, it is pluralized. So, if the predicate is used singularly, there will be only one event. If the predicate is pluralized (combined with a plural *NP*), there will be as many events as participants *irrespective of whether the interpretation is collective or distributive*. (56) states, then, that for every individual in the set denoted by the plural argument, there is an event, such that the predicate assigns the truth value 1 to every pair (e, d^R) if d has a certain role in one of the plural events denoted by the pluralized predicate.

$$(56) \quad \forall d^R \in I(\exists e(\| f(e, d^R) \| = 1))$$

With respect to objects, the ontology only consists of singular entities, individuals or events. When a singular predicate is pluralized, each singular individual is mapped into a singular event.

The second sub-domain in our ontology is that of properties.

$$(57) \quad \Theta \text{ is the set of types}$$

Types are descriptions that correspond to human categorizations. The introduction of types into the model allows us to integrate the cognitive agent's perspective on entities in the situation. The cognitive agent can assign a description to any entity, minimally

recognizing its location in space and time. A classification is the object's type assignment to an entity³⁸.

- (58) **Classification** A classification is a triple $(Objects, Types, \models)$, where *Objects* is a set of objects, *Types* a set of categories or types, and \models a relation between *Objects* and *Types*. If $o \in Objects$ and $\sigma \in Types$, $o \models \sigma$ means that the o is of type σ .

Types can be assigned to either individuals or events. Types assigned to events are called *phases*. They register the content of an event, i.e. its past and future developments³⁹.

For an event of walking, for instance, the phases register the trajectory of the walk. For each point in time, part of the content of an event is represented by its future developments. Assuming a branching time representation [Penczek, 1995], given a certain point in the trajectory, there exist a particular set of points that can continue the walk under description. This set is Markovianly determined, i.e. it does not depend on the whole history of the events but only on the point in which the system is at time t .

Considering slices of the reality that are bigger than the points of a trajectory, one can assume that a walk (at time t), at a certain time t' can either continue, or not.

$$\begin{array}{ccccc}
 \varphi_{t'} & \dots & \dots & \dots & \neg\varphi_{t'} \\
 \dots & \swarrow & \dots & \nearrow & \dots \\
 \dots & \dots & \varphi_t & \dots & \dots
 \end{array}$$

For a complex state of affairs involving more than one entity, an agent can usually assign a description to every object that she has tracked.

³⁸In some recent studies on object tracking, Pylyshyn [Pylyshyn, 2003] has shown that objects can be individuated *per se*, without any property not even spatio-temporal locations. Property assignment to objects is a conceptual operation that requires to activation of a separate module of focal attention and a certain degree of abstraction from mere *objecthood*. These two steps, object identification and object description, correspond in our model to the distinction object / type. In more classical terms, it can be related to extensionality vs. intensionality, but this comparison would lead us too far away from our discussion. Let us emphasize here that distributive and collective interpretations of a singular predicate mobilize not only the visual module but also the conceptual one and that collective interpretation in particular seems to make appeal to a higher degree of abstraction than distributivity. Pylyshyn (ibid.) has in fact shown that the visual module does not allow us to track different objects as related, and that there is no sign of attention enhancement between objects. Moreover, on the basis of the mere visual system, agents do not make predictions on the future evolutions of the movement of an object. According to this analysis, then, the distributive interpretation in which objects are captured separately is more direct than the collective interpretation in which objects are captured as pairs, and which involves predictions of the future movements of pairs of objects.

³⁹They can be compared to object files for abstract objects [Kahneman, Treisman & Gibbs, 1992], which can be seen as a memory structure or a folder which stores information pertaining to a certain object.

- (59) **State space** is a set of classifications at time t for which each tracked token is of exactly one type. The state space S is complete if every type is the type of some token.

Note that a state space is a *situation*, i.e. an agent-oriented structured part of the reality. Very importantly, a state space is relative to a certain time t . Because the agent assigns a description only to tracked objects, a situation, in this perspective, is not simply a smaller "world" that is compatible with the conceptual capacities of a cognitive agent. The agent focalizes her attention on some events in which she is interested ⁴⁰. The only descriptions that our model will take into account are those that the sentence provides us with. Similarly, the only relevant state spaces are those that can be retrieved by the material provided by the sentence.

It is very important that the "collectivity as pure dependence" interpretation be possible only by virtue of the material provided by the sentence and no other extra information. Recall that while the collective interpretation is pragmatically driven, it is semantically constrained.

More precisely, all the material that we can use to retrieve the collective interpretation comes from the described events and the events that these events lump.

- (60) **Lumping** an event e lumps another event e' iff every state of affairs containing e also contains e' .

Lumping events are the denotational counterpart of lumping propositions [Kratzer, 1989]. Any event of everyday life can be seen either as a lumping or as a lumped event: talking on the phone lumps holding the telephone; paying lumps giving money and so on. Walking trivially lumps the event of controlling the trajectory and of not moving at random. The predicate thus introduces both the descriptions of the lumping and of the lumped events into the sentence. Both can be used to retrieve the collective interpretation.

For (1) the state space at time t would be:

$$(61) \quad s := \{ trajectory_\tau \models_s e_j ; trajectory_{\tau'} \models_s e_m \}$$

This set of classifications registers the fact that there exist an event of walking of John and an event of walking of Mary, and that these two events can be described by their trajectory, at a certain time t , at which the state space s is registered in cognitive agent's mind.

"Collectivity as pure dependence" crucially relies on the entailment between the properties of some events.

⁴⁰As mentioned in note (32), it is sometimes the case that agents do not assign a conceptual description to every tracked object.

(62) **Constraint** a constraint is a closed formula of the general form $Q((\tau \models o) \Rightarrow \rho)$ where, Q is a series of quantifiers, τ a type, o an object and ρ a well-formed formula.

Types correspond to observations and constraints are entailments among observations: x having a certain property entails that y has a certain property. From speaker's perspective, observing that entity x has a certain property means to infer that another entity in the domain has another property. Constraints express then the fact that, if one observation can be made, another observation can also be made. This fact amounts to the acquisition of a piece of information.

Two lumped events are by nature linked by a constraint. There can also be two events that are not lumped, but that are linked by a constraint. In this case, the cognitive agent sees these events as forming a network.

4.4.2 Condition for collective event interpretation for distributive predicates: first version

We can now state a first version for the "collectivity as pure dependence" interpretation for singular predicates.

(63) **Condition for "collectivity as pure dependence" interpretation I.**

$$\| f^{distr}(NP^{pl}) \|_{coll}^{sit,t} = \{e_{i,i \in I} \mid \forall i \in I (\| f \|^{sit,t} e_i = 1 \ \& \ \exists \tau ((\tau \models_s e_i) \Rightarrow \forall j_{j \in I} \exists \tau' (\tau' \models_s e_j)))\}$$

When it is applied to a plural NP , a distributive predicate is interpreted collectively with respect to situation sit at time t if it denotes the set of events indexed on individuals and thematic roles such that:

1. the predicate is true for any event involving an individual with respect to a certain thematic role and,
2. there exist a description such that, if it is a description for the eventuality involving any of the participants, then, there exist a description for any other eventuality involving any other participant.

