Published in *Journal of Psycholinguistic Research,* Vol.**26**, No. **5**, 557-580, 1997

TACIT INTEGRATION AND REFERENTIAL STRUCTURE IN THE LANGUAGE COMPREHENSION OF APHASICS AND NORMALS*

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Abstract

Aphasics, brain damaged patients with no language deficit, neurologically intact elderly subjects and university undergraduates matched pictures to sentences having compelling tacit implications (e.g. the sentence *The fox grabs the hen* strongly invites one to assume that the fox will eat the hen). All groups made, for the same sentences, qualitatively similar referential errors consisting in choosing a tacit implication picture. Two auxiliary experiments using the same target sentences in other interpretive situations permitted ruling out the possibility that these errors were due to the putative intrinsic semantic properties of the sentences, showing that the sentences which were most liable to elicit integrative error varied from task to task. These results are interpreted within the conceptual framework which posits that reliable directions for interpretation are couched by the speaker in the very structure of his utterances (the utterance's referential structure) providing the hearer with means to restructure the relevant personal knowledge integrated into the interpretive process in accordance with the speaker's communicative intent. The determination of the referential structure (RSD) of utterances thus seems critical to their correct or, more precisely, conventional interpretation, and, along with the tacit integration of relevant sources of personal knowledge, constitutes the principal cognitive device enabling us to understand each other. But this device appears to be easily corruptible. It is suggested that many errors made by aphasics in language interpretation are due to a failure to follow all referential instructions, but that qualitatively similar failures also occur in normal subjects, though to a lesser degree. Language interpretation is a fallible process and aphasic errors provide remarkable clues for the understanding of its subtle referential mechanisms.

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* This study was supported in part by a grant from the Fondation Fyssen to the first author. We wish to thank Robert S. Pierce for helpful comments on an earlier version of the manuscript and Ralph Eisenberg for his efforts to make this text readable.
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Introduction

The concept of *tacit integration* refers to the phenomenon in which sources of personal knowledge are brought to bear on the perception and interpretation of an event (e.g. an utterance). Following the philosopher Michael Polanyi (1968), this phenomenon may be conceived of as quite general, constituting the very basis of *sense-giving*. Tacit integration ought not to be confused with a deliberate effort to recollect facts or apply formal knowledge in view of solving a problem or examining the validity of an assertion. The integration of personal knowledge is said to be *tacit* because it is involuntary, the domains of knowledge actually integrated into the interpretive process are *a priori* unspecifiable, and are neither explicitly referred to in the target event nor formally invited to concur. More important still, tacit integration is a part of interpretive elaboration whereas explicitly invited inference is a part of formal problem solving.

The concept of the *referential structure* of an utterance pertains to the structure of *internal relationships* obtaining between the entities involved in this utterance. This structure constitutes a referential (*hic et nunc*) mold for the knowledge integrated into the interpretive process, and its function is to curb interpretive elaboration channeling it to follow directions for interpretation which are couched by the speaker in the very form of his utterance. Implicit to this concept is the idea that the structure of an utterance contains reliable indices of the speaker's communicative intents (in the sense of conventional interpretation, see below) and that an analysis of these indices provides a schema or structure for the interpretive process. The concept of referential structure and its implications for a theory of language interpretation should become clearer as we proceed. For our present purpose let us insist on the difference between the concept of referential structure and the traditional concept of *reference* concerning the relationship between objects, events and phenomena, and linguistic tokens. The latter concept subsumes an objective relationship between utterances and things in the real world, whereas the present concept does not make such a strong assumption and simply holds that utterances provide reliable but analysis-demanding clues to what the speaker intends to communicate (e.g. Bouchard, 1984). Specifying the structure of the action implied in an event, casting actors for the parts they play therein, or situating the event in time and space all require referential directions and cannot be inferred from personal knowledge.

The determination of referential structure (RSD) and the process of tacit integration may thus be viewed as two facets of interpretive elaboration. Their collaboration buys conventional interpretation of utterances and makes language an effective means of social interaction. Yet, in practice, the two facets are so barely distinguishable that it takes errors in comprehension to recognize that there may be two sorts of machinery behind conventional interpretation. Our goal in the present study is to explore the relationship between referential structure and tacit integration by eliciting referential errors in subjects' interpretations of sentences. Such errors are commonplace in linguistic communication but they are most easily elicitable in aphasia.

Referential structure and interpretive elaboration

The *referential structure* of an utterance may be viewed *synchronically* as the *full constellation of internal relationships* holding between the entities involved in this utterance. This constellation is composed of a web of mutual relationships spun out of a variety of structural and pragmatic leads. Classically, the analysis of referential structure was ascribed to syntactic processes but it is quite easy to show that not all referential relationships can be determined by syntactic analysis. The most obvious examples are those of deixis and of anaphora - in many cases the identification of co-reference and of co-specification takes both syntactic and pragmatic knowledge and may require second-order semantic clues[1].

The web of referential relationships contains many structural leads: thematic roles, verb-argument structure, pronominal structure, prepositional structure, etc... which are often studied as independent phenomena. Yet, notwithstanding that many elements of referential structure are explorable in their own right (see Halliday and Hasan, 1976; Garnham and Oakhill, 1987; Cloitre and Bever, 1988; Altmann, 1989; Mitchell, 1989; Tanenhaus *et al*. 1989) and often admit of specific local analyses, they all share the same underlying goal: to impose a referential (*hic et nunc)* mold upon interpretive elaboration (see also Bouchard, 1984; Langacker, 1987; 1991). This commonality may explain why diverse referential leads are intricately intermingled (for instance pronoun reference often relies on the S-O relationship). Likewise, it provides the grounds for considering various referential operations within a unified cognitive perspective of *Referential Structure Determination* (RSD).

