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SEMANTIC APPROXIMATIONS AND FLEXIBILITY IN THE DYNAMIC CONSTRUCTION AND "DECONSTRUCTION" OF MEANING*

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Abstract: This paper discusses the production of semantic approximation with verbs in French, both in early lexicon acquisition (by young children of normal development) and in the context of Alzheimer disease (by patients). One of the aims of the study is to show that these productions are crucial in the structuring of the verbal lexicon because they both manifest the existence of a new sort of synonymy between verbs and enable us to show that there is a semantic flexibility which plays an important role in the verbal lexicon. In addition, we observe that the relation of semantic proximity between verbs can be treated by a computational approach.

Keywords: metaphor; mental lexicon; language acquisition; language loss.

1 INTRODUCTION

The research we present in this article represents a continuation of a long tradition of studies, from Vygotsky (1935) to Piaget (1945, 1985),

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including Clark (1973, 1997, 2003), Jakobson (1956), Gentner (1978, 1981), Gentner and Boroditsky (2001), Hofstadter (1995), Kleiber (1999), Le Ny (1979), and Prandi (2002), - linguists and psychologists whose work on conceptual and/or language development provides the foundation for our own enquiry. We point out the role of semanticcognitive flexibility in the dynamic structuring of the meanings of verbs and action-concepts, a field that has as yet received little attention (BASSANO, 2000; BERNICOT, 1981; BOWERMAN, LEVINSON, 2001, BOWERMAN; TOMASELLO, 2003; TOMASELLO; MERRIMAN, 1995).

In section 1, we present a brief overview of the production of metaphor-like utterances by young children, as well as by patients suffering from Alzheimer's disease. In Section 2, we consider the existence of these forms of utterance in a verbal framework and "intra-domain" as or "extra-domain" approximations. We then present, in Section 3, an experimental study of the production of verbal semantic approximations ("The lady tears up the glass") by means of a naming task of 17 action-videos with young children (aged 2 to 4) as well as with a population suffering from Dementia of the Alzheimer type (DAT). We compare the performances achieved during the dynamics of early acquisition of the meaning of verbs (by children) with its converse: the dynamics of "disacquisition" of the verbal lexicon, which has been under-studied in the context of Alzheimer's disease. (KIM; THOMPSON, 2004). Finally, in Section 4, we present a computational model (Prox) of the structuring of verbs/action-concepts by semantic proximity (GAUME, 2004; GAUME et al., 2005; in press) which we have adopted to test 200 semantic approximations with a verbal pivot ("I undress the orange", "He breaks the book") from recordings made of the conversations of 2-4 year-old children as well as some of the data we obtained from the experimental approach presented in this paper.

All the data referred to in this paper concern utterances in *French*: for purposes of clarity, the examples we provide will be limited here to translations into English, although we also provide the French version when we feel necessary. In section 4, we return to correspondences between the utterances described in the paper and the French lexicon.

2 METAPHOR-LIKE UTTERANCES IN 2-4 YEAR-OLD CHILDREN AND ALZHEIMER SUBJECTS

2.1 Metaphor-like utterances in 2-4 year-old children

As was pointed out by Aristotle and later by the French grammarian Dumarsais (1730): "Everyone uses metaphors in their conversation ... there is nothing as ordinary and common-place as the figurative in the language of men". But how about the 2-4 year-old language-learner who is characterised, contrary to the adult speaker, by the fact that he or she is in the phase of language-structuring, notably by progressively constituting the lexicon?

One could point out right away that observations made during this critical period of language development have demonstrated that young children produce utterances that share strong resemblances with the metaphors used by adults. However, studies in this field do not provide a clear picture of this phenomenon (LAGARANO, 1997, p. 142-143) and are almost exclusively limited to nominal utterances (DUVIGNAU, 2003).

Nevertheless, Duvignau (2002) established the existence of the production of metaphor-like utterances with a verbal pivot in 2-4 year-old children, based on a corpus of 200 metaphor-like utterances which were taken from child discourse:

- (1) "**Undress** the potato?" / the mother peels a potato 2 years.
- (2) "You **comb** the ground?" / the mother rakes the garden 2.6 years.
- (3) "The car's **dripping**" / the car goes down a slope 2.8 years.
- (4) "Go on Mum, **turn on** your eyes" / the mother has her eyes closed 3 years.
- (5) "The fountain is **being sick**" / about a fountain that is ejecting water 3.3 years.
- (6) "Oh but you've got to take care of the lorry...it's not moving ahead" / a toy which is missing a wheel 3.5 years.