Consider (1) again. Recall that the constraints bear upon the lumped events. For instance, the event of walking lumps that on following a certain trajectory and not moving at random. The type, or description of the event registers the trajectory. The collective interpretation for $((1) = (2c))$ will be as in (64):

(64) Collective interpretation for (2c)

$$\| \text{John and Mary are walking} \|_{coll}^{sit,t} = \{e_{(agent\{j\})}, e_{(agent\{m\})} \mid walk(e_j) = 1 \ \& \ walk(e_m) = 1 \ \& \ \exists trajectory_\tau ((trajectory_\tau \models_s e_j) \iff \exists trajectory_{\tau'} (trajectory_{\tau'} \models_s e_m))\}$$

(64) says that (1) is interpreted collectively if John walks, Mary walks, and if there is a certain description for the event of walking of John (e.g. the trajectory of the walk), then, this description entails that there exist a description for the event of walking of Mary.

Instead, the distributive interpretation will be as in (65):

(65) Distributive interpretation for (2c)

$$\| \text{John and Mary are walking} \|_{distr}^{sit,t} = \{e_{(agent\{j\})}, e_{(agent\{m\})} \mid walk(e_j) = 1 \ \& \ walk(e_m) = 1 \ \& \ \exists trajectory_\tau (trajectory_\tau \models_s e_j) \ \& \ \exists trajectory_{\tau'} (trajectory_{\tau'} \models_s e_m)\}$$

The trajectories describing the walks of John and Mary do not entail each other. They correspond to two concomitant but disjointed (unrelated) observations and descriptions.

4.4.3 Collectivity and dependence as entailment

Condition (63) states that under the "collectivity as pure dependence" interpretation, a sentence with a plural argument and a pluralized singular predicate, when it is interpreted collectively, denotes a plurality of events. The condition specifies the constraints that these events have to satisfy.

Nevertheless, one could argue that, instead of stating that the collective interpretation denotes a set of events as in (66) in which John and Mary are seen independently as the agents of the event of walking (and then no positing a condition on these events), we could have stated that under the collective interpretation the sentence denotes a collective event (67) in which the *group* is the agent (and then, eventually, describe the internal structure of this collective event).

$$(66) \quad \{e(agent\{j\}), e(agent\{m\})\}$$

$$(67) \quad \{e(agent\{\{j\}, \{m\}\})\}$$

A comparison with the approach of wholes as sums plus dependency relation is useful to explain why we refrain from adopting this strategy. This and our approach share the notion of dependence. However, contrary to our definition, neo-classical theories claim that the notion of dependence entails that of integration and thus that of unity. In short, they do recognize the existence from the outset of such a collective Davidsonian argument.

Let us reconsider our definition within the framework of theories of wholes as sums plus dependency relations (3.3). (65) would then become (68) and (64) would be as in (69).

$$(68) \quad \parallel \text{ John and Mary are walking } \parallel_{distr}^{sit,t} = \{e \mid \exists e', e'' \sqsubseteq e. \text{ walk}(e'_j) = 1 \ \& \ \text{ walk}(e''_m) = 1 \ \& \ \exists \text{trajectory}_\tau (\text{trajectory}_\tau \models_s e'_j) \ \& \ \exists \text{trajectory}_{\tau'} (\text{trajectory}_{\tau'} \models_s e''_m)\} \\ (\neq (65))$$

$$(69) \quad \parallel \text{ John and Mary are walking } \parallel_{coll}^{sit,t} = \{e \mid \neg(\exists e', e'' \sqsubseteq e. \text{ walk}(e'_j) = 1 \ \& \ \text{ walk}(e''_m) = 1)\}$$

As we have seen in section (3.3), under this account, the difference between the distributive and the collective interpretation relies on the fact that the parts are accessible in the first case, but not in the second. The collective interpretation in (69) is blind to the fact that each of the participants is involved in an event of walking⁴¹.

Let us focus only on the collective reading. One could improve the definition and make explicit the internal structure of the collective event argument. The definition, from a neo-classical perspective, would be as in (70):

$$(70) \quad \parallel \text{ John and Mary are walking } \parallel_{coll}^{sit,t} = \{e \mid \neg(\exists e', e'' \sqsubseteq e. \text{ walk}(e'_j) = 1 \ \& \ \text{ walk}(e''_m) = 1) \ \& \ \exists \text{trajectory}_\tau ((\text{trajectory}_\tau \models_s e_j) \Leftrightarrow \exists \text{trajectory}_{\tau'} (\text{trajectory}_{\tau'} \models_s e_m))\}$$

This representation states that under the collective interpretation the sentence denotes a collective event, and that this event is structured in two sub-events which depend on each other.

This definition, to which a neo-classical approach leads, contains a contradiction. It states that the whole exist by virtue of dependence relation among subevents which are also said to be non-accessible i.e. non-ontologically-independent and thus non-existent.

Let us consider then (69). Insofar as our aim is to state the criteria that allow us to recognize an event as being collective, we refrain from stating that a collective interpretation makes reference to a collective Davidsonian event. As we are looking for the conditions that would allow us to recognize the existence of this abstract object, and trying to make sense of the somehow tautological explanation "collectivity means reference to a group event in which there are not sub-events", we suggest that the collective event is nothing but related events, and has to be understood as "one as many that are related, without unity".

⁴¹One might also wonder if it is really worthwhile stipulating that the distributive reading makes reference to a group Davidsonian argument. For the sake of clarity, we only concentrate on the collective interpretation.

To put is rather succinctly, we are suggesting that is not entirely explicative (71) and (72) should be preferred.

$$(71) \quad \text{Collective interpretation} = \{e_{\text{collective}} \mid e \text{ no parts} \}$$

$$(72) \quad \text{Collective interpretation} = \{e_i \mid \text{there exist a dependence among the } e_i \}$$

Remember, finally, that the constraint which links the description of the events reflects the interpretation of the speaker: the difference between the collective and the distributive interpretation for (2c) is a question of perspective with regard to two extensionally identical situations. As we have argued, this notion of perspective does not only enable the cognitive agent to switch from a distributive interpretation to the collective one and vice versa. More importantly, it consists in a counterfactual reasoning in relation to the situation.

It is now time, then, to introduce other state spaces (as possible worlds).

4.4.4 Introducing other state spaces

Condition (63) has to be further elaborated. Imagine two people who are accidentally moving exactly from point A to point B . One can put a constraint between the descriptions of their walks in accordance with the observation that the two people have been following the same trajectory. It is true that, in such cases, it is observationally impossible to state the difference with two persons walking voluntarily close to each other. Nevertheless, one can formulate the difference in counterfactual terms, and state that, if two people follow the same trajectory collectively, a change in the description of one of them has to affect the whole system. Perhaps such a change does not occur. In this case the distributive and the collective situation appear to be undistinguishable extensionally.