RSD will however best be defined *diachronically*: the determination of referential structure requires a variety of processes which unfold in time according to a certain chronology. This means that RSD is a hierarchical process in which the results of certain operations constitute structural prerequisites for conducting others (see Rosenthal, 1988). Since RSD both constrains and is concomitant with the interpretive process, its hierarchical organization, in which the more basic referential operations (e.g. verb-argument structure, primary thematic relationships) precede and govern others, also defines the temporal unfolding of interpretive elaboration. Interpretive elaboration appears in this light as a gradual process, evolving from a relatively shallow global perception of what is being talked about to a fine-grained exploration of all referential indices, thus leading to the conventional interpretation of a speaker's communicative intent and presumably beyond. How far interpretation may go depends on a variety of individual and contextual factors which do not concern us here. The point is that in the course of language comprehension, interpretation gradually gets more and more elaborate, building increasingly on additional referential leads, *i.e.* moves over different in-depth levels of fineness.

There are three important implications to this view. First, interpretation need not be very elaborate in order to meet certain communicative requirements (see Moore and Carling, 1982). In fact, certain early referential operations (e.g. determination of verb-argument structure, assignment of main thematic roles) provide a basis for relatively coarse-grained shallow interpretation which may suffice in various interpretive contexts. The second implication is that we ought to be more specific with respect to the levels of interpretation we are probing in aphasiological studies of language comprehension. To make this point plain, consider that in studies of agrammatism it is usually the patient's ability to assign thematic roles which constitutes the critical test of his comprehension. But does a correct match of thematic roles really constitute an adequate metrics of sentence understanding? The present study will show that it doesn't: one may correctly match main thematic roles and still miss important information. This phenomenon is not specific to agrammatism or to aphasia in general; in fact, it also occurs in normal subjects, though to a lesser degree.

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[1] By *second-order semantic clues* we mean referential clues derived from the ongoing overall interpretive process. Consider, for instance, the following example of anaphora (from Wilks, 1975): *The soldiers fired at the women and we saw them fall*. Clearly, the co-reference of *them* can only be identified on the basis of the semantic relationships holding in the type of event referred to, and the determination of those relationships requires a partial interpretation of this sentence.

This leads us to the third implication: interpretation is a *fallible process* and is liable to break down in a variety of ways. Recall that interpretation is a gradual process which builds both on the ability to exploit all referential leads and to integrate these clues into the interpretive process. It also depends on the comprehender's appreciation of the interpretive requirements obtaining in a given communicative context. One may fail to properly appreciate these interpretive requirements and either keep on elaborating beyond what is contextually necessary or else suspend referential analysis prematurely. Film makers often use such misconstruals to create comic situations. Bear in mind, as well, that the ability to fully explore referential leads depends on an individual's education, and many subtle referential devices rely on complex grammatical structures which may not always be fully mastered or given sufficient attention, especially under stress or because of emotional disarray. Furthermore, referential clues and the knowledge tacitly integrated into the interpretive process may not always be consistent. Finally, referential skills may be variably affected by damage to the language mechanisms. Let us elaborate on the latter two points.

Suppose that there is a conflict between what one knows and what is actually intended by the speaker. In such a case, lifelong experience may prevail over formal constraints and cause a shift whereby the referential structure actually created complies with one's prior experience but not with what might be expected on conventional and/or formal grounds. This mismatch may lead one to misinterpret what has been said and eventually affect one's overt behavior. Accordingly, any sort of potential conflict between what one knows and what one might be expected to understand on conventional grounds constitutes a privileged situation for the study of RSD.

Suppose you ask a subject to match pictures to sentences which depict situations contrary to everyday experience, as for instance in:

(1) The patient cures the doctor

(2) The little girl feeds her mother.

Clearly, there is a conflict here between the referential structure one would be expected to construe and one's knowledge of the relationships between patients and doctors, or children and mothers. If in addition one is unable to exploit the right referential leads then most obviously these sentences will be interpreted solely on the basis of what one knows regardless of what has actually been said[2]. Agrammatic aphasics are reported to behave in this fashion (see Deloche and Seron, 1981). This behavior and the well-established difficulty of agrammatics with reversible sentences prompted some aphasiologists to suggest an explanation of agrammatism as a deficit in using the order of arguments as a clue for comprehension (see Schwartz *et al.* 1980; Rosenthal and Bisiacchi, 1982; Saffran, 1982). Although such an idea may seem quite reasonable as a partial explanation of agrammatic disorders in comprehension (and it did seem to us a decade ago) it is clearly modeled on languages using fixed word order (i.e. French and English) and becomes untenable when inflectional morphology becomes a principal grammatical device. If a Russian agrammatic misinterprets (1) and (2) by inverting the S-O relationship or responds at chance level to reversible sentences, it is not so because he cannot use the order of arguments (which tells him nothing about the S-O relationship), it is because he has difficulty in exploiting certain referential clues, clues which here are morphological not structural.

The idea that in agrammatic comprehension pragmatic knowledge tends to outweigh structural syntactic cues is, as such, not new. It was even somewhat tautological with respect

2 Still, even people who normally are able to exploit the right referential leads sometimes misinterpret this sort of sentences over-relying on what they know. Whenever there is a conflict between experience and referential structure chances are that lifelong experience will have the upper hand.

to the view that agrammatics interpret language in an asyntactic fashion (see Berndt and Caramazza, 1980). If there is no more syntax, all a patient is left with is lexical and pragmatic knowledge. The present suggestion is different, however. First, there is no question of agrammatics being asyntactic, as it can be shown that at least all syntactic operations pertaining to lexical identification are necessarily preserved (Rosenthal and Goldblum, 1989; de Bleser and Bayer, 1988; Baum, 1989). Second, we submit that the deficits in comprehension evidenced by these patients are principally referential in nature, i.e. due to a difficulty in fully exploiting the referential structure of sentences (see also Mauner *et al*., 1993). This does not mean that agrammatic disorders in comprehension could not be partly characterized as relative to certain syntactic operations. Yet, all these syntactic operations participate in RSD and there is more in RSD than merely syntactic operations. Agrammatic patients are liable to make referential errors in or otherwise misinterpret sentences which contain no syntactic traps or prepositional phrases, which are neither embedded nor passive. Furthermore, they may correctly assign main thematic roles but still miss important referential constraints on interpretation.

