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Incoherences in Dialogues and their Formalization Focus on Dialogues with Schizophrenic Individuals

Christophe Fouqueré · Jean-Jacques Pinto · Myriam
Quatrini

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Abstract We focus in this paper on the potential uses of Ludics, a logical framework based on recent developments in proof theory, for modeling natural language dialogues. The aim is to be able to grasp and to account for some aspects of incoherence in discourses. Among the properties relevant for studying dialogues, two features of Ludics are of interest for our purpose: the duality of viewpoints of two interlocutors as well as the possibility of ruptures. We illustrate first the potential usefulness of such a model for accounting and analysing incoherence in dialogues due to cultural gap. We then focus on dialogues with schizophrenic individuals (where we examine the psychiatric description of schizophrenia and describe its associated problems of logicity and inconsistency) to try to answer the following questions: to what extent does incoherence play a role in schizophrenic discourse? And, would a more precise characterization of “non-standard” rationality help explain the range of potential complications of schizophrenia?

1 Introduction

What does *incoherence* in dialogue mean exactly? While there is currently no explicit, scientific definition, the notion is best explained by considering situating dialogue between two distinct poles: bad adherence or disharmony on one side, and inconsistency on the other. Our aim here is to show how *Ludics* [10] as a logical theory offers the potential of a more nuanced characterization of incoherence in the context of dialogue that ultimately would lead to formulating a scientific definition.

Ludics has gained attention recently as a novel framework with foundations in proof theory that may be used to characterize meaning in a more general setting, *i.e.*, modeling natural language dialogue. The first pioneering works described the potential usefulness of Ludics for computational linguistics: in semantics [11], pragmatics [12, 8], or for studying argumentation [9] (see also [7]). Works in these three domains showcase the proof-theoretical dimension of our formal framework, which is that the meaning of a sentence/utterance/argument is the set of its justifications that may occur in a given dialogue, as the meaning of a proposition is essentially the set of its proofs. This follows the *meaning-as-use* stance of, say, D. Prawitz [15] or R. Brandom [2]. The most relevant trait of Ludics in this context is that

C. Fouqueré
Université Sorbonne Paris Nord, LIPN, F-93430, Villetaneuse, France.
CNRS, UMR 7030, F-93430, Villetaneuse, France.

J.-J. Pinto
Psychiatre-psychanalyste. Université Aix-Marseille, Marseille Cedex 07, France

M. Quatrini
IMM –UMR 7373, Université Aix-Marseille & CNRS, F-13284 Marseille Cedex 07, France

it allows for the interaction to be broken down into primitive elements, providing us with an abstract framework suitable for formalizing the nature of interaction in dialogue. In addition, since Ludics also offers a reconstruction of logic using these primitive elements, it can capture the logical dimension of discourse. Therefore, the concept of interaction that Ludics provides subsumes two essential aspects of dialogue; one being communication between participants, and the other the composition of elements or pieces of information relevant to each participant¹.

As such, the notion of coherence in discourse appear in our modeling as both the level of cohesion between successive utterances and as the composition of specific utterances in logical inferences or in evaluating meaning. The second aspect of incoherence, which concerns divergences and compositional discord, is not fully addressed in this paper with the exception of an example given in section 3. It is, nonetheless, an important aspect to consider in a thorough analysis of incoherence (see [7]).

In this work, we refer to incoherence in dialogue primarily as discords or ruptures of cohesion. The two most essential features of a Ludics framework for accounting for and analyzing ruptures of cohesion are:

- At the core of the model, each utterance in a dialogue must be considered twice: once when this utterance is produced by a locutor, and again when it is received/expected by the listener. The perfect correspondence between production and expectation is a first condition for a dialogue to be coherent.
- Each utterance should be formalized with links to previous utterances together with those that are expected. Following such dialogue threads is another condition necessary for ensuring the cohesion of successive exchanges.

In section 2, we succinctly present Ludics, highlighting the fact that it is a theory of interaction². We recall the formal objects defined in Ludics that serve as the basis our dialogue modeling, and describe how they may be useful for analyzing levels of coherence and incoherence in a given dialogue. The two following sections are devoted to the modeling of incoherent dialogues. These case studies show what could be expected using our model. In section 3, we study a case of a dialogue characterized as incoherent due to a cultural gap. In this first example, we account for two aspects of incoherence: a rupture of cohesion and an (apparent) problem of logical abilities. In the examples studied in section 4, one of the participants of each dialogue is schizophrenic. We begin by providing the psychiatric description of schizophrenia and we present problems of logical inconsistency that may appear as a result. We then show how specific elements of our framework allow us to identify an incoherence in each of these examples. Disagreement essentially appears as the co-presence of two representations within the same dialogue, each rational but each equally distinct. This is possible as our model considers *de facto* a principle of charity³.

2 A Framework for a Dialogue Theory

The logical theory Ludics is the formal framework on which our dialogue modeling is based. Ludics [10] was initially proposed by J.-Y. Girard in the early 2000's. Developing this theory was a step in his program of Geometry of Interaction, the aim of which was to account for the dynamics of logical proofs. Its objects, called designs, may be understood either as abstractions of formal proofs or as strategies. For formal proofs, designs maintain only what is relevant for the cut elimination process, hence the dynamics of a proof. Furthermore, keeping in mind that the interpretation of a formula is the set of its proofs, designs should interpret proofs as justifications of a stance or position, as strategies to win a debate. Following this twofold nature of designs, the interaction between two designs may be understood either as a cut between two proofs, giving rise to a rewriting process, or as a play between a winner and a

¹ Composition of a verb with its arguments in a semantical/syntactical approach of computational linguistic; composition of an implicative proposition with its premiss in Logic.

² Ludics is more formally presented in the annex.

³ The principle of charity, due to W. Quine [13] and D. Davidson [5], is discussed in [17].

| | |
|----------------------|--|
| ✕ rule | $\overline{\vdash \Gamma} \text{ ✕}$ |
| Negative rule | $\frac{\vdash \xi.I_1, \Delta \quad \dots \quad \vdash \xi.I_p, \Delta}{\xi \vdash \Delta} \quad (-, \xi, I_1, \dots, I_p)$ <p>where $\xi.I = \xi.1, \dots, \xi.n$ when $I = \{1, \dots, n\}$.</p> |
| Positive rule | $\frac{\xi.1 \vdash \Delta_1 \quad \dots \quad \xi.n \vdash \Delta_n}{\vdash \xi, \Delta} \quad (+, \xi, \{1, \dots, n\})$ <p>where $\cup \Delta_k \subset \Delta$ and for $k, l \in \{1, \dots, n\}$, $k \neq l$, $\Delta_k \cap \Delta_l = \emptyset$.</p> |

Fig. 1 Ludics rules

looser. Interaction between sets of designs can in some cases encode negation: two sets that interact ‘correctly’ (in *meaning*, which is confirmed by what follows) are orthogonal, *i.e.*, dual. Hence a formula is interpreted as a set of designs closed by interaction, which is referred to as a *behavior*.

2.1 Ludics in a nutshell

The precise definition of basic objects of Ludics is proposed in J.-Y. Girard’s seminal paper [10]. The reader may find these main definitions in the annex (section 6). We have provided here an overview to understand some of its basic notions.

A formal proof, as a tree of sequents linked together by logical rules, may be read in a bottom/up manner. This case corresponds to a proof search: from the conclusion of a proof towards its premisses. In this context, logical connectives may be grouped into two sets being either positive or negative. Positive connectives are entitlements for pursuing the justification on all the terms of a conjunction. Negative connectives are provisions for answering alternatives of a disjunction. The sequent calculus may then be given with only three rules. The daimon rule ✕ is specific to Ludics and essentially enables a proof search to be aborted. The two other rules contain three pieces of information: a polarity which determines the side of the sequent concerned by the rule⁴, the formula on which the rule applies, and the sub-formulas obtained by applying the rule. Furthermore, the notion of a formula is abstracted in Ludics, meaning that formulas are replaced by locations. In fact, a formula already contains the description of its subformulas, which is its *form*. On the contrary, in Ludics, the form results from the rules applied on a location. In Girard’s paper, a location⁵ is a sequence of integers: $\xi, \xi.1, \xi.3.0 \dots$. We may also make use of symbols as L_q, L_R, \dots , to ease the reading. Rules are presented in Fig. 1: as negative rules may have the same focus, these rules are merged into one sequent-like presentation.

