

Non literal communication: From pragmatical to logical and psycholinguistical aspects*

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*Thanks to Andreas Herzig and Olivier Gasquet for their relevant review of this paper.

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1 Introduction

This paper presents results of an interdisciplinary research project on *non literal communication*, taking into account the point of view of logic, artificial intelligence, pragmatics, psychology, and neuropsychology. Here we focus on indirect speech acts and irony. Hence we do not treat metaphors, allusions, and propositional speech acts.

Our framework is man-machine communicative systems. Each agent (human or artificial) participates in a conversation, and is described by his mental states. Then, the dialogue is described by the evolution of the mental states of each participant. In previous works, we have already formalized both mental states and their evolution, but only for direct speech acts.

The aim of this paper is two-folds: first, we present a formal model for non literal communication (where non literal speech acts are performed, in the sense of [Searle, 1969; 1979]). Second, we present results of an experiment in psycholinguistics that may agree or disagree this formal model (and in fact, agree it).

Generally, non literal speech acts are handled case by case (by associating to a particular syntactical structure a particular non literal speech act). But this does not allow to analyze classes of non literal speech acts, and gives no guaranty about the completeness of the method.

We propose here a method of inferring non literal acts based on an exhaustive pragmatic investigation of the different means of non literal communication [Virbel, 1999].

We mainly focus on the class of directives, i.e. acts aiming at making the hearer doing something. An indirect speech act can be realized by an assertion or a question about three different types of arguments:

1. success conditions (in the sense of [Vanderveken, 1991]) of the direct speech act;
2. reasons (not) to perform the action the literal speech act is about;
3. the preconditions of the action the literal speech act is about.

For example, if the utterance “give me the salt” realize the direct speech act (DSA), the following utterances realize different indirect speech acts (ISA) respectively:

1. “Can you give me the salt?” (query about the preparatory condition of the DSA);

2. “[This meat is tasteless], you should give me the salt” (assertion on a reason to give the salt);

3. “Do you know where is the salt?” (question on a precondition to give the salt);

Breakdown can be found in [Virbel, 1999].

2 Formalization of the inference of non literal speech acts

Based on philosophical theories of [Bratman, 1987] we have introduced in previous works a formalism that is in the same line of research as [Cohen and Levesque, 1990a; 1990b] and [Sadek, 1992]. As the latter we aim at generalizing speech act theory to a theory of communication, whose properties would be derivable from (more general) principles of rationality. The formal framework is that of an epistemic dynamic logic that fits with speech act theory [Austin, 1962; Searle, 1969].

As far as we know, there is currently no formal logic within which non literal speech acts can be inferred. In this paper we fill in this gap within the above framework.

2.1 Language

Our language is that of first-order multimodal logic without equality and function symbols. The associated semantics is in terms of possible worlds and accessibility relations (for belief) and neighborhood functions (for intention). Atomic formulas are noted p, q, \dots or $P(t_1, \dots, t_n)$. ATM is the set of all atomic formulas. Formulas are noted A, B, \dots , and $FORM$ is the set of all formulas.

AGT is the set of agents. For $i \in AGT$, $Bel_i A$ is read “agent i believes that A ”, and $Intends_i A$ is read “agent i has the intention that A ”, $Bel_{i,j} A$ is read “the agents i and j mutually believe that A ”¹. For example, $Bel_i Dest(\text{Paris})$ expresses that agent i believes that the destination is Paris. $Bel_{i,j} A$ is an abbreviation for $Bel_i A \vee Bel_j A$, which is read “agent i knows whether A is true or not”.

$FI = \{\text{Inform, Request, QueryYN, QueryWh}\}$ is a set of illocutionary forces, and $FP = \{\text{Come,}$

¹By the principles of our logic we can prove that $Bel_{i,j} A \rightarrow Bel_i A$.

Give, Take, Insert, Dial, ...} is a set names of physical actions (that we call *physical forces*, in analogy with illocutionary forces).