The present proposal, though, is not confined to the evaluation of agrammatic disorders. The suggestion that aphasic disorders in comprehension are principally referential in nature holds for other, moderate forms of aphasia. The principled distinction made in the early 1970s between syntactic and semantic disorders drew the attention of aphasiologists away from referential phenomena and even tended to conceal the very existence of referential deficits. Yet, the data available so far suggests that various aphasic groups have difficulty with referential structures (see e.g. Grossman and Haberman, 1982; Chapman and Ulatowska, 1989; Sherman and Schweickert, 1989; Shapiro and Levine, 1990).

Tacit integration and referential error

The suggestion that RSD is a fallible process and that when experiential knowledge and referential cues are inconsistent, the former is liable to outweigh the latter, is quite general. The failure to follow all referential leads is a widespread phenomenon in everyday life and is experienced virtually, if not experienced *tout court*, by any normal speaker. What makes the difference between normal speakers and aphasics is that while the former happen to misconstrue the referential structure *occasionally*, aphasics tend to misconstrue it more *systematically*. How systematically is an open question. A patient may not always misprocess the same sentence or, if he does, he may not err in the same way, and no two patients are ever identical, (a distinctiveness going beyond the obvious characteristic differences in the comprehension disorders of agrammatics and, say, mild Wernicke or conduction aphasics). However, the important point is this: *when there a failure to carry RSD through to the end, it occurs in quite characteristic ways*, whether for normals or aphasics. Many referential errors which occur in aphasics' comprehension could be made by normal subjects. Again, there is a question of degree. Normal subjects err occasionally where aphasics tend to slip up systematically. But normals do err when asked to decide whether it is the cow who kicks the horse or the horse who kicks the cow, whether the star is above or under the circle, etc... And when they err, they do so in the same way agrammatics are reported to. Referential errors in aphasics' comprehension are an expression of the normal *brittleness of RSD*.

This proposal may look a bit puzzling to someone used to conceiving of aphasia in terms of lacunae behavior (viz. the language system minus one or more disrupted components, see Caramazza and Martin, 1983), who holds that agrammatism is due to the loss of syntactic processes (and/or closed-class morphology) and nothing else, and assumes that aphasics fail on tasks that normals carry out smoothly and without error. So we would now need to adduce empirical evidence to the effect that:

- Agrammatic patients and other moderately impaired aphasics are liable to make referential errors in interpreting simple nonreversible sentences which contain no syntactic traps.
- The same errors will be found in normal subjects, though, of course, to a lesser degree.
- The likelihood of making referential errors increases with age (not so in the sense of a lesser grasp of language due to aging, but mainly in the sense of a greater reliance on experience). As we get older we may tend to rely more and more on experience at the expense of *here and now* indications. When referential cues are not redundant or otherwise congruent with experience, the greater the strength of experience the more it is likely to override referential constraints.

The foregoing considerations define the background of the present study. We sought to explore the interaction between the *determination of referential structure (RSD)* and the *tacit integration* of related personal knowledge in the process of interpretive elaboration. Specifically, the study addresses certain referential errors imputable to the failure of this interaction and which results in the unrestrained integration of personal knowledge. As mentioned earlier, the concept of tacit integration has been introduced by Polanyi (1962; 1968) with reference to the process whereby sources of personal knowledge are integrated into the perception of an event.

In language comprehension, the effect of the tacit integration of personal knowledge is counterbalanced by the use of referential clues so as to allow hearers to grasp the communicative intents of speakers. But, of course, hearers do not always interpret utterances in line with the communicative intents of speakers. Moreover, they are normally unaware of their direct integration of knowledge into the interpretive process. The occurrence of tacit integration can only be demonstrated *a posteriori*, although the unspecifiable character of personal knowledge does not make this sort of analysis easy to carry out and always conclusive. Thus, for present purposes, we shall restrict ourselves to situations where a subject's interpretation of a sentence manifests the influence of the knowledge of relevant situations. For instance, interpreting the sentence:

(3) The ball hits the window

as meaning that the ball breaks the window shows that the knowledge of what usually happens when a ball hits a window has been tacitly integrated into the understanding of this sentence[3]. There is, of course, nothing wrong with this integration except that it may sometimes lead to errors, especially when one is asked to respond on strictly referential grounds (e. g. in the context of matching this sentence to a picture).

Since the early 1970s, sentences similar to (3) were often used in psycholinguistic research to demonstrate the existence of elaborative effects in language comprehension, following the pioneer studies of Bransford and Franks (1971) and Johnson *et al*. (1973). Although many psycholinguists still qualify these effects as inferential, the elaborative effects due to tacit integration are clearly distinct from explicit inference. All elements involved in explicit inference are specifiable, as they are related to intrinsic properties of the relationships

[3] It is clearly the knowledge of what normally comes about when a ball hits a window that prompts such an interpretation, not a putative semantic property of the verb *to hit*. The following sentence:

(3') The ball hits the wall

is unlikely to be interpreted as meaning that the ball breaks the wall.

considered, whereas tacit integration contains unspecifiable components related to the conditions of occurrence of events on which the experience bears. For instance, it is not any intrinsic property of the relationship between the entities referred to that prompts one to interpret the following sentence:

(4) Theo slipped on the stairs

as meaning that Theo fell on the stairs. (4) would normally never be uttered just as a matter of informing someone that Theo slipped on the stairs and nothing else, but rather as an explanation of how Theo broke his leg, why he is in the hospital, why he could not attend the staff meeting, etc... This unwritten and hardly specifiable convention based on experience is not intrinsic to the relationship considered. It is in fact quite easy to imagine interpretive situations wherein this convention would not apply. The same sentence uttered in different contexts often leads to different interpretations: tacit integration is *not* determined by any intrinsic property of utterances.