However, if a change intervenes, it is foreseen as affecting the system in the collective case, but not in the distributive one. No prediction is made under the distributive interpretation.

We have defined state spaces as relative to a time t (59).

A state space can evolve. Its evolutions correspond to the evolutions in the phases describing the event. Recall that to keep on walking, to stop, or to change trajectory, are all possible developments of the description of a walk.⁴²

Recall (74) repeated here in (73), which represents the state space for (1) at the time of the utterance t .

$$(73) \quad s := \{ \text{trajectory}_\tau \models_s e_j ; \text{trajectory}_{\tau'} \models_s e_m \}$$

⁴²We consider that the interruption of the walk is still part of the walk, because it is a possible evolution.

This state space can evolve at t' as given in (74)

$$\begin{aligned}
(74) \quad & \text{a. } s'_1 := \{ \textit{trajectory}_\tau \models_{s'} e_j ; \textit{trajectory}_{\tau'} \models_{s'} e_m \} \\
& \text{b. } s'_2 := \{ \textit{changetrajectory}_\tau \models_{s'} e_j ; \textit{trajectory}_{\tau'} \models_{s'} e_m \} \\
& \text{c. } s'_3 := \{ \textit{trajectory}_\tau \models_{s'} e_j ; \textit{changetrajectory}_{\tau'} \models_{s'} e_m \} \\
& \text{d. } s'_4 := \{ \textit{stoptrajectory}_\tau \models_{s'} e_j ; \textit{trajectory}_{\tau'} \models_{s'} e_m \} \\
& \text{e. } s'_5 := \{ \textit{trajectory}_\tau \models_{s'} e_j ; \textit{stoptrajectory}_{\tau'} \models_{s'} e_m \}
\end{aligned}$$

Both of the persons can either keep on walking along the same trajectory, or stop, or change trajectory.

(75) states that S' is the set of set of classifications into which s can evolve, at time t' immediately following t . The immediateness depends on the granularity.

$$(75) \quad S' = \{ s' \mid \forall t, t', S. t \succ t' \rightarrow (s \hookrightarrow s') \}$$

S' registers the descriptions of the possible evolutions of the eventualities denoted by the pluralized predicate. Therefore, it is the evolution in time of the classifications in s . In other terms, the descriptions in S' follow from the descriptive content for the eventualities at s . For any possible evolution of an event or a state, the agent has to *refresh* her knowledge and, in this respect, the constraint which links the descriptions of the eventualities is dynamic.

We can then elaborate condition (63) as in (76). Note, in particular, that the existential quantifier having scope over the description of the first eventuality is replaced by the universal.

(76) **Condition for "collectivity as pure dependence" interpretation II.**

$$\| f^{distr}(NP^{pl}) \|_{coll}^{sit,t} = \{ e_{i,i \in I} \mid \forall i \in I (\| f \|^{sit,t} e_i = 1 \ \& \ \forall s'_{s \hookrightarrow s'} (\forall \tau ((\tau \models_{s'} e_i) \Rightarrow \forall j, j \in I \ \exists \tau' (\tau' \models_{s'} e_j)))) \}$$

When it is applied to a plural NP , a singular predicate is interpreted collectively in situation *sit* at time t if it denotes the set of events indexed on individuals and thematic roles such that:

1. the predicate is true for any event involving an individual with respect to a certain thematic role and,
2. for any possible state space s' accessible from s , for every description, if it is a description for the eventuality involving any of the participants, then, there exist a description for any other eventuality involving any other participant.

Let us formalize the collective and the distributive readings of (1):

(77) Collective interpretation for (1)

\parallel Jean et Marie are walking $\parallel_{coll}^{sit,t} = \{e_{(agent\{j\})}, e_{(agent\{m\})} \mid walk(e_j) = 1 \ \& \ walk(e_m) = 1 \ \& \ \forall s'_{s \leftrightarrow s'} \forall trajectory_\tau ((trajectory_\tau \models_{s'} e_j) \Rightarrow \exists trajectory_{\tau'} (trajectory_{\tau'} \models_{s'} e_m))\}$

(78) Distributive interpretation for (1)

\parallel John and Mary are walking $\parallel_{distr}^{sit,t} = \{e_{(agent\{j\})}, e_{(agent\{m\})} \mid walk(e_j) = 1 \ \& \ walk(e_m) = 1 \ \& \ \exists trajectory_\tau (trajectory_\tau \models_s e_j) \ \& \ \exists trajectory_{\tau'} (trajectory_{\tau'} \models_s e_m)\}$

These representations differ in two respects:

- (i) in (78) there is no constraint linking the descriptions of the eventualities,
- (ii) in (78) the possible evolutions of the eventualities are not taken into account (the association is accidental and can only be captured step by step).

Let us consider how the definition of collectivity applies to a concrete case:

Consider an S in which John and Mary are walking. In S' at t' one of following configurations can be verified:

1. John keeps on walking and so does Mary. There is a **co-variation** ([Lewis, 1973]), so they can be said to walk collectively in S .
2. John stops and so does Mary. Again there is a co-variation, so they can be said to walk collectively in S .
3. John stops and Mary keeps on walking. There is **no** co-variation so the formula is false at S .
4. John keeps on walking and Mary stops. Again, there is no co-variation so the formula is false at S .

When a co-variation is *observed* John and Mary *can* be *considered* as walking collectively. When there is no co-variation, John and Mary are viewed as walking distributively.

It is also possible though that two walks are observed as evolving in parallel, the parallelism remaining nonetheless accidental. (76) is a **rule** for interpretation.

It states that it is necessary that under the collective interpretation the agent foresee that two events co-varyate. It does not exclude that a parallelism is observationally verified in the case of an accidental association.

The difference between accidentality and collectivity can be stated in terms of observation / prediction. In the first case the agent observes that some events occur in parallel. In the second one, she predicts that they will co-varyate.

5 The question of co-localization and individual-level properties

With this definition of "collectivity as pure dependence" we can now come back to the question of co-localization and individual-level properties. In the following subsections we consider them in turn.

5.1 Processive view of localization

It is generally assumed (e.g. [Lasersohn, 1995], [Moltmann, 1997]) that two entities occupying the same position can be seen as collectively co-localized. The data show that this is not always the case. Recall the examples in (5a) and (6a), repeated here as (79a) and (79b)

- (79) a. The glasses and the decanters are in the cupboard
 → The glasses are in the cupboard with the decanters
 b. *The forest and the lake are on the hill
 → The forest is on the hill and the lake is on the hill
 ↯ The forest is on the hill with the lake

Collectivity as pure dependence does not require that the entities which are related be in the same place at the same time. Recall (8), repeated here as (80):

- (80) John and Mary are talking on the phone

Collectivity as pure dependence interpretation seems to apply only to processes. However, in some cases, it can apply to entities which are not acting together but only occupy the same position at the same time. We suggest that this is possible only if their localizations (in the same place at the same time) are viewed as epistemically related processes.