Let $PACT = \{\langle \text{Force}_{i,j} A \rangle : \text{Force} \in FP, A \in FORM \text{ and } i, j \in AGT\}$ be the set of physical acts. For example, the action performed by agent i of passing the salt to j is $\langle \text{Give}_{i,j} \text{ salt} \rangle$. Similarly, $ACT = \{\langle \text{Force}_{i,j} A \rangle : \text{Force} \in FI, A \in FORM \text{ and } i, j \in AGT\}$ is the set of illocutionary acts. For example, the utterance of i towards j informing the latter that the salt-shaker is broken is realized by the act $\langle \text{Inform}_{i,j} \text{ broken}(\text{salt-shaker}) \rangle$.

Let $ACT = ACT \cup PACT$. To every $\alpha \in ACT$ is associated a modal operator Done_α . $\text{Done}_\alpha A$ is read “ α has just been performed, before which A was true”². Hence $\text{Done}_\alpha \top$ is read “ α has just been performed”. $\text{Feasible}_\alpha A$ is read “ α is executable, and A will be true afterwards”³.

$\text{After}_\alpha A$ is an abbreviation of the formula $\neg \text{Feasible}_\alpha \neg A$. $\text{After}_\alpha A$ is read “after every execution of α , A is true”. $\text{Before}_\alpha A$ is an abbreviation of the formula $\neg \text{After}_\alpha \neg A$, and $\text{Before}_\alpha A$ is read “before every execution of α , A is true”.

$\text{Always} A$ is read “ A is always true”. (Semantically, this means that the associated accessibility relation contains the reflexive and transitive closure of the union of all accessibility relations associated to actions.)

2.2 Action laws and multiple effects

In the current version of our theory, there are non logical *action laws*⁴ describing the preconditions and effects associated to a speech act. For example, $\text{Before}_{\langle \text{Inform}_{i,j} A \rangle} (\text{Bel}_i A \wedge \neg \text{Bel}_i \text{Bell}_j A)$ (i.e. before every execution of an informative act of agent i towards j concerning A , agent i believes that A and does not believe that j knows whether A) is a law associating an informative act to its preconditions; $\text{After}_{\langle \text{Inform}_{i,j} A \rangle} (\text{Bel}_i A \wedge \neg \text{Bell}_j \text{Bel}_j A \wedge \text{Intends}_i \text{Bel}_j A)$ (i.e. after every execution of an informative act by i towards j about A , i believes that A , ignores whether j believes that A , and has the intention that j believes A) associates an informative act to its effects.

In the sequel we reformulate the action laws in order to take into account non literal use of some kinds of speech acts. We base ourselves on the above results (Sect. 1). We are motivated by two considerations: on the one hand there is only a finite number of way to perform a non literal act (contrarily to the intuitions that one might have in the first place). On the other hand, these different ways can be identified by their specific syntactical form. For these two reasons, we think it is legitimate to hope for a formal account.

Definition 1 Every act whose syntactical form admits an indirect act in the sense of the classification of section 1 is called a form of indirection.

² $\text{Done}_\alpha A$ is nothing but $\langle \alpha^{-1} \rangle A$ of dynamic logic.

³ $\text{Feasible}_\alpha A$ is nothing but $\langle \alpha \rangle A$ of dynamic logic.

⁴Non logical laws are axioms but not axiom schemata: substitution is not allowed.

In order to simplify our exposition we only treat here the cases where the indirect act is of the form $\langle \text{Request}_{i,j} \text{ Done}_\beta \top \rangle$ (i.e. i asks j to perform the action β), and whose preconditions and effects are respectively $\text{Bel}_i \text{Feasible}_\beta \top \wedge \neg \text{Bel}_i \text{Intends}_j \text{Done}_\beta \top \wedge \text{Intends}_i \text{Done}_\beta \top$ (i.e. i believes j can do β ⁵, does not believe that j has already the intention to do β , and has the intention that j do β) and $\text{Intends}_i \text{Bel}_j \text{Intends}_i \text{Done}_\beta \top$ ⁶ (i.e. i wants j to believe that he has the intention that j perform β).