These are utterances that Duvignau has proposed to consider, at this stage of language development, as semantic approximations and not as mistakes or true metaphors and of which she distinguished two kinds (DUVIGNAU, 2002, 2003; DUVIGNAU; FOSSARD; GAUME; PIMENTA, 2005): linguistic approximations and pragmatic approximations.

i) Metaphor-like semantic approximations which relate to an extra-domain cohyponymy between verbs, i.e., a linguistic approximation

This is the case of the six examples cited above.

In this category, the verb used by the speaker (in bold in the examples) constitutes a reference to a semantic domain that is different from that of the element with which it is combined ("undress" ... "potato"). For this reason, the approximate character of the verb can be grasped whatever the context of the utterance: detecting the approximation occurs at a linguistic level.

This type of production we are calling 'semantic approximation' can constitute metaphor or analogic under-extension. As it has been already showed in the case of nominal production, it depends both of the existence and the categorization of the conventional item in the mental lexicon (see GARDNER; WINNER, 1979; WINNER, 1979; CLARK, 1993). If a person has got a conventional verb in his/her mental lexicon ("to peel") and deliberately uses a non conventional but pertinent verb, such as saying "to undress the potato" instead of [to peel the potato], his/her verbal semantic approximation constitutes a metaphor. On the contrary, if a person hasn't got a conventional verb in his/her mental lexicon but manages to use a non conventional but pertinent verb, in using the verb "to undress" for the action [to peel the potato], his/her verbal semantic approximation constitutes a underextension not an error, because of the lexical relation that links verbs. In fact, according to Duvignau (DUVIGNAU, 2002, 2003) "to undress" and "to peel" are linked by an inter-domain synonymic relation.

- ii) Utterances which relate to an intra-domain co-hyponymy between verbs, i.e., a pragmatic approximation
 - (1) "Clara, she's shaking up the soup" / stirring the soup with a spoon 2 year

- (2) "I tie myself to the ramp" / the child hold the ramp going down the stairs 2.9 years
- (3) "The lady cuts the orange" $\!\!/$ a lady unpeels an orange 4 years

In this category, the approximate character of the verb comes uniquely from a non-correspondence between the verb used and the reality it designates. This is a matter of utterances in which the use of the verbal form does not create any semantic tension within the utterance but designates a way of carrying out an activity which does not correspond precisely to the action undertaken.

2.2 Semantic approximations with Alzheimer subjects

Dementia of the Alzheimer type (DAT) is characterized by a deterioration of semantic representations. Such a loss develops progressively and in a predictable way in function of the evolution of the different stages of the disease (BIRD et al., 2000; HODGES et al., 1992, 1995; HODGES, 2001). In this particular pathological context, one observes disturbances in the semantic component of memory accompanied by one or several other major cognitive deficits. These disorders engender a deterioration of semantic representations in DAT patients and these patients make use of semantic paraphrases which allow them to "fill in" a situation where they can't find the right words. Yet, the majority of studies of lexical-semantic deterioration in these patients have focused on nominal production. Therefore, there has been little data on verbal semantics, although one recent study suggests that there is a deterioration of the semantic characteristics of verbs which already been observed for nouns (KIM; parallels what has THOMPSON, 2004).

In this context, the study of verbal semantic approximations constitutes an innovative research focus that has been little explored.

3 STUDY OF SEMANTIC APPROXIMATION IN CHILDREN AND ALZHEIMER SUBJECTS

In order to show the important role of semantic approximations during early lexical development as well as to demonstrate its existence in the field of DAT, we elaborated an experimental protocol to elicit the production of semantic approximations in these two types of speakers. This investigation might allow us to reveal a dynamic of disacquisition of verbal semantic in Alzheimer patients, which we could then compare and contrast with the dynamic of acquisition by children.