To explain these data, we make the hypothesis that, for two entities to be said co-localized, their being in some place l has to be seen as a process regulated by an epistemic constraint. (81):

- (81) **Processive view of co-localization.** Two entities are said to be co-localized at s if they are categorized in such a way that a constraint linking the descriptions of the eventualities in which they are involved exists for any possible state space S' into which s can evolve. Requirements:

- the entities have to be at the same place l at t

- if one of the entities moves or changes its position, this affects the *knowledge* relative to the whole

Let s be a state space registering the spatio-temporal location of some entities or events. S' is such that either the entities keep the location, or change it. Very importantly, one can admit only that they can "keep their location" or be "kept in their location" if it is possible for them to change it (or to be displaced). Otherwise, S' is not the set of the a possible *evolutions* of state s .

For (79a) the state space s is such that the glasses and the decanter are in the cupboard at time t . At t' , both the glasses and / or the decanters can be kept or not in the cupboard. As long as both are foreseen as retaining their location, the "collectivity as pure dependence" interpretation is borne out.

If either the glasses or the decanters are not kept in the cupboard, the information about the other entity is lost. In fact it is enough that one entity changes its location for the agent to loose the knowledge about the system.

Definition (76) also applies to cases of co-localization for movable entities. We repeat it as (82)

(82) **Condition for "collectivity as pure dependence" interpretation and co-localization.**

$$\| f^{distr}(NP^{pl}) \|_{coll}^{sit,t} = \{e_{i,i \in I} \mid \forall i \in I (\| f \|^{sit,t} e_i = 1 \ \& \ \forall s'_{s \hookrightarrow s'} (\forall \tau ((\tau \models_{s'} e_i) \Rightarrow \forall j, j \in I \ \exists \tau' (\tau' \models_{s'} e_j))))\}$$

The constraint, which links two observations, is epistemic: the position of one entity is seen as providing information about the position of another. As we noted in the last section, the difference between accidental and non-accidental association, and, in this case, between juxtaposition and co-localization, can be stated as a difference between observation and prediction. In the first case, two entities are observed as each keeping a certain location, and in the second case, the agent foresees that if one of the entities retains the position, the other will keep it too.

An important note is needed here however. The idea that juxtaposition always enables the collective interpretation can be explained. It goes hand in hand with the idea that two co-localized entities can always be categorized as associated, as long as the processive view of co-localization holds.

This does not require, though, that co-localization be a necessary and sufficient feature for collective interpretation. It is only a possible instantiation of the more general principle of properties' dependence and epistemic constraint. For two localized entities, the act of individuating them with respect to one another has to bring some new information

with it. When, in spite of two entities being co-localized, the dependence between the properties does not carry any new information, the collective interpretation is not borne out.

As we have seen, the configuration in which the entities cannot change their position (at least in those cases where a considerable amount of time is provided⁴³), is problematic.

The processive view of co-localization explains why "collectivity as dependence" interpretations of (79b) and (79a) are not possible. Condition (81) states that two entities are said to be co-localized if it could possibly not be so.

It is thus redundant to apply an epistemic constraint to the localization of two non-movable entities (as in the case of the forest and the lake). The localization of an entity that cannot - given the agent perspective - undergo any change is independent of the localization of any other entity. Then, it is informationless to assert that their localization is stable and that it depends epistemically on that of another entity.

To conclude, the constraint with respect to possible state spaces is counterfactual: one could not know anything about one entity if one does not know anything about an other entity to which the first is related. In this sense, the constraint is informative. This is not the case, of course, for a lake and a lake that are on a mountain.

5.2 Constraints and definitory properties

We have also observed that "collectivity as pure dependence" is incompatible with individual-level properties [Carlson, 1977].

Remember (10) that we repeat here as (83):

- (83) a. John and Mary are pop stars \nrightarrow a'. *John is a pop star with Mary
 b. John and Mary are sad \nrightarrow b'. ??John is sad with Mary

[Laserson, 1995] and [Landman, 2000] would explain these data with reference to the fact that the property would be necessarily distributed on each of the individuals and this is incompatible with the principle of no redistribution (21) or the collectivity criterion (39). Nevertheless, because the "collectivity as pure dependence" reading is compatible with distributed properties, we need another explanation. One can also probably argue that individual-level properties are generic and thus do not necessarily have a Davidsonian argument.

Firstly, as we mentioned at the beginning of the paper (2), some predicates, which are supposed to have a Davidsonian event argument, are also incompatible with "collectivity

⁴³Things can always be displaced: the universe can collapse, or a thunderstorm can destroy them. Nevertheless, as cognitive agents, we can make the distinction between movable and non-movable entities.

as pure dependence" interpretation. Recall, for instance, (12), repeated here as (84)

(84) The children are asleep

Moreover, individual-level properties are not incompatible with every kind of collective interpretation, and, in particular, they are perfectly appropriate for "collectivity as collections" (e.g. (13 repeated here as (85))

(85) The blond and the brown-haired met in different rooms

Finally, insofar as not every account of collectivity is based on events (e.g. [Schwarzschild, 1996]), one has to provide an explanation that does not rest on reasons that are independent of the very notion of collectivity.

According to condition (76), the explanation follows without difficulty. (83) cannot be interpreted as a case of "collectivity as pure dependence" because the knowledge that an agent has about a definitory property of an entity is not related to the knowledge that she has about a denfinitory property of another entity.

A constraint would be redundant in the same way it was for (79a).

In (83a), the information related to the fact of John being a pop star is not related to the fact of Mary being a pop star. In the same way, for (83b), *with*-sentences can only be understood as if Mary were the cause of the sadness of John. When the preposition is absent, and there are only the conjoined phrases, the only possible interpretation is that John and Mary form a collection of sad persons. It is not possible to recover the intermediate interpretation according to which the sadness of John and that of Mary are informationally dependent.

Consider (11) repeated here as (86):

(86) ?Every time that John is sad, he is sad with Mary

If we discard the interpretation according to which John is sad because of Mary, (86) is preferable to (83b) because the agent links the epiphenomena of John's being sad to Mary's being sad. The constraint, in this case, bears upon the manifestations of the sadness of John and of Mary.

When the property is not "visible" and cannot occur iteratively, this tiny constraint cannot be established, as in (87).

(87) ??Every time that John is a pop star, he is a pop star with Mary

Possibly, the only reading for (87) is that in fact they are not pop stars, but behave like pop stars on certain occasions.

Consequently, one can relate properties to one another only insofar as they can be seen as processes, that is to say, as being able to undergo a change. The fact that things could possibly be otherwise makes possible the counterfactual reasoning upon which the "collectivity as pure dependence" interpretation is based.

If a change is possible (if the description of one of the two entities changes), then, this affects the knowledge relative to the whole system. As soon as the agent loses the information relative to one of the entities, she loses the information relative to the other.

Definitory properties cannot by nature undergo any change, and thus they are not epistemically dependent on other properties. Instead, their manifestations can be seen as "processes" and they can thus be constrained.