Formally, we associate several distinct sets of effects (which are even mutually inconsistent) to the same given act. These sets account for the performance of the act in various contexts of utterance. Typically, two sets of effects can be distinguished: those accounting for the case where speaker’s and hearer’s meaning coincide, and those where they don’t; the context will determine which preconditions and effects must be associated with the act that has been performed. Formally, the laws associating an act α with his different sets of preconditions are of the form⁷:

$$\begin{aligned} & \text{AlwaysBel}_k(A \rightarrow \text{Before}_\alpha B) \\ & \text{AlwaysBel}_k(A' \rightarrow \text{Before}_\alpha B') \end{aligned} \quad (1)$$

...

for every $k \in AGT$, where A, A', \dots are formulas that are true in a particular context of utterance. We call them *relationship criteria* (cf. Sect. 2.3 for the formal definition).

Notations 1 In the sequel, $\alpha = \langle \text{Force}_{i,j} A \rangle : \text{Force} \in FI$ represents the act which has just been performed (in the sense of the utterance meaning). $\beta \in ACT$ represents the speech act or the action whose speaker is j , whose hearer is i , and which is mentioned in the act α that has just been performed.

Example 1 Consider the utterance of the form “Can you do β ?” realizing the act (in the sense of the utterance meaning) $\alpha = \langle \text{QueryYN}_{i,j} \text{ Feasible}_\beta \top \rangle$. α is a form of indirection (cf. Sect. 1, case (a1)) and might mean “Do β ”. The preconditions associated with α are:

- i does not know the answer to the question ($\neg \text{Bell}_i \text{Feasible}_\beta \top$);
- i believes that j is capable of answering the question (i.e. $\text{Bel}_i \text{CanAnswer}(j, i, \text{Feasible}_\beta \top)$ where
$$\text{CanAnswer}(x, y, A) \stackrel{\text{def}}{=} \text{Feasible}_{\langle \text{Inform}_{x,y} A \rangle} \top \vee \text{Feasible}_{\langle \text{Inform}_{x,y} \neg A \rangle} \top$$
);
- i wants j to answer the question (i.e. $\text{Intends}_i \text{Answer}(j, i, \text{Feasible}_\beta \top)$ where
$$\text{Answer}(x, y, A) \stackrel{\text{def}}{=} \text{Done}_{\langle \text{Inform}_{x,y} A \rangle} \top \vee \text{Done}_{\langle \text{Inform}_{x,y} \neg A \rangle} \top$$
).

⁵We remind of $\beta = \langle \text{Force}_{j,i} A \rangle$ where j is the author of β , and i the addressee.

⁶Details about the formalization of speech acts can be found in [Sadek, 2000].

⁷In order to be true in all the successive timepoints they are preceded by the temporal operator Always.

Formally we thus have the following action laws (for every $k \in \mathcal{AGT}$):

$$\begin{aligned} & \text{AlwaysBel}_{i,j}(A \rightarrow \\ & \quad \text{Before}_\alpha(\neg \text{Bell}_i \text{Feasible}_\beta \top \wedge \\ & \quad \quad \text{Bel}_i \text{CanAnswer}(j, i, \text{Feasible}_\beta \top) \wedge \\ & \quad \quad \text{Intends}_i \text{Answer}(j, i, \text{Feasible}_\beta \top)) \end{aligned} \quad (2)$$

where $\alpha = \langle \text{QueryYN}_{i,j} \text{Feasible}_\beta \top \rangle$

$$\begin{aligned} & \text{AlwaysBel}_{i,j}(A' \rightarrow \\ & \quad \text{Before}_\alpha(\text{Bel}_i \text{Feasible}_\beta \top \wedge \\ & \quad \quad \neg \text{Bel}_i \text{Intends}_j \text{Done}_\beta \top \wedge \\ & \quad \quad \text{Intends}_i \text{Done}_\beta \top) \end{aligned} \quad (3)$$

where $\alpha = \langle \text{QueryYN}_{i,j} \text{Feasible}_\beta \top \rangle$

where $A, A' \in \mathcal{FORM}$ correspond to relationship criteria respectively for the literal and non literal meaning of the utterance realizing α (and remain to be defined cf. Sect. 2.3).