We now present the experimental design we have developed, the hypotheses and expected results, as well as the initial analyses of the results we have obtained:

3.1 Experimental design

Our sample consisted of:

- a) 60 non-disturbed children (no clinical psychiatric symptoms) 29-59 months old, monolingual in French;
- b) 60 non-disturbed young adults (20-40 years old);
- c) 19 non-disturbed adults (68 82 years old);
- d) 19 adults diagnosed with Alzheimer-type dementia (DAT) (70-85 years old), all native speakers of French;
- e) 10 of these presented mild-severity DAT (Mini-Mental State MMS scores between 19 and 24);
- f) 9 presented moderate-severity DAT (MMS between 10 and 18).

In order to elicit the production of semantic approximations we proposed to all our participants an action-video naming task based on the following material:

- a) *Training material*: 2 action-video sequences: [Peeling a banana] [Tearing up a shirt]
- b) Experimental material: 15 action-video sequences which related to 3 categories of activity:

/DAMAGE/	/REMOVE/	/SEPARATE/
1- burst a balloon	6- peel a carrot with a	11- saw a wooden plank
2- screw up a piece	peeler.	12- make bread-crumbs
of paper	7- peel an orange with	by hand.
3- break a glass with	one's hands.	13- slice bread with a
a hammer	8- strip the bark off a	knife.
4- squash a tomato	log	14- break up bread with
with the hand	9- undress a doll	one's hands
5- tear up a	10- take apart a lego	15- shred parsley with a
newspaper	structure.	knife.

Each participant was asked to name the activity in these actionfilms orally, proceeding in the following way:

- a) explanatory phase. "We are going to see some short films where a lady does something. When she is finished, I shall ask you 'What did the woman do? (just now)'. Then you'll have to tell me what she just did";
- b) training phase. The following films sequences are shown: [Peeling a banana] and [Tearing up a shirt]. Instructions at the time the action is completed and the results are visible: "What did the woman do? (just now)";
- c) experimental phase. We presented the 15 action films, in random order for each participant. Instructions at the time the action is completed and the results are visible: "What did the woman do? (just now)";
- d) distraction phase: between the films in order to avoid perseveration effects.

Our hypothesis was the that the production of semantic approximations would be a marker of the existence of cognitive flexibility not only in children during the early acquisition of the verbal lexicon but also in Alzheimer subjects in a situation of degeneration of the lexicon. We therefore expected the following results:

a) sample of children (2-4 years): a high level of verbal semantic approximations;

- b) all the adult judges: a low level of verbal semantic approximations;
- c) DAT sample: a high level of verbal semantic approximations.

3.2 Results

We present here the preliminary results of our study; more finelytuned analyses are still being undertaken.

It emerged first that the young children produced a large number of semantic approximations. In fact each of the children produced between 2 and 5 approximations during his or her naming task, of the kind: "She breaks a tomato" [action = to squash], "She opens a shirt" [action = to tear up], "She peels the wood" [action = to strip the bark off a log], "she smashes the leaf" [action = to crumble the leaf]. On average, all the 60 children produced semantic approximations for 25% of the naming tasks, which were distributed as follows:

- a) 16 % intra-domain semantic approximations;
- b) 7 % extra-domain semantic approximations.

The same performance profile was found in the Alzheimer population: each participant produced between 2 and 5 approximations and the whole sample also produced approximately 25% approximations of all the naming that was done. Moreover, a comparison of the performance between the 19 Alzheimer participants and 19 children aged between 2.5 and 3 years suggests a similarity between these two populations, both quantitatively and qualitatively: one can note a same high level of approximations (25%) with these sometimes being identical: "She breaks the tomato", "She opens the shirt", "She peels the wood". Moreover the distribution of semantic approximations is equivalent to what we observed with the children:

- a) 19 % intra-domain semantic approximations;
- b) 8 % extra-domain semantic approximations.

Concerning all our adult judges, their performances show that, in the case of non disturbed language, the production of semantic approximation in the proposed task was insignificant or very poor:

- a) only 1 % in the 20-40 years-old non-disturbed young adults;
- b) significatively more, but only 4 % in the 68-82 years-old non-disturbed adults.

4 THE COMPUTATIONAL APPROACH TO SEMANTIC APPROXIMATION: FIRST STEPS

4.1 Prox: a computational model of inter-item semantic proximity

In order to assess the importance of semantic approximation in structuring the lexicon, we compared a sub-sample of the data from children (obtained from the spontaneous corpus we had already collected and from our experimental results) with a mathematical/computer model (Prox), which structures the French lexicon based on dictionary entries by calculating the proximity between entries (GAUME, 2004).