Viewing Ludics as a game, one can also interpret a rule, or more specifically an action $(+/-, \xi, I)$ in the following way. The polarity $+/-$ depends on the point of view one adopts (one side or the other of interaction, one plays or the opponent plays), the focus *focus* ξ is the address of the interaction, the *ramification* I is the set of addresses on which interaction may continue. The daimon rule terminates the interaction. Therefore, the dynamics of the interaction between two designs consists in following two dual alternate sequences of actions, one in each design. An example is given Fig. 2. This example shows the travel that the interaction does between two designs based on strictly dual sequents: two loci in dual position, *i.e.*, the same address but either in the left side of the turnstyle symbol (negative position), or in the right side of the turnstyle symbol (positive position). Interaction could also occur when sequents have more than one locus, as soon as they share dual loci. One can focus on the unfolding of the interaction itself, which may result in success when encountering the daimon rule, or in failure when there is a divergence, *i.e.*, two sequents without dual shared loci. One can also focus on what remains after interaction. At each step of an interaction, shared loci are erased and what results is a

⁴ Either the positive side at the right of the turnstyle symbol or the negative one at the left of the turnstyle symbol.

⁵ We may use *address*, *locus* and *location* equivalently.

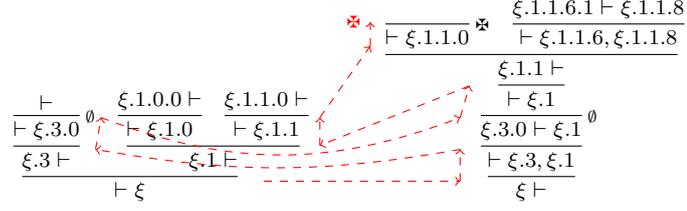


Fig. 2 Interaction (dashed line) between two (dual) designs

new design: the result of the calculus. In this way, Ludics explicitly illustrates two modes of interaction: the first one is called *closed mode* as it occurs in an empty context, while the other one is what is called *open mode* in that it occurs when contexts are non empty. The first mode is considered a confrontation between an attempt to justify a position against an attempt to refute it. The second mode is considered as a calculus, that is, a rewriting process.

Example 1 Designs and their proof-like presentation

- The design based on $\vdash \Gamma$ which contains a unique action \star is:

$$\overline{\vdash \Gamma} \star$$

This design is an abstraction of one degenerated proof: a non logical axiom or an assertion without justification at all.

- The design, based on $\vdash \xi$, drawn on the left in Fig. 2 is presented below with rules labelling each step:

$$\frac{\frac{\frac{\vdash}{\vdash \xi.3.0} (+, \xi.3.0, \emptyset) \quad \frac{\xi.1.0.0 \vdash}{\vdash \xi.1.0} (+, \xi.1.0, \{0\}) \quad \frac{\xi.1.1.0 \vdash}{\vdash \xi.1.1} (+, \xi.1.1, \{0\})}{\xi.3 \vdash} (-, \xi.3, \{0\}) \quad \frac{\xi.1 \vdash}{\xi.1 \vdash} (+, \xi, \{1, 3\})}{\vdash \xi} (-, \xi.1, \{\{0\}, \{1\}\})$$

This design could be understood as an abstraction of the beginning of a proof search for justifying the formula $\neg\neg(A \wedge B) \wedge \neg\neg V$, where V is the constant associated with the true formula.

$$\frac{\frac{\overline{\vdash V}^{axV} \quad \frac{\frac{A_1 \vdash \quad B_1 \vdash}{\vdash A \quad \vdash B} \vee_l}{\neg V \vdash} \neg_l}{\vdash \neg\neg(A \wedge B) \wedge \neg\neg V} \wedge_r$$

REMARK : We may observe the difference between the rules (or actions) \star and $(+, L, \emptyset)$. The first one corresponds to a non logical axiom, that is a premiss without logical legitimacy. The second corresponds to a logical axiom, as the one introducing the true formula V . It is denoted by the symbol \emptyset in labels of rules (as in Fig. 2).

2.2 Ludics as a model of dialogue

Based on the Ludics apparatus, our model of dialogue is organized in two levels.

- With respect to the first level, a dialogue is seen only as an alternate sequence of interventions. Interventions are only considered according to (i) their role in the flow of interventions: an intervention is either initial (because it starts the dialogue), or is anchored on a previous one and opens possible

continuations of the dialogue, (ii) the fact that interventions are produced by one locutor while they are at the same time received by the other locutor. We interpret interventions by means of *dialogue acts* that express entitlements or decisions of the speaker, and also their acknowledgments by the addressee. With the notion of dialogue act, we retain only that such a language act (i) is either produced or received by a given locutor, (ii) opens a finite set of dialogue continuations, (iii) is either anchored on a previous act or creates a new discussion thread. This first level captures the surface of a dialogue [8], *i.e.*, the threads or branches successively visited during the dialogue, as a confrontation between two strategies, that is, as an interaction between two trees of *addresses* where utterances appeared. This enables us to focus on the notion of convergence/divergence occurring in the dialogue, since a dialogue is convergent only when a produced dialogue act is correctly received by the listener.

- To address the other dimensions of dialogue, in particular to account for the content of these interventions, but also to identify specific aspects of convergence/divergence, we complete the modelisation by adding a second level and set a *cognitive base* for each locutor. A cognitive base contains, roughly speaking, the varying ranges of knowledge and abilities used for building utterances as well as for receiving and recording them. Formally, these elements are represented by *designs*. An open interaction between these designs, that is cut elimination between formal proofs as in sequent calculus, enables to account for various operations, for example: updating, inferential executions, and so on.

Viewing the dialogue as a trace of an interaction between two designs makes explicit the fact that there are two points of view. Therefore, it allows us to observe the success or the failure of a communication between these two points of view, *i.e.*, the fact that the dialogue may fail or end with a drop. Dialogues may end badly because of misunderstandings, disagreements, or a lack of information ... and it is necessary to be able to represent such situations. At each step in Ludics, an interaction may continue if a negative action exists in one design that is paired to the positive action ‘played’ by the other design. Transposed in our modeling, a dialogue may continue without divergence provided that the current intervention produced by a locutor (a positive action) is correctly received/expected by the addressee (the dual negative action exists). An interaction is convergent when it ends with a daimon, and is divergent when an action has no dual counterpart. These two cases allow for interpreting two standard final situations in dialogues: either the dialogue finishes well or there is a misunderstanding between the two locutors.

The aim of declaring cognitive bases is twofold: (1) a cognitive base contains the set of statements that are assumed by each locutor; (2) it also contains the linguistic elements used and received during the dialogue process. Indeed, one of the issues is to evaluate the correctness of such commitments and to potentially update them. Formally, a commitment state is a set of designs corresponding to factual or inferential propositions (accessible through their justifications). For that purpose, we use the logical reading of Ludics, hence interpreting the logical negation of a proposition, a contradiction, or a logical inference. While the level of surface of dialogues makes only use of the closed mode of interaction, the management of cognitive bases, their updating and their use in the dialogue in progress make use of the open mode of interaction.

To clarify, we do wish to add that we are purposefully not addressing automation of our modeling process. Our focus here is exclusively on conceptual and methodological aspects.