Condition (76) allows us to make a distinction between constraint proof properties and properties that are available for connections. This distinction overlaps that which holds between individual-level and stage level properties, and sheds a new light on the view of localization, establishing a distinction between processive and stable localization.

6 Extensions

6.1 Generalization to groups

Until now we have considered cases of conjoined *NPs*. Definition (76) easily extends to cases of plural, non-conjoined *NPs*.

(88) The boys are singing

(88) can be interpreted in three ways: as a case of "collectivity as collection" (in this configuration each boy sings but independently of the others); as a case of "collectivity as team credit" (the boys are singing in a chorus, and perhaps some of them are not singing) or as a case of "collectivity as pure dependence" (some boys are coordinating their singing and each of them sings).

The difference between the interpretation as a case of "collectivity as pure dependence" and "collectivity as team credit" is that it is necessary in the first case, but not in the second, that every boy sing. This is possible if one admits [?] that sentences with singular predicates can be interpreted, given some contextual information, as cases of team credit responsibility. In this case, one can know that the boys form a chorus. We consider these cases in turn.

With respect to "collectivity as pure dependence interpretation", it is clear that (76) will apply.

We want to grasp the fact that the description of any of the events involving any of the boys is linked to the description of the rest of the group. Following [Lasersohn, 1995,

p.142], we agree that considering the group as a unity is not suitable. Again, this would be an over-zealous ontological claim, considering the consequences of the notion of unity. Instead, we suggest condition (90):

(89) **Condition for "collectivity as pure dependence" interpretation for groups.**

$$\| f^{distr}(NP^{pl}) \|_{coll}^{sit,t} = \{e_{i,i \in I} \mid \forall i \in I (\| f \|^{sit,t} e_i = 1 \ \& \ \forall s'_{s \leftrightarrow s'} \ \forall j \in I (\forall \tau ((\tau \models_{s'} \wp(e_{i-e_j})) \implies \exists \tau' (\tau' \models_{s'} e_j))))\}$$

When it is applied to a plural NP , a singular predicate is interpreted collectively in situation sit at time t if it denotes the set of events indexed on individuals and thematic roles such that:

1. the predicate is true for any event involving an individual with respect to a certain thematic role and,
2. for any possible state space s' accessible from s , for every participant; for every description, if it is a description for the eventuality involving any of the participants except one in particular, then, there exist a description for this particular participant.

Note that this definition forbids to pick two particular individuals in the set and see them as to be singing together. This has to do with a problem of individuability. If John and Peter are two individuals in the set in which every member is coordinating his singing with the singing of every other member, one cannot describe them by asserting *John and Peter are singing* \rightarrow *John is singing with Peter*.

It follows that the constraint does not symmetrically link an individual with the rest of the set and the rest of the set with a particular individual in the set. In fact, if one of the members of the group stops singing, the rest of the group not necessarily stops. The inverse is not true. This is why the property of the group constrains the property of each individual, but not vice versa.

At this point, there is a strong similarity between the interpretation of "collectivity as pure dependence" and the "team credit" interpretation. Let us consider this second interpretation, then.

This asymmetry captures the foundational intuition that, within a group, whenever there is a team credit responsibility, the action of an individual does not radically change the behavior of the rest of the group. At what point, and to what extent the action of a relevant selection of individuals affects the behavior of the whole is pragmatically determined. The only change we have to introduce, then, is in the force of the quantifier.

We do not necessarily require that every boy sing, but only that a relevant part does. The interpretation of the quantifier *Part* is strictly pragmatically determined.

(90) **Condition for "collectivity as team credit".**

$$\| f^{distr}(NP^{pl}) \|_{coll}^{sit,t} = \{e_{i,i \in I} \mid \text{Part } i \in I(\| f \|^{sit,t} e_i = 1 \ \& \ \forall s'_{s \hookrightarrow s'} \ \forall j_{j \in I} (\forall \tau((\tau \models_{s'} \wp(e_{i-e_j})) \implies \exists \tau'(\tau' \models_{s'} e_j))))\}$$

Ceteris paribus, this definition states that, if a relevant part of the members satisfies predicate *f*, then, the rest follows.

Note, that this view of the notion of team credit responsibility, is not based on that of monad or unity, but considers the internal behavior of the parts of the whole. But because the study of this notion is outside the scope of this paper, let us come back to the extensions of the notion of "collectivity as pure dependence".

6.2 Reciprocity

Nowadays it is recognized [Higginbotham, 1980], [Gillon, 2003] that the semantics and the pragmatics of reciprocity are strictly related to those of collectivity. Subscribing to this hypothesis, we briefly show in this section, without providing a comprehensive account and leaving aside a large number of details, how our definition of wholes as networks can extend to reciprocity.

Foundational studies of reciprocal statements [Langendoen, 1978], [Dalrymple et al., 1998] have shown that there are many different configurations into which the notion of reciprocity can decline.

This variety can either be explained by the existence of an underspecified sense - as Gillon argues in a very recent study [Gillon, 2003], where he advances the hypothesis that *symmetry* is the basic feature - or, following [Dalrymple et al., 1998], one can assume that there are as many meanings as configurations, and that the appropriate meaning is contextually selected⁴⁴. In what follows we make the hypothesis that not only that this variety can be contextually generated from a unique under-specified condition, but also that symmetry is not the default value of the meaning of reciprocity.

Intuitively, entities involved in a reciprocal relation form a network. It is generally assumed that there is a relation *R* that holds between the members of the group. *R* takes two arguments, and does not need to be symmetrical: any member of a group can enter relation *R* either as the first or the second argument. Making explicit what is sometimes left implicit in the literature, this relation can be analyzed in two active-passives relation, and each member can enter the relation either on its passive side, or the active one.

⁴⁴[Dalrymple et al., 1998, p.93] propose the famous Strongest Meaning Hypothesis.

The specificity of reciprocity with respect to comitativity⁴⁵ lies precisely in this active-passive configuration which holds pairs of individuals together.

If under the collective reading the entities have to satisfy a property "in parallel" (e.g. *sing, walk ...*) or, at most, "as in a mirror" (*talk on the phone, ...*), under the reciprocal reading, they have to satisfy "converse" properties (*look at each other, talk to each other ...*). This is not due to the very essence of the property, but to the presence of *each other*⁴⁶.

Note that, in the "mirror" relation, which most resembles the "converse" one, none of the individuals enters an active-passive relation: *John and Mary are talking on the phone* presents John and Mary as having a conversation: whenever one of them is listening to the other, she or he is not seen as the patient of the action, as if he or she were "talked to by" the other⁴⁷. Instead, the assertion *John and Mary are talking to each other* is not interpreted as if John and Mary were having a conversation. Each of them, in turn, is seen as the addresser and the addressee.

More generally, reciprocals constrain the relation between the individuals in such a way that if τ is the property that one of them satisfies, τ^- is the converse of this property that the other has to satisfy: to put it another way, it forces the individuals to enter an active-passive relation with respect to the predicate.