The present study involved sentences similar to (3) and (4). The subjects were aphasics, brain damaged patients with no language deficit, elderly individuals with poor educational background, and students enrolled in introductory courses in psychology. In order to further illustrate the present proposal on the non-intrinsic character of tacit integration, we used the same sentences in three experiments, each based on a different task.

EXPERIMENT 1

Subjects

Initially, sixteen aphasic subjects were selected to participate in this experiment on the basis of their ability to carry out written orders. Two aphasics apparently failed to understand the instructions and their results were not included in the following analyses. The remaining fourteen patients were diagnosed on the basis of the Italian version of the BDAE (Goodglass and Kaplan, 1972) as: 7 Broca's (including 3 agrammatics), 1 Conduction, 4 Wernicke's and 2 Anomic aphasics. Although the patients varied with respect to education they all completed at least a 5 year curriculum and, prior to the onset of brain injury, all fluently spoke and read Italian (in addition to their regional dialect).

A group of fourteen brain damaged patients (ranging in age from 21 to 38) who suffered from traumatic head injury but presented neither aphasia nor alexia was selected as the first control group. The patients were tested within six months from the incurrence of brain damage (eleven patients during their initial hospitalization, three patients during the follow-up neurological rehabilitation). Five patients suffered from large bilateral lesions, five from lesions to the right hemisphere, and four to the left hemisphere. All these patients had at least 8 years schooling background.

The study also involved 19 elderly individuals (mean age: 70.2, SD: 5.6) with a poor educational background (mean schooling: 5.8 years) but all fluently speaking and reading Italian, and 10 students enrolled in introductory courses in psychology at the University of Padua. None of the subjects in these last two groups had a history of neurological disease. The elderly controls were administered a series of neuropsychological tests to ensure that no subjects with initial dementia were included in this group.

Materials

The linguistic material consisted of 20 present-tense, simple declarative sentences in Italian. There were two types of sentences: 10 sentences holding compelling tacit implications[4] and thus inviting tacit integration - *TI sentences* (see Table 1), and 10 control sentences with no compelling implications - *C sentences.*

For each sentence, the pictorial material consisted of three color drawings. For *TI sentences* there was one picture depicting the event referred to in the sentence (*correct picture*), one showing the most compelling pragmatic implication of this event (*TI picture*) and one distractor featuring the same characters and/or objects but involving a different action (*distractor picture)*. The picture material for *C sentences* consisted of one *correct picture* and two *distractor pictures* constructed according to the same principles.

In order to ensure that the *correct* and the *TI pictures* are not ambiguous, which would bias the subjects' choices, we selected them from a larger sample by asking an additional group of 10 subjects to choose which among each set of *correct* and *TI pictures* best fitted the target sentence. All sets that prompted hesitation were removed and the pictures retained in the present experiment (see Table 1) were clearly unambiguous for these subjects.

TABLE 1 : Tacit Implication (TI) and Control (C) Sentences used in the study

TI	C
1. La bambina compera un gelato. *The little girl buys an ice cream.*	1. Il passegero monta sull'autobus. *The passenger gets on the bus.*
2. La volpe afferra la gallina. *The fox grabs the hen.*	2. Il professore scrive sulla lavagna. *The teacher writes on the blackboard.*
3. La palla arriva contro la finestra. *The ball hits the window.*	3. Il poliziotto ferma l'automobile. *The policeman stops the car.*
4. L'uomo prende una sigaretta. *The man takes a cigarette.*	4. L'uomo lava l'automobile. *The man washes the car.*
5. Il cacciatore spara al cinghiale. *The hunter shoots at the boar.*	5. La ragazza si alza dal letto. *The girl gets up out of bed.*
6. Il campione di karatè colpisce il mattone. *The karate champion hits the brick.*	6. Lo sciatore discende da una pista. *The skier comes down the run.*
7. Il violinista afferra il suo strumento. *The violinist grabs his instrument.*	7. Il medico visita il malato. *The doctor examines the patient.*
8. L'uomo fa cadere il vaso. *The man drops the vase.*	8. Il calzolaio ripara la scarpa. *The shoe repairman repairs the shoe.*
9. La donna scivola sulle scale. *The woman slips on the stairs.*	9. Il gatto beve il latte. *The cat drinks the milk.*
10. La nave si scaglia contro le rocce. *The ship rushes towards the rocks.*	10. L'uomo va in bicicletta. *The man rides the bicycle.*

Procedure

The experiment was conducted at the Clinica Neurologica dell'Università di Padova, at the Clinica Neurologica di Vicenza, and at the Istituto di Psicologia dell'Università di Padova. Subjects were instructed that they would be presented with sentences and arrays of pictures

[4] We use the term *tacit implication* only as a convenient way of saying that a sentence is very likely to prompt tacit integration of related sources of knowledge into the process of sentence interpretation, and to cause referential error. This does not mean that tacit implication would have the status of logical implication.

and they would be requested to choose for each sentence the picture corresponding *exactly to what the sentence says*. Two examples of sentences (one *TI* and one *control*) were given for training (even though aphasic subjects were already well used to this procedure). On each trial, a subject was presented with a sentence printed on a card and the corresponding array of pictures. The spatial arrangement of pictures varied from trial to trial. Subjects were tested individually in a single session.