The method chosen to extract the dictionary graph consisted of selecting verbs included in the dictionary as "nodes" of the graph and recognising the existence of an "edge" between node A and node B if, and only if, the term B in the dictionary was also present in the definition of the term A.

Contrary to "feature-based similarity", the similarity of relations is not determined by the "local" comparison of two given verbs, but by considering their respective "global" position in a network. Prox thus enables one to obtain a conceptual map: generating a holistic space of the meaning of words, more particularly by forming a global map that reflects the general structure of all the nodes of a graph (in this case, the verbs).

In figure 1, we present the global map of the verbs in French, presented on a scale of 1/50 (200 verbs out of a total of 10860 verbs) that Prox generated from the dictionary graph:

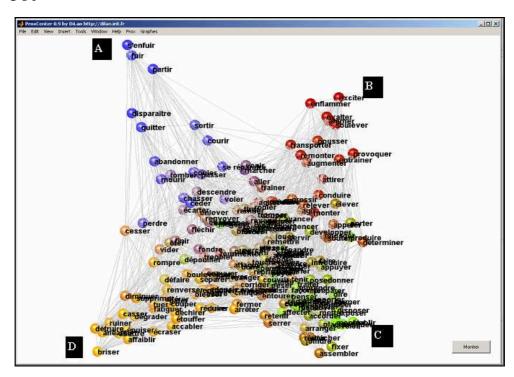


Figure 1 – The proxemic and conceptual tetrahedron of French verbs (200 verbs).

When one analyzes the lexical treatment performed by Prox, one can see that it consists of a distribution of verbs by semantic proximity (GAUME, 2004). It actually brings to the surface the conceptual zones, that is, the collections of verbs which present the same semantic notion. We can thus identify in Figure 1 four major conceptual zones:

- a) a zone determined by the proximity of verbs such as "flee" and "leave" ("fuir", "partir");
- b) a zone determined by the proximity of verbs such as "excite" and "emphasize" ("exciter", "exalter");
- c) a zone determined by the proximity of verbs such as "assemble" and "fix" ("assembler", "fixer");
- d) a zone determined by the proximity of verbs such as "destroy" and "break" ("détruire", "briser").

The issue becomes one of initially demonstrating that this proxemic organisation of verbs constitutes a model of how humans treat semantic proximity between verbs, as this is manifested in young children

4.2 Comparing prox with the semantic approximations of young children

In order to validate the proxemic organization of the lexicon as calculated by Prox (Figure 1) which engenders generic verbs (like "casser" - "break" in Figure 2) around which the specific verbs are connected (like "écraser" "déchirer" — "squash" and "tear up" in Figure 2) and which relate all the verbs in terms of their semantic proximity, we have carried out a first comparison of the data obtained from the children and this structuring of the lexicon by Prox:

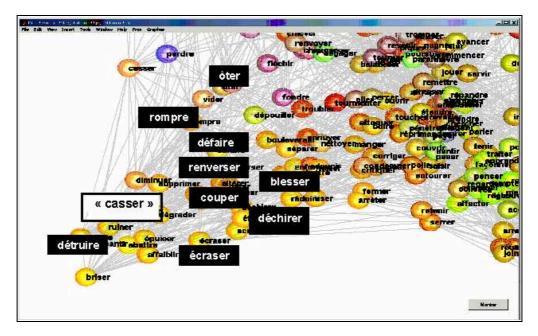


Figure 2 – Proximity between approximate verbs and conventional verbs.

Figure 2 shows our initial results. In fact, the combined approximate verbs (200) which came from our spontaneous corpus

(such as "casser" in Figure 2) and a first collection of 20 approximate verbs obtained from our experimental results in the action-naming task (such as "casser" in Figure 2) demonstrate a semantic proximity relationship in Prox with the corresponding conventional verb (these verbs are shown in white in Figure 2 – used in more than 70% of cases by adult judges to name the same action). Thus the approximate verb "casser" (break), used by one child to name an action [tear up a book] ("the woman breaks a book") or by another [squash a tomato] ("She breaks a tomato"), or by a third child [slice the bread] ("She breaks the bread"), are shown in Prox as close to the corresponding conventional verb. In Figure 2 déchirer (tear up), écraser (squash) and couper (cut) are the three examples which are considered in this graph. Thus we can observe in Figure 2 that Prox arranges within the same semantic zone an approximate verb ("casser") and its corresponding conventional verb.