It is important to stress that there are cases where the preconditions of the literal and the non literal act are mutually inconsistent (as was the case in example 1). This means that from a pragmatical point of view, either the literal or the non literal act is a success, but not both. Logically, a necessary and sufficient condition is that the relationship criteria A, A', \dots of the laws under concern are inconsistent (only one relationship criterion can be true at the same time).

The acts which aren't forms of indirection keep on having unconditioned preconditions and effects via action laws that are respectively of the form $\top \rightarrow \text{Before}_\alpha A$ and $\top \rightarrow \text{After}_\alpha A'$ (which is logically equivalent to $\text{Before}_\alpha A$ and $\text{After}_\alpha A'$), as shows the following example.

Example 2 Let $\alpha = \langle \text{Inform}_{i,j} p \rangle$ be an illocutionary act. If we suppose that no conversational implicature is ever achieved by the performance of α , then α is not among the forms of indirection. For every context, the action laws for the preconditions is of the form $\text{AlwaysBel}_{i,j} \text{Before}_{\langle \text{Inform}_{i,j} p \rangle} (\text{Bel}_i p \wedge \neg \text{Bel}_i \text{Bell}_j p)$.

2.3 Criteria

The problem is now to formally define the different relationship criteria that we need.

As we have seen in the previous section, an indirect speech act can be realized by asserting or questioning about three principal types of arguments (cf. Sect. 1). We are thus able to detect some remarkable syntactical forms: those which compose of indirections.

Definition 2 Let α be a form of indirection of type (1)⁸ (by assertion or closed question about a success condition of the corresponding direct act). Then we call primary relationship criterion of α every precondition of that act which is of the same type (sincerity or context relevance) than that mentioned in the propositional contents of α .

⁸This number refers to items of Sect. 1.

The primary relationship criteria are directly related to the non literal illocutionary act, contrarily to the other relationship criteria which require domain laws.

Example 3 The act $\alpha = \langle \text{QueryYN}_{i,j} \text{Feasible}_\beta \top \rangle$ (cf. the example 1) is a closed question about the context relevance precondition of the corresponding direct act. The context relevance precondition of α is $\neg \text{Bell}_i \text{Feasible}_\beta \top$ (i.e. i ignores whether j can perform β). Then in the above laws (2) and (3) it is sufficient to take $\neg \text{Bell}_i \text{Feasible}_\beta \top$ for A and $\text{Bell}_i \text{Feasible}_\beta \top$ for A' .

If the context relevance precondition is true in this example then the agent favors literal over non literal interpretation. If the other way round the agent believes that the context relevance precondition is false then he will favor the non literal understanding.

It is not always necessary to choose between the two interpretations, in particular when the criteria are consistent. This is illustrated by the following example.

Example 4 Let $\alpha = \langle \text{Inform}_{i,j} \text{Intends}_i \text{Done}_\beta \top \rangle$ be realized by an utterance of the form “I (want + would like + intend) you to do β ” (assertion about the sincerity condition of the corresponding direct act; case (1)). The sincerity condition of the informative act is: $\text{Bel}_i \text{Intends}_i \text{Done}_\beta \top$, and that of the requesting act is: $\text{Intends}_i \text{Done}_\beta \top$. In our logic, these two conditions are logically equivalent. It follows that the primary relationship criterion is the same in both cases. This accounts for the fact that i informs j about his desire and at the same time asks j to satisfy it.

2.4 Other non literal acts

Up to now we have only addressed case (1) of the above classification of section Sect. 1.

Logically, case (3) can be treated as a particular case of (1). Indeed, asking j to do β has as context relevance precondition that i believes that j can execute action β . Such a belief logically implies that i believes that:

1. all the preconditions required for the execution of β hold for j (e.g. j knows where the salt is, or he knows how to know where is the salt);
2. j is able to perform all the subactions that are necessary to perform β (e.g. j can reach the salt).

In what concerns case (2), it is clear that we need domain laws allowing us to link the reasons and explanations of the literal act to the performance of the corresponding non literal act. This case is more delicate than the others, and is the subject of ongoing research. We only illustrate the case by an example (borrowed from [Vanderveken, 1997]).