Results and discussion

Table 2 presents the mean percentages of picture choices for the two types of sentences (see Appendix the for individual results of each aphasic patient). *Control sentences* gave rise to practically error-free performance in all groups of subjects (even aphasics made less than 5% distractor choices). On the other hand, all groups made referential errors[5] on *TI sentences*, though to a variable degree. Aphasics were more inclined to choose *TI pictures* (over 50% of choices), than elderly subjects (25%), head injury patients (15.7%), and students (9%). Yet, it is striking to note that although students were least likely to manifest tacit integration through referential error they nevertheless picked *TI pictures* in a significant proportion of cases. Moreover, it seems that neither group of subjects chose *TI pictures* as one of the possible ways of misinterpreting target sentences. If that were the case there would be many *distractor* choices, but Table 2 shows that such choices were very sporadic.

	Tacit Implication Sentences			**Control Sentences**	
Picture Choice	Correct	TI	Distractor	Correct	Distractor
Aphasics (14)	41.4	54.3	4.3	95.7	4.3
Elderly (19)	72.1	25.3	2.6	98.4	1.6
Head injury (14)	82.2	15.7	2.1	96.4	3.6
Students (10)	91	9	0	100	0

TABLE 2 : Mean Percentages of Various Picture Choices for TI and Control Sentences

An analysis of variance conducted on correct responses shows a significant main effect of subject group ($F(3,53)=19.11$; $p < .001$). A post hoc analysis (Newman Keuls') further reveals that aphasics were significantly less correct than the elderly ($p< .01$), head injury patients ($p< .01$), and students ($p< .01$); and the elderly were less correct than students ($p< .05$). No significant difference was found between students and head injury patients nor between the latter and the elderly. The main effect of sentence type is also significant ($F(1,53)=162.1$; $p < .001$) - *control sentences* being much less likely to elicit errors than *TI sentences*. There is a significant global interaction between groups and sentence types ($F(3,53)=20.42$; $p < .001$). Post hoc comparisons reveal no significant difference between groups on *control sentences* and significant differences on *TI sentences*. Specifically, on *TI sentences* aphasics made more errors than elderly subjects ($p< .01$), head injury patients ($p < .01$) and students ($p< .01$); and the elderly erred more than students ($p< .05$). Again, no

[5] A referential error is considered a picture choice which is inconsistent with conventional interpretation.

significant difference was found between students and head injury patients nor between the latter and the elderly.

It is quite striking to notice that all groups fall into the trap of tacit implication, even though there is a significant difference in degree. The finding that even university students, who are well-trained to carry out tasks on formal *hic et nunc* grounds, are nevertheless liable to over-rely on experiential knowledge at the expense of referential cues is perhaps the most unexpected. It should be recalled that the experimental material consisted of simple declarative sentences which contained no syntactic traps, and that each sentence (along with the corresponding array of pictures) was in front of the subjects who were free to take all the time they needed to examine the stimuli and to make their choices. When *TI responses* arise in a memory experiment it is always possible to argue that elaboration is posterior to "regular understanding" and that recognition or recall favor confusion between what had been directly understood and what emerged through further elaboration. In the present experiment, such an explanation would not hold. One may thus be led to conclude that the finding of *TI errors* in all groups, and particularly in student controls, corroborates our proposal on the normal brittleness of RSD.

The finding that aphasic patients made significantly more *TI errors* on *TI sentences* than brain damaged patients with no language deficit (head injury patients), who did not differ significantly from students, permits ruling out the possibility that integrative error was merely due to brain damage. The observation that elderly subjects made significantly more *TI errors* than students corroborates our suggestion that the likelihood of referential errors increases with age. If we admit that RSD is naturally brittle, the greater the strength of experience the more it is likely to override referential constraints with which it is inconsistent (assuming that age has something to do not only with the "amount" but also with the "strength" of experience). In this sense, the performance of head injury patients whose scores range in between students and elderly subjects appears to be better accounted for by their age (mean 28.4) than by them being brain damaged patients.

Finally, the finding that moderately impaired aphasics made a negligible proportion of *distractor errors* and more than 50% of *TI responses*, lends support to our general proposal relative to the difficulty of aphasics to make correct use of referential cues. This is not to say that all linguistic forms of aphasia stem from the same underlying impairment. One will find enough different leads in RSD for a distinct characterization of various aphasic disorders. As stated earlier, our aim is not to provide a differential characterization of aphasic groups, but to explore the interaction between RSD and tacit integration in the course of interpretive elaboration, and to understand the conditions under which they may fail to collaborate in an effectual manner. Thus the observation that aphasics' errors are only quantitatively different from those made by other subjects favors the idea that their pathological behavior builds upon the normal brittleness of RSD. Even a cursory look at Table 3 lets one see that the same sentences elicit most *TI responses* in all groups of subjects. There is indeed a strong positive correlation for *TI responses* to *TI sentences* between all groups of subjects (aphasics vs. elderly, $r = .897$, $p = .0004$; aphasics vs. head injury, $r = .805$, $p = .005$; aphasics vs. students, $r = .783$, $p = .0074$; elderly vs. head injury, $r = .843$, $p = .002$; elderly vs. students, $r = .892$, $p = .0005$; and head injury vs. students, $r = .810$, $p = .005$). In the present setting (viz. the target sentence with the corresponding array of pictures), all groups are inclined to misconstrue the same referential structures.