2.3 How to use Ludics to account for incoherences?

Our model is based on Ludics precisely because interaction is the core notion of this theory. Ludics effectively breaks down an interaction by way of introducing elementary concepts: polarity, location (or address), justification and relation, that we then use to understand the different aspects of incoherence occurring in dialogue. Moreover, Ludics provides us with a concept subsuming both interaction as *communication* and interaction as *process*, both of which are a part of any dialogue. *Communication* designates the alternate succession of interventions between a locutor and the addressee. *Communication*

also comes with a number of implicit underlying rules. At the very least, a locutor should be able to maintain a degree of continuity between his or her current and preceding utterance. Our model takes this continuity into account by the fact that addresses created by previous actions become foci of current actions. *Process*, rather abstractly, constitutes the mix of several elements from which a new object is produced. This could be, for example, the *computation* of a function on arguments. It could be also a *syntactically correct* sentence obtained by combining several lexical items, or the *meaning* of a sentence that we may calculate from the meaning of its components. Another case is an assertion affirmed once an inference is applied on relevant conditions.

The overall success of a dialogue depends on the successful functioning of each of those various levels. It needs an implicit agreement on the meaning of successive statements as well as on the relevance of new ones with respect to previous interventions. Concretely, our model has as motto interaction between designs. This characteristic is essential for being able to account for incoherence. In fact, a dialogue may be characterized as *divergent* if at least one of all necessary interactions fails. This may be the case between designs interpreting the discussion but may also be the case between designs in a cognitive data base. In the first case, it concerns the surface of the dialogue, *i.e.*, the sequence of utterances. In the second case, it concerns logical or semantical abilities of the participants. Note that neither the meaning of a sentence, a word, or reasoning are treated by formulas in our framework. When applying Ludics, formulas are recovered as (closed) sets of designs. In our framework, as we think it should be the case for natural language in general, meanings may never be fully defined. In fact, Ludics allows us work with designs, or their closure, *i.e.*, formulas: integrating contradictions at the level of designs does not induce contradictions at the level of logics. Neither classical nor nonmonotonic or modal logic enables this to the same end.

As our model explicitly describes all the constitutive elements of a dialogue, we are first able to identify and observe eventual ruptures and then analyse them accurately. One way of conceptualizing a chain of successful interventions and their underlying agreements is to consider that the intervention that a locutor produces belongs to the expectations of the addressee. Even if those expectations remain implicit in most dialogical situations, the total lack of these expectations highlights a rupture during an exchange. Secondly, a dialogue may be considered coherent when the participants are aware that they are sharing a large base of heterogeneous elements, or at least they are ready to build a shared base with the person they are communicating with. These bases or backgrounds remain implicit except when a misunderstanding becomes apparent. What we call cognitive bases in our model enable us to consider such backgrounds and therefore they allow us to examine these (dis)agreements with more precision.

In addition to interaction as an essential characteristic, other elements are equally useful for our purposes. We begin by associating to each participant a design, *i.e.*, the tree of dialog acts an individual produces or receives (which are, in fact, interpreted). This in itself has an immediate application if, for example, a divergence occurs when two dialogue acts are not perfectly dual. Furthermore, the content of a specific utterance can be particularly revealing in a case of non-convergence. A divergence may be due to a non-coincidence either of the focus, *i.e.*, the link with previous intervention, or of the ramification, *i.e.*, the link with following interventions.

In section 3, we consider an incoherent dialogue where the incoherence is made explicit by a divergence between an utterance of a locutor and the expectations of the addressee. This quite caricatural illustration of divergence enables us to present this in our modeling as a first and paradigmatic case of rupture of cohesion. We chose this quasi artificial simple case study to outline how our model may be used to consider base cognitive issues for explaining a misunderstanding. In section 4, we focus on dialogues between a schizophrenic patient and a psychologist. This represents a first in terms of attempting to concretely define incoherence in dialogues with schizophrenics.

$$\begin{array}{c}
\frac{\vdash L_{no} \quad \vdash L_{yes}}{L_R \vdash} \\
\frac{L_R \vdash}{\vdash L_Q} \\
\text{P's dialogue acts}
\end{array}
\qquad
\begin{array}{c}
\frac{L_{not-know} \vdash}{\vdash L_R} \\
\frac{\vdash L_R}{L_Q \vdash} \\
\text{N's dialogue acts}
\end{array}$$

Fig. 3 Divergence at the surface of a dialogue

3 A rupture in dialogue, presumably due to a cultural gap

The following short dialogue is cited from a study by M. Chemillier [3], on the mathematics of traditional African games. He reports an exchange involving an ethnologist who conducted the following dialogue during his survey on logical abilities of natives in non-Western societies.

Example 2 *An ethnologist P interviewing a native N recorded the following dialogue:*

- P: “All the Kpelle cultivate rice (P_1).
Mister Smith does not cultivate rice (P_2)
Is Mister Smith a Kpelle?” (Q)
- N: “I do not know, I do not know M. Smith.” (R)

This short (and artificial) dialogue was presented by M. Chemillier as a misunderstanding situation due to a cultural gap. We choose to use it because the misunderstanding is precisely expressed by an incoherence during a dialogue. We also chose to include it because it concerns logical abilities (with respect to one protagonist of the dialogue). We show how the property of calculi, with elements from cognitive bases, should be utilized to maintain coherence.

3.1 Why such a dialogue may be considered **divergent**?

The above dialogue can only be considered to be **divergent** if read from the perspective of the ethnologist **P**. From this person’s viewpoint, the dialogue may be described as follows: she provided the native with information P_1 and P_2 , and then asked a question Q , while knowing the ability to answer the question was contained in the information (P_1 and P_2) just provided. Therefore, after asking her question, the ethnologist is ready to receive either a logically correct answer (*no*), or an incorrect response (*yes*). She did not, however, anticipate the answer given by **N** and consequently is unsure how to continue the dialogue.

A representation of this dialogue is shown in Fig. 3 as an interaction between two designs, each of them being the dialogue seen from the viewpoint of one locutor. Each design is the tree of justifications of dialogue acts produced/received successively by a locutor. We may observe that, while the question asked by **P** is well received by **N** (we have an exact duality $(+, L_Q, \{L_R\})/(-, L_Q, \{L_R\})$), the answer produced by **N** is not well received by **P**: neither $(-, L_R, \{L_{no}\})/(+, L_R, \{L_{not-know}\})$ nor $(-, L_R, \{L_{yes}\})/(+, L_R, \{L_{not-know}\})$ are pairs of dual actions. This allows us to clearly illustrate the divergence: a non-correspondence between the expectation of **P** and the answer produced by **N**.

3.2 How may we analyze this divergence?

Our approach to analyzing divergence between two conversational partners was to compare the observed dialogue with the “ideal” exchange anticipated by ethnologist. To this end, we began by building onto the surface form of the dialogue what we identified as links to the cognitive base for each locutor. We should recall that when the surface of a dialogue is represented by patterns of interaction between two designs of dialogue acts, the locutor is not only aware of their production but, further, they may also represent the strategy used by each locutor for managing the dialogue.

$$\begin{array}{c}
\vdots \\
\frac{\vdots}{\vdash L_{\text{no}} \star} \quad \frac{L_{\text{corr}} \vdash}{\vdash L_{\text{yes}}} \\
\hline
\frac{L_R \vdash}{\vdash L_Q} \quad \frac{}{P_2 \vdash L_Q} \quad \emptyset \\
\hline
\frac{}{\vdash L_{P_2}, L_Q} \quad \emptyset \\
\hline
\frac{}{P_1 \vdash L_{P_2}, L_Q} \quad \emptyset \\
\hline
\vdash L_{P_1}, L_{P_2}, L_Q
\end{array}$$

Fig. 4 **P**'s strategy

Using this as a basis allows us to then rebuild the complete strategy of **P**, represented in Fig. 4. This design is exclusively that which is associated with the dialogue seen from the viewpoint of **P** in Fig. 3 extended to the full dialogue, including P_1 and P_2 as information provided by **P** that enables **N** to answer the question Q . In the strategy of **P**, the first four steps (according to a bottom-up reading) correspond to the information successively provided by **P**, and that which is supposed to be received by **N**. The two utterances P_1 and P_2 (in fact the *formal proofs* or *designs* associated to them) are initially contained in **P**'s cognitive base. In what we might view as an ideal situation, these utterances would be correctly received by the addressee, in that they would be successively recorded in their cognitive base (formally the designs are copied by means of a copycat strategy). The fifth and the sixth steps correspond respectively to the question asked by **P** and the answer that **N** may give (according to **P**). If, at the level of the surface of the dialogue, each of these latter are modeled by a unique dialogue act, what happens at the level of the cognitive base is significantly more complicated.