Suppose i asks “Does John have a girlfriend?” and j answers “John is gay”. Instead of answering “no”, j informs i about a fact from which i will understand that the answer to his question is “no”. In that case, j 's literal act has been performed felicitously⁹, and the relationship criterion (that we then call “secondary”) relative to the utterance meaning is a tautology (\top). But a non literal act has also been

⁹In the sense of [Austin, 1962], i.e. the conditions of success, non defectiveness and satisfaction are all fulfilled.

performed – the one relative to the “no”, which is implied conversationally). The performance of that act requires the existence of a mutual belief (from j 's point of view) according to which “if someone is gay then he has no girlfriend”. This belief has the status of a domain law. In such a context, j 's answer together with i 's knowledge of domain laws allows i to deduce the answer he expected, and thus to associate a non literal act to j 's utterance (that is also of the informative type). We formalize this below.

Example 5 Let $\alpha_1 = \langle \text{QueryYN}_{i,j} p \rangle$ and $\alpha_2 = \langle \text{Inform}_{j,i} q \rangle$ ¹⁰. The action laws are then the following (supposing that $\text{AlwaysBel}_{i,j}(q \rightarrow \neg p)$ is a domain law):

$$\begin{aligned} & \text{AlwaysBel}_i \text{Before}_{\alpha_2} (\text{Bel}_j q \wedge \neg \text{Bel}_j \text{Bel}_i q) \\ & \text{AlwaysBel}_i (\text{Bel}_i \neg p \rightarrow \text{Before}_{\alpha_1} (\text{Bel}_j \neg p \wedge \neg \text{Bel}_j \text{Bel}_i \neg p)) \end{aligned} \quad (4)$$

After the performance of α_2 , if i thinks that j is sincere then he believes that j believes that q . If moreover i has no reasons to doubt the competence of j at this piece of information then he starts to believe q himself (cf. for more details about belief dynamics of agents participating in a dialogue). i will deduce that the preconditions of the non literal act are satisfied.

This example illustrates that sometimes the relationship criterion for the “non literal effects” of an act depends on the performance of the act with the literal meaning (while the preceding examples illustrate that this is not always the case).

The next section shows how psycholinguistic experiments can help answering to the formal choices to be made. Reciprocally, this will enable us to show how the formalism allows to take into account in a natural and coherent way experimental results that are heterogeneous.

3 Psycholinguistic experiment

3.1 Issues

Sentence meaning or discourse meaning is not only inferred from words' meaning. Actually, when a friend tells us: “You have a great talent for artistic thing” when our drawing looks like nothing good, knowing the linguistic code and words' meaning is not sufficient to understand that this kind of remark is not really a compliment. So, how can we understand that what our speaker wants to mean is different from what he says? How does the speaker can say something and means something else?

Some psycholinguistic studies [Gibbs, 1994] have worked about the nature of cognitive processing used by normal subjects to understand non literal utterances, to agree or disagree to pragmatic models particularly to the traditional model named “standard pragmatic model” stemmed from theory of conversational implicature of Grice and from the work of Searle about the theory of speech acts.

Traditional model of comprehension of what is meant makes the basis hypothesis that “special” cognitive processes are needed to understand non literal utterances.

If a literal utterance can be understood via normal cognitive mechanism, hearers must recognize that non literal utterance is deviant before determining his meaning. The traditional point of view [Clark and Lucy, 1975], suggests that it would be more difficult to process non literal utterances than their literal counterpart. A modified version of this model, named “multiple-meaning model” [Clark, 1979], suggests that comprehension of non literal meaning involves a simultaneous processing of literal and non literal meaning, but not a sequential processing. Results of Clark & Schunk [1980] extend this model, insisting on the role of politeness in the way that hearer chooses his answer to an indirect request. Notice that as the traditional model, this new model always needs an additional process that work in parallel with processes of literal language understanding.