All this is mere intuition. The novelty of our account, which takes its inspiration from the notion of whole as network, consists in interpreting the active-passive relation in the light of the (technical) notion of dependence and of epistemic constraint. Moreover, we refrain from presupposing the existence of a group in which the members are linked by relation R and from analyzing the possible configurations of this relation in a second step. As we have argued with respect to "collectivity as pure dependence" cases, it is by virtue of being related by relation R that they form a group. This change in perspective sheds a different light on the significance that this relation has in the definition of the notion of reciprocity. Our aim will not to uncover the possible configurations of this relation, but what, in its very essence, makes the notion of reciprocity what it is.

Since [Langendoen, 1978] it has been shown that the relation need not be symmetrical, i.e. the entity that is looked at by one entity does not necessarily have to look back at the entity that is being looked at by⁴⁸. This asymmetry gives rise to the different

⁴⁵From now on, by "comitativity" we will always be referring to the "comitativity as dependence" reading.

⁴⁶A lot could be said about floating quantifiers. We do not provide an analysis here of the lexical *each other*, but, in general, of the reciprocal relation, taking for granted the presence of this operator [Dalrymple et al., 1998], [Schwarzschild, 1996], [Gillon, 2003].

⁴⁷Of course, the notions of agent-patient have to be understood with respect to one another. As we argue in the following paragraphs, these are not labels for thematic roles, but for conceptually driven properties that are enhanced by the reciprocal interpretation.

⁴⁸Recall here the famous example [Dalrymple et al., 1998, pages 166 and 171] *The pirates were staring at each other*.

configurations discussed at length by [Dalrymple et al., 1998].

In taking this claim seriously, the specificity of our analysis is that, at the root of the very notion of reciprocity, each individual need not satisfy, at the same time, and with respect to any other individual, both of the roles (active-passive).

Our hypothesis is, therefore, that, if an underspecified sense exists, it is, trivially, the least constrained. The least constrained configuration is the one in which there are some entities which satisfy the active side of the action or state, and some others which satisfy the passive one⁴⁹.

The definition of reciprocity we are about to propose, in the same way as that of collectivity, is intensional and is based on the application of a constraint over properties of entities. Crucially, the definition of reciprocity has to grasp the fact that the entities which enter a reciprocal relation, even if non-symmetrical, form a group. To achieve this, the definition expresses the fact that if there is an individual who satisfies property τ , *this property is such that* there is another individual who satisfies the converse property τ^{-} ⁵⁰.

Again, the constraints bear upon descriptions and not over individuals, and this avoids the accidental association. Note, in fact, that this does not amount to asserting that for any individual who satisfies the active side of the property, there exists elsewhere another individual who satisfies the passive side of the property: the entailment links the properties -passive and active - and not the entities. Let us first introduce the definition and then come back to these crucial considerations.

(91) **Reciprocity**

$$\| (NP^{pl} \text{ each other}) \|_{rec}^{sit,t} = \{e_i, i \in I \mid \forall i \in I (\| f \|^{sit,t} e_i = 1 \ \& \ \forall s'_{s \hookrightarrow s'} (\forall \tau ((\tau \models_{s'} e_i) \Rightarrow \exists j, j \in I, \exists \tau^- (\tau^- \models_{s'} e_j))))\}$$

A sentence is interpreted as involving a meaning of reciprocity in the situation *sit* at time *t* if it denotes the set of events indexed on individuals and thematic roles such that:

1. the predicate is true for any event involving an individual with respect to a certain thematic role and,
2. for any possible state space s' accessible from s , for every description, if it is a description for the eventuality involving any of the participants, then, there exist another participant and a converse description which is the description for the eventuality in which this participant is involved.

⁴⁹This can be identified with Inclusive Alternative Ordering [Dalrymple et al., 1998, p.175]: "... says that every member x of the set A participates with some other member in the relation R as the first *or* the second argument, but not necessarily in both roles ...".

⁵⁰This statement is very different from the extensional formulation provided by [Dalrymple et al., 1998, p.175].

This definition states that any individual has to be involved in relation R but not that she / he has to satisfy both of the properties (direct and converse). It states instead that, as soon as one individual satisfies one part of the reciprocal relation, this entails that there exist another individual with satisfy the converse.

The nature of the active-passive relation. Note that we have not introduced two separate sets of entities, each occupying the thematic roles "agent" and "patient" respectively. Entities are indistinguishable on the basis of a syntactic and semantic relation: in other words, they are interchangeable. This interchangeability certainly constitutes an additional resemblance between collectivity and reciprocity. The asymmetric active-passive distinction is more likely a conceptual one and is strictly related to the contextual information providing us with certain entities in an "active" position, and some others in a "passive" one.

Moreover, this active-passive distinction can take the form of positional relations in space and time: for two entities that are placed on top of each other, the surface property "on top of" brings about its converse: "below". Reciprocals exploit this very general mechanism.

Non-accidentality As for collectivity as pure dependence, one has to make sure that the entities form a group, and that the relation is not accidental. Particularly with respect to reciprocity, this constraint amounts to stating that even though some people are looking at each other "in chain", or not in a strictly symmetrical way, this very act of looking and being looked at has to involve a "coordinated" relation. If someone (p_1) is looking at someone else (p_2), and a third person (p_3) is being looked at by a fourth one (p_4), there is only a pair of co-occurring events. They are not constrained, and there is only a purely accidental juxtaposition: they do not form a network.

The very notion of network based on dependence is grounded on the idea that there is a constraint (entailment) that bears upon the properties (passive and active), which means that the entities do not satisfy the property accidentally with respect to one another: the fact that one person p_1 is being looked at by another person p_2 is constrained and dependent on the fact that some other person p_3 is looking at, perhaps, a fourth person p_4 . The people, then, do form a *group*, or pairs, of entities that are looking and being looked at. Again, as for comitativity, the very notion of group results from the constraint and the dependence that links the people to one another.

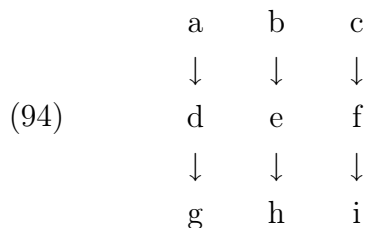
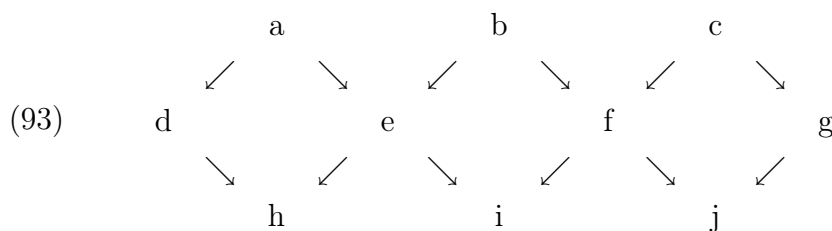
Let us just consider some examples, and in particular the cases of non symmetrical relations which seem to pose the most difficult problems for actual theories [Gillon, 2003].