In fact, in what is considerably more than just an exchange of information, **P** anticipates that the native will be able to perform a long list of calculus:

1. The native is meant to then record the propositions:

P_1 : "All the Kpelle cultivate rice."

P_2 : "Mister Smith does not cultivate rice."

This means that, the two following designs should be stored in the cognitive base of **N**:

$$\begin{array}{c}
\frac{}{\vdash C(a)} \quad \emptyset \quad \frac{}{\vdash C(b)} \quad \emptyset \\
\hline
\frac{}{K(a) \vdash C(a)} \quad \emptyset \quad \frac{}{K(b) \vdash C(b)} \quad \emptyset \\
\hline
\vdots \quad \vdots \\
\hline
K(x) \vdash C(x)
\end{array}
\quad \text{and} \quad
\begin{array}{c}
\frac{}{\vdash} \quad \star \\
\hline
\frac{}{C(\text{Smith}) \vdash} \quad \emptyset
\end{array}$$

If x is a kpelle then x cultivates rice.

Smith does not cultivate rice.

2. Answering the question "Is Mister Smith a Kpelle?", requires the native to test the statement "Mister Smith is a Kpelle", *i.e.*, by temporarily adding the following design to his/her cognitive data base

$$\frac{}{\vdash K(\text{Smith})} \quad \emptyset$$

and should then use these three designs to *perform logical calculi*.

3. First calculation: the co-presence in her cognitive base of two pieces of information *sharing* an element, the locus **K(Smith)**, *triggers* a rewriting process, which then results in the information "Mister Smith cultivates rice", as shown in Fig. 5.
4. Second calculation: once again, the co-presence of two pieces of information that share an element, the locus **C(Smith)**, *triggers* a calculation:

a dialogue. More narrowly still, we support the approach taken by certain specialists in the field who posit that analysis of the unique nature of these exchanges should consider the principle of charity versus characterizing ‘madness’ as simply the absence of logicity or rationality. Indeed, the principle of charity is a natural consequence of our modeling: once divergences have been observed to occur at the surface of dialogue and elementary manifestations of rupture are localized, rebuilding coherence inside the dialogue seen from the viewpoint of the schizophrenic participant then becomes possible.

In the following section, we begin by describing how precisely schizophrenic discourse may be affected by logicity and rationality. We then formalize two examples of dialogues between a psychiatrist and an individual diagnosed with schizophrenia to illustrate the potential usefulness of our model for analysing ruptures in conversational dialogue.

4.1 Logicality and coherence in schizophrenic language

The psychiatric description of schizophrenia has been the subject of complex discussions related to diagnosis which have gone as far as to challenge not only the uniqueness of the disorder itself but also the merits of preserving the very term schizophrenia that, for centuries, has been inextricably linked to negative connotations. Without delving too far into either of these debates, for our purposes here we have chosen to work from the classic description of schizophrenia used by French psychiatric clinics up to the 1980’s which clearly emphasizes the primary problems associated with schizophrenia conversation as being a lack of logicality and coherence. Manifested in its most common form, termed “paranoid”, these are described as:

- a negative side called “dissociation syndrome”: disintegration of the psychic life, deconstruction of the personality,
- and a delusional positive production aspect called “autistic delusion” or “paranoid delusion”.

The loss of logicality and coherence, in this classical approach, is invoked:

- as occurring simultaneously in the dissociation syndrome manifested as the four aspects (ambivalence, quirkiness, impenetrability, detachment) that one describes in it in the ideo-verbal (thought and language), affective, and behavioral spheres, and the first two classically place greater emphasis on illogicality and inconsistency of words, feelings and conduct;
- and in the paranoid delusional syndrome, where fundamental experiences (feelings or sensations of strangeness, depersonalization or influence) are secondarily poorly “rationalized” by the patient: “This delusion (...) is solely expressed by an abstract and symbolic language; it cannot be penetrated and reconstructed by the observer who is simply allowed, in general, to note its incoherence; it uses modes of thought or magical knowledge; it is constituted by beliefs and ideas that form an hermetic conception of the world. What is characteristic in the spontaneous evolution of this delusion is its chaotic, fragmentary and disjointed nature” [6].

The four other classical forms of schizophrenia are:

- two very serious forms, often without expressed delusion: “hebephrenic schizophrenia” and “catatonic schizophrenia”,
- a minor form, called “simple schizophrenia”, where delusion is not expressed and dissociation is less important,
- and lastly a very early form, “heboidophrenia”, where the symptoms of schizophrenia combine with those of psychopathy.

In the following two brief dialogues between a schizophrenic and a psychologist, both of which are quoted in a PhD thesis [21] and which we will model below in Ludics, the condition is seen to manifest in one of two ways, either the “simple” form or the “paranoid” form, given that the two patients were chosen for being at the beginning stages of their diagnosis, or having just started receiving treatment. This is because in the case of a confirmed or established diagnosis of a formal thought disorder (according to the classical

approach) outward signs of disordered speech signaling the presence of “schizophasia” often do not occur, if they exist at all, which could greatly complicate or even prohibit effective modeling. Schizophasia has been described as corresponding “to a pathological language made of neologisms and distorted words, without respect for the grammatical or syntactic structure, totally incomprehensible for the entourage. It was Emil Kraepelin who introduced the term schizophasia to designate a particularly serious alteration of the verbal expression. It accompanies mental dissociation and affective discordance in the paranoid and autistic forms of schizophrenia, at a fairly advanced stage of evolution” [18]. The multiple alterations observed in this schizophasia: prosody-intonation, phonetics, syntax, semantics (hermetic metaphors, neologisms, neosemies⁶) thus constitute a major obstacle in the context of analyzing propositions [21] in the speech of schizophrenic patients.

On the other hand, verbal productions of these patients do not seem to contain delusional and/or hallucinatory elements. They only show an apparent “formal thought disorder”. Lastly, the two examples we will discuss do not present associations by assonances, what would be another source of difficulty for modeling. These associations by assonances are identified in [21] and defined as follows: “Items depending on the factor *language structure*, they are peculiarities of a speech in which sounds rather than semantic and conceptual relations seem to govern the choice of words, so that the speech becomes less comprehensible and that redundant terms are used. In addition to the rhythm games, this discourse is made of puns, and the phonetic proximity between certain terms can generate a new idea”. Referring again to the same source [21], they are illustrated by the following example. The patient: “*I’m not trying to make myself heard, I’m trying to make myself understood. If you can make sense with nonsense, then good luck. I am trying in a sense to make sense with nonsense. The sense does not interest me anymore, there are too many one way signs, the "cents" interest me. To be honest, it’s the francs that interest me*”⁷. Being aware of the absence of certain schizophrenic symptoms in the two dialogues chosen for our modeling will allow us to establish limits associated with the charity principle that we propose may be used to temper the classical approach.

4.2 Two examples of dialogue

In this section, we study the modeling in Ludics of two short conversational exchanges between a schizophrenic patient and a psychiatrist. These two examples come from F. Verhaegen’s PhD thesis [21]. His aim was to account for successes and failures of schizophrenics as they are engaged in a dialogue. Both were chosen for illustrating specific propositions particularly suited for modeling conversational abilities of a schizophrenic, and in particular their ability to understand the intention of their addressees with respect to their own actions. The dialogues are transcribed as in [21], *i.e.*, in French and with prosody indications⁸. An English translation is provided as a footnote.

4.2.1 A dialogue about TV

Example 3 Here **S** is the schizophrenic patient, **P** is his (normal) addressee.⁹

⁶ “Neosemy is a semantic innovation of which the jobs testify” [16].