TI sentences	Aphasics	Elderly	Head Inj.	Students
1. The little girl buys an ice cream.	14.3	0	7.2	0
2. The fox grabs the hen.	28.6	10	14.3	0
3. The ball hits the window.	78.6	30	14.3	0
4. The man takes a cigarette.	35.7	10	7.2	0
5. The hunter shoots at the boar.	14.3	0	0	0
6. The karate champion hits the brick.	92.8	60	28.6	40
7. The violinist grabs his instrument.	50	0	7.2	0
8. The man drops the vase.	42.8	0	21.4	0
9. The woman slips on the stairs.	92.8	80	35.7	30
10. The ship rushes towards the rocks.	92.8	60	21.4	20

TABLE 3 : Mean Percentages of *TI Responses* for each *TI Sentence*

One could object to this interpretation claiming that the referential errors we found in the present experiment are due to the intrinsic properties of the sentences used. A means of refuting this objection would be to show that the same sentences do not elicit qualitatively similar responses in other experimental settings. Specifically, sentences which most irresistibly elicit *TI responses* in the present condition may not lead to the greatest amount of *TI responses* in other conditions, and vice versa. Two auxiliary experiments were thus designed with the aim of showing that the likelihood of tacit integration is determined to a greater extent by the overall setting than by any supposedly intrinsic properties of the sentences. In order to provide data for item comparison with the results of Experiment 1, these experiments involved the same target sentences in two different experimental settings. Experiment 2 used the technique of sentence evaluation where subjects were requested to judge whether the sentences they were presented strongly invited them to think that... (e.g. whether the sentence *The woman slips on the stairs* strongly invites them to think that she *falls*). Experiment 3 was based on a classical recognition technique wherein the recognition test involved the target, its tacit implication, and a foil.

EXPERIMENT 2

Subjects

10 students enrolled in introductory courses in psychology at the University of Padua participated in this experiment. No subject had a history of neurological disease and all were native speakers of Italian.

Materials

The linguistic material of this auxiliary experiment is based on the 20 target sentences used in Experiment 1, 10 *TI sentences* and 10 *C sentences*. It will be recalled that the basic difference between them is that *TI sentences* hold *compelling* tacit implications (e.g. one is strongly compelled to consider when hearing the sentence *The fox grabs the hen* that the fox will eat the hen) whereas *C sentences* hold no such compelling implications though of course any sentence may hold potential implications. Each target sentence was printed on a separate page of a booklet accompanied by its compelling or one of its potential implications (respectively for *TI* and *C sentences*). For the *TI sentences*, the implications were conceptually[6] the same as in Experiment 1. The sentences in the booklets were in random order fixed once and for all.

Procedure

Subjects were tested together in the same session. They were seated one at a table. At the beginning of the session they were instructed that they would have to evaluate whether a sentence (printed in normal characters) strongly invites them to consider that X (sentence printed in italics), and were given two examples (with no answer provided by the experimenter). Then each subject was given a booklet and was requested to write on each page *yes* or *no* according to his or her assessment of the sentence and its proposed implication. Subjects were not allowed to look back at pages for which an answer had already been provided. The whole session lasted less than 15 minutes.

Results and discussion

On the whole, subjects gave many more *yes* responses in the *TI condition* (mean percentage 82) than in the *C condition* (mean percentage 19). This result is admittedly trivial and does not merit any further attention. What does merit attention is the *qualitative* (viz. sentence by sentence) distribution of *yes* responses to *TI sentences* and their tacit implications. Table 4 presents the mean percentages of *yes* responses to each *TI sentence* and collapsed[7] mean results (of the three groups) for these sentences from Experiment 1.

A comparison of these results shows very different overall trends in responses to target stimuli in the two experimental settings. Tacit implications that subjects in Experiment 2 judged as the most compelling (e.g. items 1, 4, and 5) did not give rise to the greatest amount of *TI responses* in Experiment 1. As a matter of fact, the trends appear to be clearly unrelated[8], the same sentences do not elicit qualitatively comparable results in the two experimental settings. For instance, the sentence : *The man takes a cigarette* is considered by all subjects in Experiment 2 as strongly inviting them to think that the man is going to smoke a cigarette but in Experiment 1 the subjects seldom chose the *TI picture* of a man smoking a cigarette. Still, one might object at this point that there is a difference between explicit appreciation of implications and implicit semantic or interpretive effects. We shall return to this issue below and consider now another auxiliary experiment using the same sentence material but in another different setting, in which no explicit appreciation is required or likely to occur.

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6 By *conceptually* we mean that they were not identical but equivalent as much as pictorial and linguistic representations may be thought of as equivalent.

7 It would be more appropriate to use in this comparison the results of control students only. However, there was an important floor effect for this group due to the specificity of the experimental condition. We thus felt it more appropriate to calculate for each sentence a mean over the three groups, especially because there was a strong correlation between the groups. This procedure is not, strictly speaking, correct and thus the following comparison should not be viewed as demonstrative but merely informative.

8 We tentatively calculated a correlation between the two trends ($r= -.574$; $p= .083$), which, although statistically abusive, lets one appreciate just how related are the scores from these two experimental settings.

TI sentences	Yes	Exp. 1
1. The little girl buys an ice cream.	100	5.4
2. The fox grabs the hen.	90	13.2
3. The ball hits the window.	60	30.7
4. The man takes a cigarette.	100	13.2
5. The hunter shoots at the boar.	100	3.6
6. The karate champion hits the brick.	80	55.4
7. The violinist grabs his instrument.	80	14.3
8. The man drops the vase.	70	16.1
9. The woman slips on the stairs.	80	59.6
10. The ship rushes towards the rocks.	60	48.6

TABLE 4 : Mean Percentages of *yes responses* for each *TI Sentence* and collapsed mean *TI responses* from Experiment 1

EXPERIMENT 3

Subjects

40 students enrolled in introductory courses in psychology at the University of Padua participated in this experiment. No subject had a known history of neurological disease and all were native speakers of Italian.

Materials

The material of this experiment consisted of the 20 sentences (10 *TI* and 10 *C*) from Experiment 1 (see above).