Consider the famous example (92) taken from [Langendoen, 1978, p.191]:

(92) The speakers succeeded each other to the podium

The difficulty rises for theories based on symmetry as default value in that the first speaker does not succeed anybody. Definition (91) does not require that the first speaker succeed some other speaker. It states instead that, for every speaker who succeeds another speaker, there is a speaker who is succeeded by another one. These speakers, are, respectively the last one and the first one in the queue.

The same pattern of reasoning is also valid for more complex configurations, such as intermediate alternative reciprocity [Dalrymple et al., 1998, pages 172] or inclusive alternative ordering [Dalrymple et al., 1998, pages 174]. Consider configurations (93) and (94) which illustrate, respectively, these two cases:



In the same way, for tables stacked on top of each other in a pyramid, which is given by [Dalrymple et al., 1998, p.173] as a particular case of intermediate alternative ordering, the only requirement is that for every table which is on the top of another table, there is at least one table below another table. Pyramidal, chain-like configurations are possible arrangements. However (and here we are in agreement with [Gillon, 2003], [Schwarzschild, 1996] and many others), there exists an underspecified sense which subsumes these configurations.

Cases of generally felt prototypical reciprocity (strong symmetric reciprocity, e.g. *John and Mary looked at each other*), are the most constrained: they require that the person who is looking at another person have her gaze returned by the persons she looks at. Given the contextual information that there are only two entities, definition (91) can generate this interpretation appropriately.

To sum up: a lot remains to be said about reciprocity. Our aim here is only to open a new direction of investigation on the basis of two basic hypotheses: (i) reciprocity and plurality are two strictly related domains (following, among many others,

[Schwarzschild, 1996], [Gillon, 2003], [Higginbotham, 1980]); (ii) there is an underspecified sense, which is contextually constrained.

The notion of "collectivity as pure dependence" that we have explained in terms of "wholes as network" offers an interesting insight. We have claimed that the difference between collectivity and reciprocity lies in the relation between the properties that the participants have to satisfy. In reciprocal statements, the entities have to enter an active-passive relation. This is not the case for "collectivity as pure dependence".

As it is based on the very notion of constraint between properties as non accidental association, definition (91) guarantees that the active-passive relation in which some entities are involved is not the pure coincidence of randomly tracked events.

Definition (91) uniquely requires that if an individual satisfies a property either actively or passively, this property is such that another individual satisfies its converse: it is the very occurrence of the property which entails that its converse occurs too. Individuals who satisfy such related properties do enter a group which is precisely held together by reciprocal relations.

The configurations discussed by [Dalrymple et al., 1998] and previously introduced by [Langendoen, 1978] and others, can then be considered as the result of the application of the general definition in some specific contexts.

7 A brief note on *together* and *with*

In this paper we have been analyzing the abstract notion of collectivity with respect to plural and coordinated NPs. The condition for collective interpretation has been given independently of any lexical instantiation. As we promised in section (4.3), we shall now present very briefly some considerations related to lexical forms of *together* and of *with*, to find out whether one of these items instantiate the definition, or whether condition (76) is under-specified and is differently constrained by these two items.

[Moltmann, to appear] shows that *together* has different meanings when it is in the adnominal or in the adverbial position: the first one imposes a sum reading (95), whereas the second one imposes collective, non-sum interpretation (96):

(95) John and Mary together earn 5000\$

(96) *John and Mary earn 5000\$ together

With also triggers non-sum interpretation, so we compare it with the adverbial *together*.

There seem to be two major differences.

First, *together* requires that the individuals satisfy parallel properties, whereas *with* does not.

(97) The president and his bodyguards behind him are making the declaration together

(98) The president is making the declaration with his bodyguards behind him

(97) can only mean that the president and his bodyguards are all making the declaration, whereas (98) means that only the president is making the declaration.

Secondly, *together* is compatible with the end point of an accomplishment, whereas *with* looks for the preparatory phase of the end point.

(99) John and Mary have finished the book together

(100) John has finished the book with Mary

(99) can mean that John and Mary have each finished reading the same book, at the same time. The *with*-sentence means that John and Mary have collaborated in reading (or possibly wrtining) at least the final part of the book.

Thirdly, *with* is compatible with cases where one entity influences the other, without the influence being symmetrical:

(101) The tides and the moon move together

(102) The tides move with the moon

(101) registers the fact that both the tides and the moon move, but does not allow to make any inference on how it is possible and which entity is responsible for the movement. If one finds that the movement of the tides depends on that of the moon, it is by virtue of encyclopedic information. (102) clearly means, instead, that it is because the moon moves, that the tides move too. *With* brings this information lexically. Of course, *with* does not require such an asymmetry, as shown in (103), which illustrates the typical comitativity reading:

(103) John is walking with Mary

Finally, let us note that *with* is compatible with punctual achievements only when a relation between two events can be recovered.

(104) My grandfather and my grandmother died together

(105) My grandfather died with my grandmother

(106) can means that my grandparents died at the same time; (107) strongly suggests that there is a relation between the two deaths. This is emphasized by cases where this relation is *a priori* non-existent:

(106) My grandfather and the vice president of my firm died together

(107) ??My grandfather died with the vice president of my firm

Whereas (106) means that my grandfather and the vice president of my firm died at the same place and at the same time, (107) is uninterpretable, insofar as one cannot recover any relation between the two men and thus between their deaths.

Our hypothesis is that, in a spectrum that moves from whole as sum to whole as dependence, *together* stays closer to the sum meaning and *with* to the dependence reading.

Together requires a symmetry among the events it links, but puts no constraints on possible (past and future) evolutions of the phases that describe the component events. *With* is compatible with asymmetry, and bears upon possible (past and future) evolutions of the events involving the participants.

The underspecified condition (76) will then be instantiated, respectively, by *together* and *with* as in (108), (109) and (110).

(108) **Together**

$$\| \text{together}(NP^{pl})(f^{distr}) \|^{sit,t} = \{e_{i,i \in I} \mid \forall i \in I (\| f \|^{sit,t} e_i = 1 \ \& \ \exists \tau ((\tau \models_s e_i) \Rightarrow \forall j_{j \in I} \exists \tau' (\tau' \models_s e_j)))\}$$

Together takes sets of plural entities as its first argument and one-place predicate denotation as its second argument⁵¹. The sentence will then denote a set of events such that:

1. the predicate is true for any event involving an individual with respect to a certain thematic role, and,
2. there exist a description such that, if it is a description for the eventuality involving any of the participants, then, there exist a description for any other eventuality involving any other participant.

Because *together* is compatible with punctual processes, without requiring that the entities share a particular relation (in the past or in the future), as *with* does, we do not need to introduce possible evolutions. Note also that the entities have the same role with respect to the collectivization.

We can formulate then two definitions for *with*: a more underspecified one, in which every entity has the same role (109), and a second (110), more constrained, in which the entities are indexed in such a way that the properties describing the entities in a *with*-complement denotation influence the properties of the other entities.

⁵¹See [Laserson, 1995, p.223].