Moreover, some studies [Gibbs, 1982] have shown that non literal language needs not special cognitive processes to be understood. In fact, a lot of studies using reading time measurements show that people does not need additional mental efforts to understand non literal utterances. Non literal utterances might easily be understood thanks to context and more specifically to common background information (knowledge, believes, and attitudes that are identified as shared by speaker and hearer in a discourse situation).

Following this theoretical framework, in this study, we want to determine whether there exists a hierarchy of complexity between various non literal speech acts versus literal speech acts defined as follows:

- violations of the maxim of relation and violations of the maxim of quantity (L says p , and he wants to say exactly q);
- indirect requests (L says p , and he wants to say exactly $p + q$);
- ironic statements (L says p , and he wants to say exactly non p ; in other words, he wants to say exactly the opposite of p in the context of utterance);
- direct speech acts (L says p , and he wants to say exactly p).

In other words, the aim of this study, among healthy subjects, is to determine whether an indirect request, for instance, requires more processing to be understood than a ironic statement. In order to test such an hypothesis, we compare reading time (RT) measures for different subtypes of stimuli belonging to each of the four above mentioned categories.

3.2 Experiment

Method

40 normal young subjects (between 18 and 21 years old), right-handed and all native French speakers were tested individually.

The stimuli were presented in a different random order for each subject on a computer screen. The text was centered on the screen. In order to be able to distinguish the story from the assertion/statement which the subject had to judge, the latter appeared on the screen in blue whereas the story appeared in white.

¹⁰For example, p is *Has Girlfriend* (John) and q is *Gay* (John).

Only the “V” key, the “N” key and the space key were available on the keyboard. The other keys were hidden by a cardboard. The “V” key was masked by the letter “F” for false¹¹, and the “N” key was masked by the letter “V” for true¹².

Subjects had to read each story in two stages. They had to press the space key to move from the first part of the text to the next. Then, they had to make a true-false judgment by using either the “V” or the “F” key. Subjects had not the possibility to make any corrections afterwards.

For each of these manipulations, subjects were only allowed to use their right index finger. Before starting the proper experiment, subjects were trained with ten stimuli, different from the ones to be used in the experiment. The task lasted about 30 minutes, with a pause of three minutes halfway across the test.

The computer recorded both the latency of the reading/comprehension of the target sentence (Reading Time: RT) and the decision latency of the judgment task (Decision Time: DT).

There were 112 stimuli distributed as follows: 56 non literal, or “implicit” speech acts, with: 14 violations of the maxim of relation (VMR), 14 violations of the maxim of quantity (VMQ), 14 indirect requests and 14 ironic statements and 56 literal, or “explicit”, speech acts (corresponding to the literal counterparts of the 56 previous stimuli). We present below an example of stimuli belonging to each category.

Example 6 (VMR) *C’est vendredi et Bernard part se promener à la montagne le lendemain. Il dit à Yves: “Veux-tu venir avec moi?”/ Yves lui dit: “J’ai beaucoup de travail à faire pour lundi.”/[this segment is the target sentence of the implicit stimulus] Yves lui dit: “Non, je ne viendrai pas avec toi, j’ai beaucoup de travail à faire pour lundi.”/[this segment is the target sentence of the explicit control stimulus]*
Affirmation: *Yves va marcher en montagne avec Bernard (Faux).*

Example 7 (VMQ) *Monique veut aller faire les courses en voiture. Elle dit à Edmond: “Où as-tu posé les clés de la voiture?”/ Edmond lui dit: “Quelque part dans le salon.”/ Edmond lui dit: “Dans le salon, mais je ne sais plus où exactement.”/*
Affirmation: *Edmond ignore la place exacte des clés (Vrai).*

Example 8 (Indirect request) *Robert est à un dîner d’affaires avec M. Chaumont. Il veut du pain pour manger son fromage./ Robert dit à M. Chaumont: “Pouvez-vous me donner le pain?”/ Robert dit à M. Chaumont: “Donnez-moi le pain, s’il vous plaît.”/*
Affirmation: *M. Chaumont va donner le pain à Robert (Vrai).*

Example 9 (Ironic statement) *Géraldine vient de refaire son appartement. Elle a repeint avec des couleurs affreuses./ Son amie Nadège lui dit: “Tu devrais être décoratrice d’intérieur.”/ Son amie Nadège lui dit: “J’ai toujours pensé que tu avais mauvais goût.”/*
Affirmation: *Géraldine a mauvais goût pour la décoration (Vrai).*

¹¹“Faux” in French.