⁷ “Je n’essaie pas de me faire entendre, j’essaie de me faire comprendre. Si vous pouvez faire du sens avec du non-sens, alors bonne chance. J’essaie en un sens de faire du sens avec du non-sens. Le sens ne m’intéresse plus, il y a trop de sens uniques, les “cents” (prononcé à l’anglaise) m’intéressent. Pour être franc, ce sont les francs qui m’intéressent.”

⁸ ↘ stands for a descending pitch, ↗ for a rising pitch, → for a silent pause.

⁹ I watch TV (↘)/ News (↗)/ News yes programs I like Thalassa / Yes; you then like news (→) so you know a little bit of everything that’s going on, eh (→)/ I was fired from the E factory. I worked in a filtration company as mechanic, then I was fired (↘).

| | |
|---|---|
| $\frac{L_{\text{more on fired}} \vdash}{\vdash L_{\text{fired}}}$ | $\frac{L_{\text{more on news}} \vdash}{\vdash L_{\text{yes-Thalassa}}}$ |
| $\frac{L_{\text{yes-Thalassa}} \vdash}{\vdash L_{\text{info}}}$ | $\frac{L_{\text{info}} \vdash}{\vdash L_{\text{descript}}}$ |
| $\frac{L_{\text{descript}} \vdash}{\vdash L_{\text{TV}}}$ | $\frac{L_{\text{TV}} \vdash}{\vdash}$ |
| S's dialogue acts | P's dialogue acts |

Fig. 6 The dialogue according to **P**

- S** *Je regarde la télévision* (\searrow)
P *Les informations* (\nearrow)
S *Les informations oui les émissions, j'aime bien Thalassa*
P *Ouais; vous aimez bien les infos alors* (\rightarrow)
donc vous êtes au courant de tout ce qui se passe un petit peu, euh (\rightarrow)
S *J'ai été licencié de la manufacture de E. J'étais dans une boîte de filtration
comme mécanicien-ajusteur, et puis j'ai été licencié* (\searrow)

We modeled (shown in Fig. 6) the surface of this dialogue from the perspective of the psychiatrist **P**. From the perspective of **P**, and also according to F. Verhaegen – and presumably for most readers – the dialogue appears relatively simple, as it is formed by little else save the interaction between two lines of successive interventions, each justified by the immediate previous one. The dialogue is initiated by **S**, who opens a topic of discussion: watching T.V. The addressee **P** accepts to explore this theme, and attempts to open it up to a consensual sub theme: news. **S** continues on this sub theme and offers an additional opening: he watches also television programs. **P** prefers to pursue the subject of news. At this point a clear rupture occurs in the dialogue. Instead of continuing on the theme of news and answering **P**, **S** introduces a completely new topic: his firing. In Fig. 6, the rupture appears as actions $(+, L_{\text{yes-Thalassa}}, \{L_{\text{more on news}}\}) / (-, L_{\text{yes-Thalassa}}, \{L_{\text{fired}}\})$ are not pairwise dual. According to **P** – and to F. Verhaegen –, the schizophrenic does not respect one of the constraints of conversation: he does not answer a question.

Nevertheless, the dialogue can be interpreted in another way. First, we may observe that **P** makes an attempt to persuade her addressee in that she continues to keep the discussion focused on television by speaking about news and nothing else. In a sense, she ignores the other sub theme suggested by **S**, *i.e.*, television programs. Here, the charity principle may be adopted when we consider rebuilding the dialogue according to the viewpoint of **S**. Since a locus concerning **S**'s firing is opened during the dialogue, one may imagine that this opening was available from the very beginning. With respect to such an interpretation, the first dialogue act produced by **S**, expressed by *I watch TV*, opens at least two loci: the first being L_{descrip} , allowing the possibility of exploring TV as a theme, and a second locus L_{cause} , which tackles the question of why time should be spent watching TV. If we take this interpretation into account at its face value, we obtain yet another representation of the same dialogue (Fig. 7). Two branches are opened by the first speech act of **S**. On the situated furthest to the left, **S** accepts to continue discussing the topic that **P** has chosen: watching TV. He interprets the question of **P** (*The news?*) as an invitation to go on. He is collaborative as he adds another element, *i.e.*, specific television programs. There is, however, a minor discontinuity in the dialogue, which seen from the viewpoint of **S**, is due to **P**. After answering the question, **S** thinks that the subject is closed and continues on a new subject, the program Thalassa (his intervention is the sequence of three dialogue acts: $(+, L_{\text{info}}, \{L_{\text{yes}}\}) (-, L_{\text{yes}}, \emptyset) (+, L_{\text{emis}}, \{L_{\text{thalassa}}\})$). Since his intervention is not well received by **P**, who does not understand that the branch above L_{info} is closed and does not accept the invitation to speak about Thalassa, **S** decides to start in the subject which hold importance for him: his firing. Then, he plays a sequence of dialogue acts: beginning with $(-, L_{\text{cause}}, \{L_{\text{cause}+})$ in order to return to the branch in which he is interested, and then $(+, L_{\text{cause}+}, \{L_{\text{firing}}\})$ in such a way that this topics is introduced.

| | |
|--|--|
| $\frac{\frac{\frac{L_{Thalassa} \vdash}{\vdash L_{emis}}}{L_{yes} \vdash L_{emis}} \emptyset}{\vdash L_{info}, L_{emis}} \quad \frac{L_{firing} \vdash}{\vdash L_{cause+}} \quad \frac{\frac{L_{info+} \vdash L_{cause}}{\vdash L_{yes}, L_{cause}}}{L_{info} \vdash L_{cause}}$ | $\frac{\frac{L_{descript-}}{\vdash L_{TV}}}{\vdash L_{TV}} \quad \frac{L_{cause-}}{\vdash L_{TV}} \quad \frac{\frac{\frac{L_{info} \vdash L_{cause}}{\vdash L_{descript}, L_{cause}}}{L_{TV} \vdash}}{\vdash L_{descript}, L_{cause}}$ |
| S's dialogue acts | P's dialogue acts |

Fig. 7 The dialogue according to **S**

4.2.2 A dialogue about politics

The dialogue below was studied by M. Rebuschi, M. Amblard and M. Musiol in [17]. In their paper, the authors defend the fact that analyses should first and foremost be led by the principle of charity. To illustrate their thesis, they formalize a conversation between a psychiatrist **P** and a schizophrenic **S** within the framework of SDRT (Segmented Discourse Representation Theory [1]). We propose an interpretation of this same conversation using our model of dialogues. We use the same annotation as the authors – and therefore the same breakdown – in which we associate locutor and index to each section of the intervention.

Example 4 *The dialogue below is between a schizophrenic **S** and a psychiatrist **P**:¹⁰*

- S**₁₂₄¹ *Oh ouais (↗), et pis compliqué (↘) et c'est vraiment très très compliqué (→)*
S₁₂₄² *La politique c'est quelque chose quand on s'en occupe il faut être gagnant parce qu'autrement, quand on est perdant c'est fini quoi (↘).*
P₁₂₅ *Oui*
S₁₂₆ *J.C.D. est mort, L. est mort, P. est mort euh (...)*
P₁₂₇ *Ils sont morts parce qu'ils ont perdu à votre avis (↗)*
S₁₂₈ *Non ils gagnaient mais si ils sont morts, c'est la maladie quoi c'est c'est (→)*
P₁₂₉ *Ouais, c'est parce qu'ils étaient malades, c'est pas parce qu'ils faisaient de la politique (↗)*
S₁₃₀ *Si enfin (→)*
P₁₃₁ *Si vous pensez que c'est parce qu'ils faisaient de la politique (↗)*
S₁₃₂ *Oui tiens oui il y a aussi C. qui a accompli un meurtre là (→) ils étaient présents aussi à B. Mais enfin (→) c'est encore à cause de la politique ça*

This dialogue unfolds in a strange manner; it is hard for the locutor **P** – as well as analyst and the reader with her – to retrieve any semblance of a guiding thread between the interventions **S**₁₂₄¹, **S**₁₂₆ and **S**₁₂₈. Our focus is held at the beginning of the dialogue: from its start until the intervention **S**₁₃₀, and then gradually more narrowly, our focus shifts to the *half-dialogue*, corresponding to the participation of **S** formalized inside a design containing the succession of the dialogue acts that **S** produced (positive acts) and the dialogue acts that she receives (negative acts). Below, we present this half-dialogue three times. First, we account for the participation of **S** from the perspective of **P**, until the latter is faced with an apparent discontinuity. Then, we propose the presentation of this design once **P** tries to correct his first interpretation in order to preserve an element of coherence. Finally, we show that yet another interpretation may be possible which is to rebuild the viewpoint of **S**.