(109) **With.** Symmetric condition.

$$\| \text{with } (NP)(f^{distr}) \|^{sit,t} = \{e_{i,i \in I} \mid \forall i \in I (\| f \|^{sit,t} e_i = 1 \ \& \ \forall s'_{s \hookrightarrow s'} (\forall \tau ((\tau \models_{s'} e_i) \Rightarrow \forall j, j \in I \exists \tau' (\tau' \models_{s'} e_j))))\}$$

With takes sets of entities as its first argument and predicate denotation as its second argument. The sentence denotes a set of events such that:

1. the predicate is true for any event involving an individual with respect to a certain thematic role, and,
2. for any possible state space s' accessible from s , for every description, if it is a description for the eventuality involving any of the participants, then, there exist a description for any other eventuality involving any other participant.

Contrary to *together*, *with* is sensitive to (past and future) evolutions of the eventualities involving the participants. Note that this definition is identical to definition (76). This means that *with*-symmetric constructions instantiates the notion of collectivity prototypically.

Condition (109) can be strengthened in such a way that the entailment between the description rests on asymmetric relations between the entities.

In *with*-asymmetric constructions the entities do not play the same role in the influencing-influenced relation and we can express this by indexing the events involving the denotations of a *with*-complement differently. Let J be this set of entities.

(110) **With.** Asymmetric condition.

$$\| \text{with } (NP)(f^{distr}) \|^{sit,t} = \{e_{i,i \in I}, e_{j,j \in J} \mid \forall i \in I, j \in J, (\| f \|^{sit,t} e_i = 1 \ \& \ \| f \|^{sit,t} e_j = 1 \ \& \ \forall s'_{s \hookrightarrow s'} (\forall \tau ((\tau \models_{s'} e_j) \Rightarrow \exists \tau' (\tau' \models_{s'} e_i))))\}$$

With takes sets of entities as its first argument and predicate denotations as its second argument. The sentence denotes a set of events such that:

1. the predicate is true for any event involving an individual with respect to a certain thematic role, and,
2. for any possible state space s' accessible from s , for every description, if it is a description for the eventuality involving any of the participants in the denotation of the first *with*-argument, then, there exist a description for any other eventuality involving any other participant in the denotation of the predicate.

With and *together* are complex items that would deserve closer attention⁵². In particular, it remains to be shown how the different meanings⁵³ of *with* interact, and to establish whether condition (109) can function as an underspecified model for all of them.

8 Conclusion

In this paper we have analyzed and defined a particular notion of collectivity, namely "collectivity as pure dependence". We have first observed, on a phenomenological level, that there are different ways of looking at groups: groups as sums, groups as teams and groups as dependent entities. On the basis of this descriptive distinction, we have made the hypothesis that different models have to be deployed to explain these different kinds of togetherness effect.

Previously, this hypothesis had been taken seriously by neo-classical approaches. These consider that there are different kinds of wholes that one can classify according to the internal level of the integration of their parts.

At the extreme end of the spectrum there are two conceptions of wholes: wholes as sums and wholes as unites. We have shown that both of these conceptions are not appropriate to explain the cases of collectivity as pure dependence which are characterized by two basic features: (i) there has to be a coherence relation between the properties of the parts, and (ii) the group does not have to be neither presupposed nor necessarily generated. In fact there is no group supervening the dependence relation among the parts.

On the one hand, these features have led us to question theories which consider wholes as collection. Because these theories subscribe to the universal existence of sums, they fail to characterize the difference between an accidental (juxtaposition) and a non accidental association.

On the other hand, views of wholes as unities or monads, are not appropriate either, because they fail to capture the fact that the whole does not exist outside its parts and their dependencies.

In order to retain these two features into the representation, we have introduced a definition of whole which is grounded on the epistemic constraints on properties and inference. The label we have chosen is "wholes as networks" which captures the intuition that the whole does not exist as a separate entity but it is nonetheless more than the union of its parts. We have made the hypothesis that for two entities whose properties entail each other, these two entities are epistemically dependent and do form a network.

⁵²For *together*, see, in particular [Lasersohn, 1995] and more recently [Moltmann, to appear].

⁵³Adnominal *with* can mean *part-whole relation*, adverbial *with* can mean *instrumentality*, *manner*, adsentential *with* can have a meaning of *cause* and *concession*.

We have argued that the notion of dependence lies in between that of juxtaposition and that of cause, that is semantically driven but pragmatically constrained. We have firstly analyzed cases of plural and conjoined *NPs* and, more generally, cases of collectivity as pure dependence interpretation without overt collectivizing adverbials. Our account is semantically constrained, sensitive to the distinction between individual-level and episodic-level predicates. It is, however, pragmatically driven and crucially relies on contextualized speaker perspective.

The notion of perspective plays a crucial role. This is not only because it serves the purpose of looking at a unique set of entities either collectively or distributively, but also, and more importantly, because the definition we have produced is a rule of interpretation based on a counterfactual reasoning.

If an identical situation, e.g. two people walking side by side, can be interpreted either distributively or collectively, it is because the speaker can interpret it either as an accidental association or as a regular one. In this second case, she links the descriptions of the entities in such a way that if one of them does not satisfy the property in some accessible world w' , this will affect the knowledge relative to the other entity/ies to which it is related and thus the whole system. The label we have chosen for this model is "whole as network".

This explanation sheds new light on the interpretation of co-localization and definitory properties. On the one hand, it has led us to define a notion of processive vs. definitory localization. On the other hand, it has provided a new pattern of interpretation for the classical distinction between individual-level and episodic level predicates that we have reinterpreted as constraint proof properties and constraint non-proof properties. Our hypothesis is that non-processive localization and definitory properties bring the most stable information with regard to an entity so that it is informationless to epistemically relate them to the occurrence of another property of another entity.

Subsequently, we have shown how the definition of wholes as networks can be extended to other cases.

We have first considered how it can shed a new light of cases of "team credit" interpretation, and we have suggested to introduce, *ceteris paribus*, a pragmatically constrained quantifier *Part* which picks up a relevant part of entities which have to satisfy the property and which replaces the universal quantifier requiring that every entity satisfy the property.

Then, we have extended this model to reciprocity and have made the hypothesis that different configurations of reciprocal statements are all generated by an underspecified sense that we have formulated as a constraint between two converse properties. The information that one entity satisfies a certain property brings with it the information

that another entity satisfies the converse one. Because this transfer of information takes the form of an entailment, the fact that two entities accidentally satisfy two converse properties is not retained as a case satisfying a reciprocal statement. Again, our aim was not to presuppose the existence of a group of reciprocally related entities, but to catch the foundations of this relation.

To conclude, we have shown how the general definition of "collectivity as pure dependence" is instantiated by *together* and *with*, suggesting that the symmetric *with* instantiates the notion prototypically.

We endorse the hypothesis that there are different types of collective statements that cannot be reduced to a unique model. A lot of work remains to be done, however, if we wish to represent the whole spectrum of configurations. Collectivity as pure dependence and wholes as networks represent only a very small portion of this complex domain.

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