¹²“Vrai” in French.

Results and discussion

We present results concerning reading time of the target sentence by young normal subjects.¹³

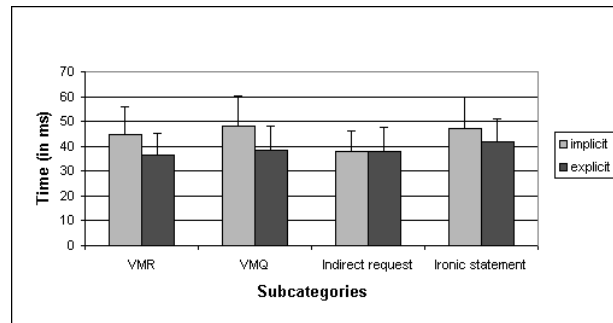


Figure 1: Corrected reading times for subcategories.

Results show that a hierarchy of complexity exists. In other words, the explicit stimuli are indeed easier to process than the implicit ones for all the subjects tested. However, our results give only partial conclusions because there does not exist significant differences between all the implicit subcategories. Indeed, if indirect requests are understood more easily than the other non literal speech acts, and if the violations of the maxim of relation are understood more easily than the violations of the maxim of quantity and than the ironic statements, we cannot say anything about the differences between ironic statements and violations of the maxim of quantity.

Moreover, our results show that subjects understand more easily the violations of the maxim of relation, the violations of the maxim of quantity, and the ironic statements than their explicit counterpart, but such a difference in comprehension does not exist for the indirect requests. A possible explanation of this observation may lie in the fact that we only used conversational requests (as example presented in the group a1) (cf. Sect. 1) and several studies [Clark, 1979; Clark and Schunk, 1980; Gibbs, 1979; 1982] have shown the prominent role of conventionality in discourse processing. Thus, in contrast to Searle and according to Gibbs [1982], the indirect requests would be processed directly without any need to activate their literal meaning. This would confirm the “easiness” of comprehension of this non literal speech act. This fact also emphasizes the important role of conventionality in discourse processing. Then, Gibbs [1982] shows that, a situational context given, subjects analyze what these requests conventionally mean without processing sentence literal meaning first. So, we can suppose that for all the subcategories tested, subjects process the literal speech act and the non literal speech act, insofar as they pay attention to the conventional meaning of the utterances. It may exist, in this special case, an interaction between conventionality and the special social context where it appears. This leads to confirm the logical formalism presented previously (cf. Sect. 2).

¹³Following results are obtained from statistical analysis like analysis of variance (ANOVA).

4 Conclusions

The approach presented in this paper offers a great interest because it allows confrontation of both psycholinguistics and knowledge representation in Artificial Intelligence methods.

From a logical point of view, this framework is consistent with respect to our dynamic epistemic logic (cf. our previous works). It is a first step towards the treatment of non literal speech acts within a formal approach of the dialogue. It is important to emphasize the pragmatic foundation of this work: the recent results in this domain allow us to define a method of inferring non literal acts based on an exhaustive pragmatic investigation of the non literal communication [Virbel, 1999].

The fact that non literal stimuli entail reading times longer than in the literal version is in favor of processes in which comprehension of the literal meaning constitutes a step.

Thus, according to classical theories, non literal meaning might be derived from literal meaning and others information (conversational background) joined with pragmatic rules (felicitous conditions of illocutionary acts, conversational maxims). However, the question to know whether the whole processing is a parallel or a sequential processing is still open.