Procedure

This was a standard recognition experiment. Subjects were tested collectively in two experimental sessions (20 subjects per session). Subjects were seated individually. At each table there was a response booklet turned upside down and subjects were requested not to touch it before being instructed to do so by the experimenter. This booklet contained each of the 20 target sentences accompanied by two foils. For *TI sentences* there was, besides the target, a *TI foil* and a *same characters or objects but different action distractor*. For *C sentences* there were two *distractors* constructed following the same principle of different action. The position of *correct sentences* and of *TI foils* varied from triplet to triplet. Subjects were instructed to listen very carefully to sentences read by the experimenter because they will be tested afterwards for the correct recognition of these sentences. They were warned that the test would be difficult because the recognition booklet contains foils. Sentences were read by the experimenter who immediately afterwards invited the subjects to turn to the booklets, placing them right-side up, and start crossing out sentences they were sure they recognized. Each session lasted less than 30 minutes.

Results and discussion

We shall not discuss the results of this auxiliary experiment in full detail as it bears on a well-known and amply documented effect, and because all we are interested in here is the distribution of responses to different *TI sentences.* On the whole, for *TI sentences* subjects more often correctly recognized the target (mean 6.2) than made incorrect choices of a foil (3.6)[9]. The latter consisted massively in the choice of the *TI foil* (mean 3.25) and seldom in the choice of the *different action distractor* (mean .35). This global pattern of results is hardly surprising for an immediate recognition procedure so we may turn now to a comparative analysis of responses consisting in picking *TI foils* for *TI sentences*. Table 5 provides the mean percentages of *TI foils* chosen for each *TI sentence* and Figure 1 plots the results (in terms of *TI responses* to *TI sentences*) of all three experiments.

TI sentences	TI foils
1. The little girl buys an ice cream.	42.5
2. The fox grabs the hen.	22.5
3. The ball hits the window.	25.0
4. The man takes a cigarette.	52.5
5. The hunter shoots at the boar.	45.0
6. The karate champion hits the brick.	40.0
7. The violinist grabs his instrument.	22.5
8. The man drops the vase.	45.0
9. The woman slips on the stairs.	5.0
10. The ship rushes towards the rocks.	22.5

TABLE 5 : Mean percentages of *TI foils* chosen for each *TI Sentence*

There indeed appears to be yet another trend in *TI responses* to *TI sentences* (here the choice of TI foils) as compared to the previous experiments. In fact, Figure 1 shows different trends in all three experiments. If we consider the two experiments which required no explicit appreciation of *TI sentences* (Exp. 3 and Exp. 1), the trends do not really appear to be related ($r= -.563$; $p= .09$). Nor does there seem to be any correlation between the scores on the recognition (Exp. 3) and judgment (Exp. 2) experiments ($r= .474$; $p= .167$). The objection raised with respect to the interpretation of Experiment 2 on the grounds that there is a difference between the explicit appreciation of an implication and implicit integrative effects turns out to be unfounded as an objection to the claim that there appears to be no intrinsic TI value to the sentences used. Were there an intrinsic *TI* or *semantic value* to these sentences, it would manifest itself in one or the other interpretive situation. The relative weight of tacit integration, or, more precisely, of the sources of knowledge integrated into the interpretive process, is clearly more dependent on task demands than on any putative intrinsic semantic values. With these observations in mind we may now turn to the general discussion.

[9] There is also a mean of .2 omissions which explains why correct and incorrect responses make only 9.8 and not 10.

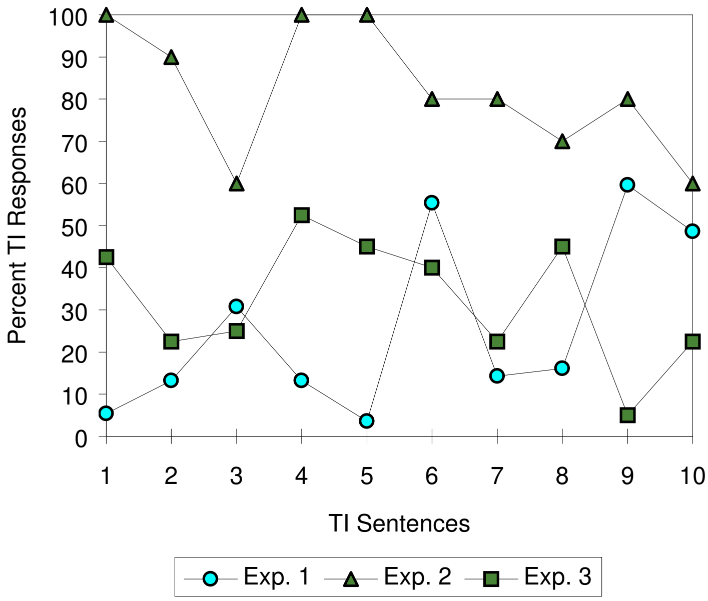

FIGURE 1. Percentages of TI responses for each TI sentence in Experiments 1, 2, and 3.

General discussion

The results of the present study lend support to the idea that thematic role assignment is too rough a metrics of aphasic and normal comprehension skills for a fine-level exploration of the interpretive process. Many subtle deficits or interpretive errors likely to occur in both aphasic and normal populations apparently remain beyond the purview of observation owing to the insensitivity of our current exploratory tools. These deficits and interpretive errors may be due to the inability either to fully determine the referential structure of utterances or to apply it in a complete fashion to the process of utterance interpretation so as to properly counterbalance the effects of knowledge integration. As noted earlier in this paper, the determination of referential structure is a process which unfolds in time following a certain chronology. This means that RSD is a hierarchical process where the results of certain operations constitute structural prerequisites for conducting others (see Rosenthal, 1988). The earlier operations may provide a basis for relatively coarse-grained shallow interpretation which may be adequate in certain interpretive contexts. Verb-argument structure and thematic role assignment indeed appear to be two important early referential operations relatively well-preserved in certain aphasic groups (Shapiro and Levine, 1990; Canseco-Gonzalez *et al.* 1990) and these spared capacities may account for many reports of agrammatic, anomic or conduction aphasics' successful performances on comprehension tests. The present suggestion is, however, that this successful performance is restricted to tests probing relatively shallow interpretive skills. What generally counts as good comprehension skills of mildly impaired aphasics may thus turn out to be relatively good coarse-grained approximate comprehension skills. A variety of subtle deficits in the ability to follow all directions for interpretation provided by the speaker may now invade the aphasiological literature. This invasion would be welcome not only because it may open up new avenues for neurolinguistic research but also because it may lead us to revise our views of language, in general, and of normal language comprehension, in particular.