1. S's dialogue acts interpreted by P prior to correction

¹⁰ **S**₁₂₄¹ Yeah (↗), and complicated (↘) really complicated (→). **S**₁₂₄² Politics, it is really something when you do it well but you have to be a winner because otherwise, if you're a loser it's over (↘). **P**₁₂₅ Yes. **S**₁₂₆ J.C.D. is dead, L. is dead, P. is dead uh (...). **P**₁₂₇ They died because they lost in your opinion (↗). **S**₁₂₈ No, they won, but if they are dead, it's the disease. It's it's (→). **P**₁₂₉ Yes, they were ill, not because they were doing politics (↗). **S**₁₃₀ Yes but (→). **P**₁₃₁ If you think it's because they were doing politics (↗). **S**₁₃₂ Yes yes there is also C. who committed a murder (→) they were also at B. but well (→) it still comes down to politics.

| | | |
|---|-------------|---|
| ⋮ | ⋮ | |
| $\frac{}{\vdash L_{\text{confirm}}}$ | S_{128} | $S_{128} = \dots$ |
| $\frac{L_{\text{examp}} \vdash}{\vdash L_{\text{yes}}}$ | P_{127} | $P_{127} = (-, L_{\text{examp}}, \{L_{\text{confirm}}\})$ P asks confirmation. |
| $\frac{}{\vdash L_{\text{yes}}}$ | S_{126} | $S_{126} = (+, L_{\text{yes}}, \{L_{\text{examp}}\})$ S seems to give some examples. |
| $\frac{L_{\text{to-win}} \vdash}{\vdash L_{\text{pol}}}$ | P_{125} | $P_{125} = (-, L_{\text{to-win}}, \{L_{\text{yes}}\})$ S receives the <i>yes</i> from P asking for elaboration. |
| $\frac{}{\vdash L_{\text{pol}}}$ | S_{124}^2 | $S_{124}^2 = (+, L_{\text{pol}}, \{L_{\text{to-win}}\})$... and says that one needs to win. |
| $\frac{L_{\text{com}^+} \vdash}{\vdash L_{\text{complic}}}$ | S_{124}^1 | $(-, L_{\text{com}^+}, \{L_{\text{pol}}\})$ S keeps the turn ... |
| | | $S_{124}^1 = (+, L_{\text{complic}}, \{L_{\text{com}^+}\})$ S opens the discussion on the locus L_{complic} . |

Fig. 8 **S**'s dialogue acts interpreted by **P** before correction

| | | |
|--|-------------|---|
| ⋮ | ⋮ | ⋮ |
| $\frac{L_{\text{no-confirm}} \vdash L_{\text{yes}}}{\vdash L'_{\text{confirm}}, L_{\text{yes}}}$ | S_{130} | $S_{130} = (+, L'_{\text{confirm}}, \{L_{\text{no-confirm}}\})$... but S does not confirm |
| $\frac{L_{\text{ill}} \vdash L_{\text{yes}}}{\vdash L_{\text{but}}, L_{\text{yes}}}$ | P_{129} | $P_{129} = (-, L_{\text{ill}}, \{L'_{\text{confirm}}\})$ Once again, P asks confirmation ... |
| $\frac{L_{\text{no}} \vdash L_{\text{yes}}}{\vdash L_{\text{confirm}}, L_{\text{yes}}}$ | S_{128}^2 | $S_{128}^2 = (+, L_{\text{but}}, \{L_{\text{ill}}\})$... and proposes another reason. |
| $\frac{L_{\text{no}} \vdash L_{\text{yes}}}{\vdash L_{\text{confirm}}, L_{\text{yes}}}$ | S_{128}^1 | $(-, L_{\text{no}}, \{L_{\text{but}}\})$ S keeps the turn ... |
| $\frac{L_{\text{examp}} \vdash L_{\text{yes}}}{\vdash L_{\text{yes}}, L'}$ | P_{127} | $S_{128}^1 = (+, L_{\text{confirm}}, \{L_{\text{no}}\})$ S makes this error explicit. |
| $\frac{L_{\text{to-win}} \vdash L'}{\vdash L_{\text{pol}}, L'}$ | S_{126} | $P_{127} = (-, L_{\text{examp}}, \{L_{\text{confirm}}\})$ P misinterprets it. |
| $\frac{L_{\text{com}^+} \vdash L'}{\vdash L_{\text{complic}}, L'}$ | S_{124}^1 | $S_{126} = (+, L', \{L_{\text{examp}}\})$ S gives examples: she uses a (new) locus L' . |
| | ⋮ | ⋮ |

Fig. 9 **S**'s dialogue acts interpreted by **P** after correction

In Fig. 8, we find on the left the design that presents the dialogue acts corresponding to the intervention of **S** as they are interpreted by **P**. These dialogue acts are commented on the right side of the figure. We retrieve the thread of dialogue with a bottom-up reading.

The three first dialogue acts correspond to the first intervention of **S** who opens a discussion on the theme *something is complicated*: on the locus L_{complic} where a positive dialogue act is performed. Then, **S** seems to develop this affirmation even further by maintaining the turn with a negative dialogue act. After this negative action, **S** goes on saying that what is complicated is politics, while at the same time, she elaborates on this theme saying that (in politics) one needs to be a winner.

The first intervention of the psychiatrist (P_{125}) beginning with a simple *yes* encourages **S** to continue the debate. In the next turn, **S** mentions three persons who are dead (S_{126}). **P** thinks that these three people are examples of losers and asks for confirmation (P_{127}). But **S**'s answer invalidates **P**'s interpretation and results in a misunderstanding (S_{128}).

2. **S**'s dialogue acts interpreted by **P** after correction

Therefore, **P** has to correct her first interpretation. She knows now that it is not correct to link the pending thread from S_{124}^2 and the dialogue act S_{126} . Thus, if the intervention S_{126} is not the continuation of a thread that has already been opened, it is necessarily a new thread. **P** tries a new interpretation with a second initial locus L' , as represented in Fig. 9. **S** anchors her new topic at L' : the death of three people. Moreover, the locus L_{yes} that **P** opened as an invitation for pursuing the previous theme of *Politics is complicated* is not pursued.

| | | |
|--|--|---|
| $\frac{\vdots}{\vdash L_{\text{confirm}}} S_{128}$ | \vdots | |
| $\frac{\vdash L_{\text{confirm}}}{L_{\text{examp}} \vdash} P_{127}$ | $S_{128} = \dots$ | Correction by S of P 's misunderstanding. |
| $\frac{L_{\text{examp}} \vdash}{\vdash L_{\text{win}}} S_{126}$ | $P_{127} = (-, L_{\text{examp}}, \{L_{\text{confirm}}\})$ | P asks confirmation. |
| $\frac{\vdash L_{\text{win}}}{L_{\text{finish}} \vdash L_{\text{win}}} P_{125}$ | $S_{126} = (+, L_{\text{win}}, \{L_{\text{examp}}\})$ | S gives examples of deaths (even for winners). |
| $\frac{L_{\text{finish}} \vdash L_{\text{win}}}{\vdash L_{\text{win}}, L_{\text{lost}}} S_{124}^2$ | $P_{125} = (-, L_{\text{finish}}, \emptyset)$ | The <i>yes</i> from P is received as an agreement. |
| $\frac{\vdash L_{\text{win}}, L_{\text{lost}}}{L_{\text{com}^+} \vdash} S_{124}^1$ | $S_{124}^2 = (+, L_{\text{lost}}, \{L_{\text{finish}}\})$ | S says politics is complicated when one loses. |
| $\frac{L_{\text{com}^+} \vdash}{\vdash L_{\text{complic}}} S_{124}^1$ | $(-, L_{\text{com}^+}, \{L_{\text{win}}, L_{\text{lost}}\})$ | S keeps the turn: she establishes the alternative. |
| | $S_{124}^1 = (+, L_{\text{complic}}, \{L_{\text{com}^+}\})$ | S opens the discussion on the locus L_{complic} . |

Fig. 10 Interpretation of **S**'s dialogue acts according to **S**.