In addition, the logical formalization presented relies on a linguistic-pragmatics basis. The aim of this formalism is on the one hand to process inferences of indirect speech acts and on the other hand to perform this processing in a dynamic way (i.e. during the dialogue). Moreover, the formalism had to be consistent with experimental results. Thus, actions laws depending on relationship criteria, have two advantages: first, to directly bind a context of utterance with effects of the performed act; second, to allow (when it is necessary) the use of the literal speech act to define whether the non literal speech act had been performed. (Note this result agrees with psychological experiments on language.)

Finally, from a psycholinguistic point of view, it is necessary to rely on a theoretical framework as rigorous as possible. Thus, our experiments can be fine tuned in order to obtain usable results. Thus, it is particularly relevant to use a classification of non literal speech acts in order to define stimuli in the best way.

Moreover, on the one hand, psychological experiments provides a criterion of plausibility to logic. On the other hand, logic (via its inference processes) provides to psycholinguistics, models for cognitive processing. These models might allow to choose the best experimental tasks to test subjects, and to interpret our results.

These results are added to our previous common works. They offer new perspectives of investigation in the domain of non literal communication, privileged domain of study for man-machine dialogue systems.

References

[Austin, 1962] John L. Austin. *How To Do Things With Words*. Oxford University Press, 1962.

[Bratman, 1987] Michael E. Bratman. *Intention, Plans, and Practical Reason*. Harvard University Press, 1987.

[Clark and Lucy, 1975] H.H. Clark and P. Lucy. Understanding what is meant from what is said : a study in conversationally conveyed requests. *Journal of verbal learning and verbal behaviour*, 14:56–72, 1975.

[Clark and Schunk, 1980] H.H. Clark and D.H. Schunk. Polite responses to polite requests. *Cognition*, 8:111–143, 1980.

[Clark, 1979] H.H. Clark. Responding to indirect speech acts. *Cognitive psychology*, 11:430–477, 1979.

[Cohen and Levesque, 1990a] Philip R. Cohen and Hector J. Levesque. Intention is choice with commitment. *AI Journal*, 42(2–3), 1990.

[Cohen and Levesque, 1990b] Philip R. Cohen and Hector J. Levesque. Rational interaction as the basis for communication. In Philip R. Cohen, Jerry Morgan, and Martha E. Pollack, editors, *Intentions in Communication*. MIT Press, 1990.

[Gibbs, 1979] R.W. Gibbs. Contextual effects in understanding indirect requests. *Discourse Processes*, 2:1–10, 1979.

[Gibbs, 1982] R.W. Gibbs. A critical examination of the contribution of literal meaning to understanding non literal discourse. *Text*, pages 9–28, 1982.

[Gibbs, 1994] R.W. Gibbs. *The poetics of mind*. Cambridge University Press, 1994.

[Sadek, 1992] M. D. Sadek. A study in the logic of intention. In Bernhard Nebel, Charles Rich, and William Swartout, editors, *Proc. Third Int. Conf. on Principles of Knowledge Representation and Reasoning (KR'92)*, pages 462–473. Morgan Kaufmann Publishers, 1992.

[Sadek, 2000] M. D. Sadek. Dialogue acts are rational plans. In M.M. Taylor, F. Néel, and D.G. Bouwhuis, editors, *The structure of multimodal dialogue*, pages 167–188. Philadelphia/Amsterdam, 2000. John Benjamins publishing company. From ESCA/ETRW, Workshop on The Structure of Multimodal Dialogue (Venaco II), 1991.

[Searle, 1969] John R. Searle. *Speech acts: An essay in the philosophy of language*. Cambridge University Press, 1969.

[Searle, 1979] J. R. Searle. *Expression and Meaning*. Cambridge University Press, 1979.

[Vanderveken, 1991] D. Vanderveken. *Meaning and Speech Acts*, volume 1 : *Principles of language use*. Cambridge University Press, 1991.

[Vanderveken, 1997] Daniel Vanderveken. Formal pragmatics of non literal meaning. *Linguistische Berichte*, 1997.

[Virbel, 1999] Jacques Virbel. Contributions de la théorie des actes de langage à une taxinomie des consignes. In J. Virbel, J.-M. Cellier, and J.-L. Nespoulous, editors, *Cognition, Discours procédural, Action*, volume II. PRESCOT, 1999.