5 DISCUSSION AND PERSPECTIVES FOR FUTURE RESEARCH

These initial data therefore allow us to underline the importance of the approximations and to bring to light the flexibility which underlies them during the early lexical development of the verbs, but they also cast an important light on the course of degeneration of the verbal lexicon with Alzheimer-type dementia (DAT) speakers, who present a lexical structuring that is apparently similar to the one characterising young language-learners. These data appear to us to account well for the following processes: the dynamics of disacquisition of verbal semantics occurring with these patients. It is appropriate to refer to this as "disacquisition" and not just as a difficulty in accessing the lexicon, particularly in the sense that their approximations are not, or are very rarely, accompanied by attempts at self-correction, or showing evidence of developing a model that could be a marker of the problem of access to the lexical item which they are looking for. In fact, this lack of selfcorrection or of modeling constitutes a substantial argument for the existence of a profound semantic disorder, and not, therefore, of a problem of access to the lexical-phonological form of the word.

In addition, the initial advances we are making at the computational level enable us to validate this dynamic model of the construction of meaning (DUVIGNAU; GARDES-TAMINE; GAUME, 2004; DUVIGNAU; GAUME, NESPOULOUS, 2004; DUVIGNAU; FOSSARD; GAUME; PIMENTA, 2005) and provide the opportunity to compare this computational model with all the experimental data obtained from the children and the Alzheimer subjects.

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Título: Aproximações e flexibilidades semânticas na construção e "desconstrução" dinâmica do significado

Autor: K. Duvignau; M. Fossard; B. Gaume; M.A Pimenta; J. Elie

Resumo: Esse artigo discute a produção da aproximação semântica com verbos em francês, tanto na aquisição do léxico inicial (por crianças pequenas sem problemas de desenvolvimento) quanto no contexto do mal de Alzheimer (por pacientes). Um dos objetivos do estudo é mostrar que essas produções são cruciais para a estruturação do léxico verbal por dois motivos: elas manifestam a existência de um novo tipo de sinonímia entre verbos e nos permitem mostrar a existência de uma flexibilidade semântica que desempenha um papel importante para o léxico verbal. Além disso, observamos que a relação de proximidade semântica entre verbos pode ser investigada através da abordagem computacional.

Palavras-chave: metáfora; léxico mental; aquisição da linguagem; perda da linguagem.

Titre: Approches et flexibilités sémantiques dans la construction et "déconstruction" dynamique de la signification

Auteur: K. Duvignau; M. Fossard; B. Gaume; M.A Pimenta; J. Elie

Résumé: Cet article discute la production de l'approche sémantique avec des verbes en français, autant dans l'acquisition du lexique initial (par des petits enfants sans problèmes de développement), que dans le contexte du mal d'Alzheimer (par des malades). L'un des objectifs de l'étude est celui de démontrer que ces productions sont cruciales dans la structuration du lexique verbal pour deux raisons : elles expriment l'existence d'un nouveau type de synonymie parmi les verbes et permettent de démontrer l'existence d'une flexibilité sémantique qui joue un rôle important dans le lexique verbal. Par surcroît, on se rend compte que le rapport d'approche sémantique entre verbes peut être recherché à travers la démarche informatique.

Mots-clés: métaphore; lexique mental; acquisition du langage; perte du langage.

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Resumen: Este artículo discute la producción de la aproximación semántica con verbos en francés, tanto en la adquisición del léxico inicial (por niños pequeños sin problemas de desarrollo) como en el contexto del mal de Alzheimer (por pacientes). Uno de los objetivos del estudio es mostrar que esas producciones son cruciales para la estructuración del léxico verbal por dos motivos: ellas manifiestan la existencia de un nuevo tipo de sinonimia entre verbos y nos permiten mostrar la existencia de una flexibilidad semántica que desempeña un papel importante para el léxico verbal. Además de eso, observamos que la relación de proximidad semántica entre verbos puede ser investigada a través del abordaje computacional.

Palabras-clave: metáfora; léxico mental; adquisición del lenguaje; pérdida del lenguaje.