This enables her to elaborate on a new interpretation of the intervention S_{128} . She breaks this intervention into two parts. She first definitively buries the erroneous interpretation: indeed, the dialogue act S_{128}^1 is followed by a negative one that allows **S** to keep the turn, expressed by *no*. Then, on the new opened locus L_{but} , **S** may elaborate on her chosen theme: the death of three people. Unfortunately, **P** is unable to check if this new interpretation is correct. In fact, she does not know how to create a link S_{130} to the current dialogue thread: either the thread of discussion is indeed new, as in his corrected interpretation, and in such a case, the theme of politics is not at issue, or the thread of discussion was the one opened from the beginning, as in her first interpretation, but in such a case it appears to be incoherent. The pair winning/losing is one possible alternative as it is impossible to consider one as a refinement of the other.

3. Can we rebuild the viewpoint of **S**?

When she starts the dialogue, **S** formulates an opinion: *Politics is complicated*. More precisely, she starts by stating that something is complicated, and then she continues the debate with politics. We may suppose that, implicitly, what is being said is that politics is complicated. Given the length of her first intervention, we divided the dialogue thread – as did other researchers who analyzed the same text – into two parts: the first part introduces a theme, the second part starts to develop it. The link between these two parts is (according to our model) a negative dialogue act that enables the speaker to maintaining the turn. The negative dialogue act is an implicit intervention, which could be made explicit in the cognitive base of **S**, or, speaking more simply, if it occurs inwardly.

With respect to what is said thereafter, we propose that **S** elaborates her topic by using two loci: her dialogue act could be $(-, L_{\text{comp}^+}, \{L_{\text{win}}, L_{\text{lost}}\})$ expressing that *all politics is complicated*, regardless of any notion of success or failure. Then, **S** decides to comment on the first item of her alternate topic: politics is complicated when one loses. She receives a *yes* from her addressee as an agreement (P_{125}): this effectively closes the thread on losers. After that, she comments on the second item of her alternate topic: politics is complicated even for winners. For this purpose, she quotes three examples (S_{126}). With respect to this interpretation, **S** receives the question (P_{127}) *They died because they are lost in your opinion* (\nearrow) as a misunderstanding on the part of **P** that she then corrects in (S_{128}): they did not die because they were losers, but because they were ill. Plausibly, **S** may think that they were ill because of politics, that is what **S** says at the end of the dialogue. Fig. 10 presents this interpretation.

4.2.3 Comment

Our decision to use these particular examples was clearly not to offer any in depth analysis of incoherent conversation specific to schizophrenia. Our intent was rather to underline the contextual relevance of our model for understanding the principle of charity. Our formalization provides an explicit representation of the loci on which utterances are anchored and the justifying links between them. Once such links have

been explicitly established, one may retrieve, or at least speculate on, the internal calculus performed by the locutors when they participate in a dialogue. Viewing a dialogue as an interaction between two designs presupposes the existence of these two designs. An interaction may only take place if each design is adapted, *i.e.*, dual to the other. Hence there is space for detecting differences that exist between two viewpoints, or the degree to which they are potentially incompatible while maintaining respective rationality.

What we have sought to show is that schizophrenics may not lack coherence or logicity in their thinking, but are instead may lack interactional abilities. This concerns the capacity to put oneself in the minds of one's addressee, and conversely the ability to offer even minimal signs of being able to understand the progress of one's thoughts. This means that a schizophrenic patient may not be able to provide his or her interlocutor with the necessary clues to follow the thread of their statements. This may correspond to a "lack of empathy" due to a lack of consideration of what could help the other through the course of a dialogue. Ultimately, this prevents understanding of the logical function of a specific verbal behavior.

However, as one of the authors observed, it might be more apt to interpret a conversation with someone diagnosed with schizophrenia as a dialogue with three participants, one of which, when ignored, ushers in an additional coupling of patient/caregiver: heard voices (whose clinical indices are attitudes of listening, "*barrage*"¹¹ or "fading"). The existence of this third participant is revealed to us if the patient is cured (*e.g.*, the young schizophrenic Renée [20]), during periods of remission, or in the case of a favorable paraphrenic evolution that allows for a coherent narrative of the disease [19]. Hearing or reconstructing this interlocutor could help to recover some consistency. In [14], one may find the example of a reconstituted syllogism invoked to account for the following sentence: "*Ces choses-là il faut que tu me les dises avec la bouche.*"¹², addressed to his silent therapist by a schizophrenic exhibiting auditory hallucinations who logically concludes that telepathic communication does in fact exist.

In order to explicitly describe the role of utterances from an extra participant involved in a the dialogue, the "cognitive bases" part of our model may be useful. Indeed, this could potentially be where heard voices appear to be recorded as propositions in the cognitive framework of the schizophrenic. Inferential calculi within the schizophrenic's cognitive base may be reconfigured, which could potentially explain their next conversation – based interventions – as we saw this illustrated in section 3 for the native Kpelle. Once again, the act of reconstructing inferential calculi clearly follows the principle of charity: in essence like borrowing inferential abilities as soon as one tries to rebuild inferential calculi offered by a dialogue participant.

5 Conclusion

For the two manifestations of incoherence we presented in our introduction, our main consideration was incoherence in the case of rupture of cohesion. In fact, we observed that violations of logical rules were in the end relatively rare. Furthermore, logical coherence may be more appropriately viewed as a particular case of cohesion, particularly if we consider the broader meaning of the term. The extent to which our modeling allow us to discriminate between several cases of cohesion ruptures. In all cases, a rupture is denoted by a non correspondence between a positive dialogue act and a negative one. Such a divergence may be due either to an erroneous interpretation or to a non respect of (implicit) rules of conversation (as illustrated in the examples given in section 4). It may also occur between a produced utterance that does not belong to the expected utterances. This divergence does not necessarily reflect the inability to follow a dialogue. Its interpretation requires a rebuilding of designs, that is dialogue strategies, to reconfigure the reasoning needed to explain the nature of the misunderstanding (as shown in the example of section 3).

¹¹ French (metaphoric) word for "dam".

¹² "These things you have to tell me with your mouth."

Another interest of Ludics for examining incoherence in dialogue, perhaps more incidental, is that our model forces us to consider both viewpoints of the dialogue as it becomes necessary to rebuild the justification relations between produced and received utterances for each protagonist. This enables to retrieve possible interpretations which were not visible *a priori*. Moreover, when we rebuild the expected reactions of the addressee to compare them with those received, we are induced to establish explicit cognitive contexts for each locutor. This may then highlight the context wherein a particular conversational behavior may be described as incoherent. It also in part makes it possible to precisely identify the norm that is not being respected. Making explicit this context, by means of the cognitive base level within our modeling, we are therefore able to distinguish between either a lack of normality or a lack of normativity.

Finally, while at a glance it might initially appear that we rely very little on the articulation between cohesion and logical composition, whereas this is in fact the core of the formal theory of interaction that served as the foundation for our dialogue modeling. Such an articulation between inferential calculi and cohesion at the level of the dialogue thread is the very issue we addressed in section 3. Our recommendation is that future works consider similar situations for what they may tell us about semantical and pragmatical abilities. Specifically, we believe this should be the methodological starting point for studying the secondary effects on dialogue of heard voices and other hallucinations.