Language comprehension is still pervasively deemed in the psycholinguistic literature a sort of mapping device. This leaves little room for interpretive errors (which ought not to be confused with perceptual errors, e.g. "slips of the ear"), "interpretive repair" (e.g. whereby the hearer's interpretation complies with the speaker's communicative intent but not with any standard interpretation of the utterance) or any sorts of communicative mismatch. The finding that such "errors" are not exceptional but pervasive and the very intervening role of the interpretive situation may thus suffice to cast doubt on the strict determinacy of language and on the mapping character of language comprehension. Such errors may not be due to a failure on the part of the mapping mechanism, but rather signal the relative indeterminacy of interpretation.

On the other hand, it is not even necessary to adhere to the present conceptual framework of tacit integration and referential structure to accept the view that linguistic communication is naturally brittle and that interpretation takes different in-depth levels of fineness. All these levels are not obligatory for smooth communication, and when they are reached there may be substantial individual differences of interpretation. But most of the time, hearers and readers are able to achieve a certain intermediary, conventional level of interpretation. On this account, language remains an overwhelmingly reliable, though imperfect, means of communication, either because relatively coarse-grained shallow interpretation may often be sufficient or because, under normal conditions, linguistic communication allows for various sorts of on-line, midcourse adjustments which provide grounds for conventional interpretation.

Still, beyond the suggestion that interpretive elaboration is a fallible process due to the normal brittleness of RSD, the present findings have, in our view, clear aphasiological relevance. We submit that the above-reported (and most other) errors made by aphasic patients in language interpretation are *referential* in nature (see also Hickok and Avrutin, 1995), much as are errors of interpretation found in normal subjects. Somehow, somewhere the personal knowledge involved in language interpretation has to be restructured by following the *here and now* indications of the speaker's communicative intents. It is clearly these ingredients which enter into the interpretive process: errors due to an overreliance on personal knowledge are too pervasive to be viewed as merely accidental, and if the notion of correct interpretation has any meaning then the clues for such correct interpretation have to be couched by the speaker in his utterance. The results of the elderly subjects involved in this study make sense only in this framework: the subtle balance of referential clues and of personal knowledge may not always resist the increased burden of experience. For otherwise one would have to assume that our neurologically intact grandparents are all impaired in language comprehension.

The general trend in neurolinguistics during the past two decades has been to show how aphasics *qualitatively differ* from normals (and, lately, from each other) in comprehension. The failure, by a patient, to interpret correctly a particular type of sentence (correctly interpreted by normal controls) was assumed to stem from damage to the corresponding sub-component of language processing and *ipso facto* to demonstrate the existence of this sub-component in the normal system. There is nothing wrong in principle with this sort of inference except that, as far as the normal system is concerned, it is fairly indirect and the relationship between a deficit and a putative (damaged) sub-component of normal processing is not logically warranted. There may be two ways out of this trap. One way is to avoid the logical problem by defining that relationship pleonastically (e.g. to conclude that, if a patient has problems in interpreting gender information, he is impaired at the level of representation where gender information is specified) but this is quite unenlightening. Another way is to provide independent evidence for the existence of the putative sub-component by conducting a study with normal subjects (as advocated by Semenza *et al*. 1988) but this procedure has seldom been employed.

Still, there is a way of identifying theoretical components of normal processing by finding *qualitatively similar* (though quantitatively different) patterns of performance in normal and aphasic subjects. The present study illustrates this latter approach. In the main experiment aphasics, elderly individuals and students all tended to err by picking the picture representing a compelling pragmatic implication of a target sentence, and all tended to err for the same sentences. In doing so, they were not biased by any sort of putative intrinsic semantic properties of these sentences for, as we showed by conducting two auxiliary experiments, such properties simply do not exist[10]. It is unlikely that this finding of the same pattern of behavior in aphasics and normals would arise in the context of a neurolinguistic study seeking differences between aphasics and normals, for the sentences eliciting errors in controls would be dropped altogether from the experiment.

[10] Although this latter point is secondary to the present issue, it clearly invites one to reconsider the metaphor of accessing the meaning of words in the mental lexicon and perhaps to adopt a more conservative view according to which there would not be a semantic but only a morphological (word-form) inventory available to the interpretive process. Following such a view, words in that morphological inventory would be associated with the knowledge of situations in which they normally occur, and the interpretive process would not be semantic first and knowledge-based afterwards, but rather the other way around.

Appendix

Experiment 1. The individual results of aphasic patients.

	Tacit Integration Sentences			Control Sentences	
Patients	Correct	TI	Distractor	Correct	Distractor
1. Anomic	6	4	0	10	0
2. Broca	5	5	0	9	1
3. Broca agrammatic	5	5	0	10	0
4. Wernicke	6	4	0	10	0
5. Broca agrammatic	3	6	1	9	1
6. Anomic	6	4	0	10	0
7. Conduction	3	7	0	10	0
8. Broca agrammatic	4	4	2	9	1
9. Wernicke	3	7	0	10	0
10. Broca	5	5	0	9	1
11. Broca	2	6	2	10	0
12. Wernicke	2	8	0	10	0
13. Broca	4	6	0	9	1
14. Wernicke	4	5	1	9	1

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