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6 Annex

Definition 1 (Base) *A base is a non-empty finite set of sequents: $\Gamma_1 \vdash \Delta_1, \dots, \Gamma_n \vdash \Delta_n$ such that each Δ_j is a finite set of addresses, at most one Γ_i may be empty and the other Γ_i contain each exactly one address. Furthermore if an address appears twice then one occurrence is in one of Γ_i of a sequent and the other in one of Δ_j of another sequent, otherwise an address appears only once.*

Definition 2 (Action) An action κ is

- either a positive proper action $(+, \xi, I)$ or a negative proper action $(-, \xi, I)$ where the address ξ is said the focus of the action, and the finite set of integers I is said its ramification,
- or the positive action daimon written \mathfrak{A} .

An address $\xi.i$ is justified by an action $(+, \xi, I)$ when $i \in I$. By extension an action $\kappa = (\epsilon, \xi.i, J)$ is justified by an action $\bar{\kappa} = (\bar{\epsilon}, \xi, I)$ when $i \in I$, $\epsilon \in \{+, -\}$, $\bar{+} = -$ and $\bar{-} = +$. The notation $\bar{\kappa}$ may be extended to sequences of actions by $\bar{\epsilon} = \epsilon$ and $\overline{w\bar{\kappa}} = \bar{w}\bar{\kappa}$. When w is a \mathfrak{A} -free sequence of actions, we write also $\tilde{w} = \overline{w\mathfrak{A}}$ and $\widetilde{w\mathfrak{A}} = \bar{w}$.

Definition 3 (Chronicle) A chronicle \mathfrak{c} based on $\Gamma \vdash \Delta$ is a non-empty and finite alternate sequence of actions such that

- Positive proper action: A positive proper action is either justified, i.e., its focus is built by one of the previous actions in the sequence, or it is called initial.
- Negative action: A negative action may be initial, in such a case it is the first action of the chronicle and its focus is in Γ . Otherwise it is justified by the immediate previous positive action.
- Linearity: Actions have distinct foci.
- Daimon: If present, a daimon ends the chronicle.
- Polarity: If Γ is empty, the first action of \mathfrak{c} is positive, otherwise it is negative.

Definition 4 (Coherence on Chronicles) Two chronicles \mathfrak{c}_1 and \mathfrak{c}_2 are coherent, noted $\mathfrak{c}_1 \circ \mathfrak{c}_2$, when the two following conditions are satisfied:

- Comparability: Either one extends the other or they first differ on negative actions, i.e., if $w\kappa_1 \circ w\kappa_2$ then either $\kappa_1 = \kappa_2$ or κ_1 and κ_2 are negative actions.
- Propagation: When they first differ on negative actions and these negative actions have distinct foci then the foci of following actions in \mathfrak{c}_1 and \mathfrak{c}_2 are pairwise distinct, i.e., if $w(-, \xi_1, I_1)w_1\kappa_1 \circ w(-, \xi_2, I_2)w_2\kappa_2$ with $\xi_1 \neq \xi_2$ then κ_1 and κ_2 have distinct foci.

Definition 5 (Designs, Slices, Nets) A design \mathfrak{D} , based on $\Gamma \vdash \Delta$, is a set of chronicles based on $\Gamma \vdash \Delta$, such that the following conditions are satisfied:

- Forest: The set of chronicles is prefix closed.
- Coherence: The set is a clique of chronicles with respect to \circ .
- Positivity: A chronicle without extension in \mathfrak{D} ends with a positive action.
- Totality: \mathfrak{D} is non-empty when the base is positive, in that case all the chronicles begin with a (unique) positive action.

A slice is a design \mathfrak{S} such that if $w(-, \xi, I_1), w(-, \xi, I_2) \in \mathfrak{S}$ then $I_1 = I_2$.

A net is a finite set of designs on disjoint bases.

A design is then a set of chronicles or a forest of actions (when one cares of justification between actions) that satisfies several constraints. It can also be presented as a sequent tree, however with ambiguity due to the possible weakening of addresses created by actions. We describe in example 5 a design based on $\vdash \xi$ as a set of chronicles (on the left) and as a sequent tree (on the right):

Example 5

$$\begin{array}{l}
 \{ (+, \xi, \{1, 3\}); \\
 (+, \xi, \{1, 3\})(-, \xi.1, \{0\}); \\
 (+, \xi, \{1, 3\})(-, \xi.1, \{0\})(+, \xi.1.0, \{0\}); \\
 (+, \xi, \{1, 3\})(-, \xi.1, \{1\}); \\
 (+, \xi, \{1, 3\})(-, \xi.1, \{1\})(+, \xi.1.1, \{0\}); \\
 (+, \xi, \{1, 3\})(-, \xi.3, \{0\}); \\
 (+, \xi, \{1, 3\})(-, \xi.3, \{0\})(+, \xi.3.0, \emptyset) \}
 \end{array}
 \qquad
 \frac{\frac{\frac{\xi.1.0.0 \vdash}{\vdash \xi.1.0} \quad \frac{\xi.1.1.0 \vdash}{\vdash \xi.1.1}}{\xi.1 \vdash} \quad \frac{\vdash}{\xi.3 \vdash}}{\vdash \xi}$$

Definition 6 (Closed cut-net) A net of designs \mathfrak{R} is a closed cut-net if

- addresses in bases are either distinct or present twice, once in a left part of a base and once in a right part of another base,
- the net of designs is acyclic and connected with respect to the graph of bases and cuts.

An address present in a left part and in a right part defines a cut. In a closed cut-net, the (unique) design whose base is positive is called the main design of the cut-net.

Definition 7 (Interaction on closed cut-nets) Let \mathfrak{R} be a closed cut-net. The design resulting from the interaction, denoted by $\llbracket \mathfrak{R} \rrbracket$, is defined in the following way: let \mathfrak{D} be the main design of \mathfrak{R} , with first action κ ,

- if κ is a daimon, then $\llbracket \mathfrak{R} \rrbracket = \{\mathfrak{x}\}$,
- otherwise κ is a proper positive action $(+, \sigma, I)$ such that σ is part of a cut with another design with last rule $(-, \sigma, \mathcal{N})$ (aggregating ramifications of actions with the same focus σ):
 - If $I \notin \mathcal{N}$, then interaction fails.
 - Otherwise, interaction follows with the connected part of subdesigns obtained from I with the rest of \mathfrak{R} .

Following this definition, either interaction fails, or it does not end, or it results in the design $\mathfrak{D}\text{ai} = \{\mathfrak{x}\}$. The definition of orthogonality follows:

Definition 8 (Orthogonal, Behaviour)

- Let \mathfrak{D} be a design of base $\xi \vdash \sigma_1, \dots, \sigma_n$ (resp. $\vdash \sigma_1, \dots, \sigma_n$), let \mathfrak{R} be the net of designs $(\mathfrak{A}, \mathfrak{B}_1, \dots, \mathfrak{B}_n)$ (resp. $\mathfrak{R} = (\mathfrak{B}_1, \dots, \mathfrak{B}_n)$), where \mathfrak{A} has base $\vdash \xi$ and \mathfrak{B}_i has base $\sigma_i \vdash$, then \mathfrak{R} belongs to \mathfrak{D}^\perp if $\llbracket \mathfrak{D}, \mathfrak{R} \rrbracket = \mathfrak{D}\text{ai}$.
- Let \mathbf{E} be a set of designs of the same base, $\mathbf{E}^\perp = \bigcap_{\mathfrak{D} \in \mathbf{E}} \mathfrak{D}^\perp$.
- \mathbf{E} is a behaviour if $\mathbf{E} = \mathbf{E}^{\perp\perp}$. A behaviour is positive (resp. negative) if the base of its designs is positive (resp. negative).