RELATIONSHIP BETWEEN AUDITIVO-VOCAL SHORT-TERM MEMORY AND LEXICAL KNOWLEDGE IN DOWN'S SYNDROME.

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ABSTRACT

Some neuropsychological studies of brain damaged patients presenting memory deficits suggest that working memory directly contribute to the long-term learning of non-familiar phonological structures. It seems that a phonological store impairment leads to problems in learning new words (Baddeley, Papagno & Vallar, 1988). Gathercole and Baddeley (1993) studies of normal young children lead to the same conclusion. Phonological short-term memory abilities of 4-5 years-old children directly influence lexical acquisition. Children who exhibit the higher phonological memory skills produce higly discriminable and stable phonological memory traces. For these children, there is a greater probability that memory traces become durable and semanticaly linked to the referent. One can then conclude that the phonological short-term memory abilities directly influence the way young children acquired new vocabulary items. A study of memory abilities and lexical knowledge of Down's syndrome subjects (mental age:3;5 to 5;4 years old, chronological age: 8;10 to 25;11 years old) lead us to the following conclusion: in Down's syndrome subjects, as well as in normal subjects, one cannot reject the hypothesis that lexical knowledge are linked to the subjects phonological short-term memory abilities and more specially to nonword repetition.

INTRODUCTION

- **Gathercole and Baddeley (1993):** developmental study (± 100 children, 4 years old to 6 years old).

→ Lexical knowledge assessment: short form (32 items) of the British Picture Vocabulary Scale (B.P.V.S., Dunn & Dunn, 1982): receptive vocabulary (designation task).

→ verbal short-term memory abilities assessment: a nonwords repetition task.

Why nonwords repetition as memory measure ? → Three reasons:

1. Immediate recall tasks can reflect the contribution of the long-term knowledge as well as of the verbal short-term memory processes (Hulme, Maughan & Brown, 1991).
2. Non-familiar verbal strings repetition is a natural activity for young children Æ it is an activity on with children partly base the language acquisition process.
3. Nonwords repetition is less sensitive to strategies used during ordered recall (i.e., subvocal rehearsal).

Is there a relationship between both variables ?

→ The correlation between memory span and lexical knowledge is "highly significant" (in the authors terms), about 0.524-0.559. According to these data, children short-term memory abilities (assessed with nonwords repetition) explain about 27 % - 31 % of the lexical knowledge's variance.

What can we expect in Down's syndrome subjects ? If there is in this kind of subjects a relationship between verbal short-term memory abilities and lexical knowledge, what is the implication on language acquisition ?

EXPERIMENT

- **SUBJECTS:** 23 Down's syndrome subjects.
  - 8 children: chronological age (CA): 6;10 years old to 11;2 year sold (mean: 8;10 years old).
    mental age (MA): 3;1 years old to 3;9 years old (mean: 3;5 years old).
  - 6 adolescents: CA: 15;3 years old to 19;6 years old (mean: 17;8 years old).
    MA: 3;7 years old to 7;8 years old (mean: 5;4 years old).
  - 9 adults: CA: 22;1 years old to 32;11 years old (mean: 25;11 years old).
    MA: 3;6 years old to 5;11 years old (mean: 5;0 years old).

- **METHOD:**

1. Calculation of the global MA with the "Echelles Différentielles d'Efficience Intellectuelle" (E.D.E.I, Perron-Borelli & Mises, 1974).
2. Calculation of the non-verbal MA with the Coulour Matrix of Raven -PM47- (Raven, 1947).
3. Lexical knowledge:

Gathercole & Baddeley (1993) used the short from of the British Picture Vocabulary Scale (B.P.V.S.) which is a receptive vocabulary test (32 words).

Contrarily to Gathercole & Baddeley (1993), we used a Productive Vocabulary Test (T.V.P., pilot version) with 732 words (from 13 semantic categories) → naming task.

4. Verbal short-term memory span:

   a[1]. Digit span: digit strings (from 2 to 8 digits) were orally presented. The subjects were asked to repeat the digits immediately after the examiner (five stes of 2, 3, …8). The digit span was the maximum string of digits an individual was able to repeat correctly (in presentation order) after the examiner.

   b[1]. Word span: the method was identical to the one used for the digit span. The words used were monosyllabic and phonologically dissimilar.

   c[2]. Nonwords repetition: 40 nonwords (1, 2, 3 and 4 syllabes) were orally presented. The subjects were asked to repeat each nonword immediately after the examiner. (N.B.: This task is a memory task and not a articulatory task. So, it is less the phonemic quality of the nonwords that the structural correspondence between the model of the examiner and the production of the subject which is important. In this optic, the systematic articulatory errors of the subjects were not taken into account).

[1] Gathercole & Adams (1993) recent data show that in young children nonwords repetition and classical memory span (digit and word span) are correlated. So, we decide to add this two measures in the analysis.

[2] In their 1993's experiment, Gathercole & Baddeley only used nonwords repetition in order to assess short-term memory abilities (as they think that classical memory span tasks can reflect the use of long-term memory knowledge. See Hulme, Maughan & Brown, 1991). We want to point out that this is not entirely correct → nonwords repetition is influenced both by a memory factor (nonwords length) and a linguistic factor (wordlikness) (see Gathercole, Willis, Emslie & Baddeley, 1992).

- **RESULTS:**

1] Correlation between lexical knowledge and memory abilities of the subjects have been calculated (Pearson product-moment correlation coefficient, r) (Table 1).

	CA	Global MA	Raven	Nonwords	Digit span	Word span
Lexicon	0.43 *	0.77 **	0.52 **	0.81 **	0.76 **	0.58 **
CA	1.00	0.43 *	- 0.10	0.22	0.07	0.04
Global MA		1.00	0.57 **	0.77 **	0.81 **	0.50 *
Raven			1.00	0.56 **	0.69 **	0.53 **
Nonwords				1.00	0.54 **	0.59 **
Digit span					1.00	0.74 **
Word span						1.00

Table 1. Correlations between the lexical tasks and the short-term memory tasks.

* = significant: $p<0.05$ ** = significant: $p<0.01$

The global percentage of correct naming is linked to the three memory span tasks, CA, global MA and non-verbal MA.

→ at this stage, it seems that Gathercole and Baddeley (1989, 1993) hypothesis (a strong relationship between verbal short-term memory and lexical knowledge in young children) is confirmed with Down's syndrome subjects.

2] We realized stepwise regressions in order to determine the real part of variance in lexical knowledge explained by memory performance once the influence of global MA and AC have been eliminated (Table 2).

	F of the stepwise regression	**% of variance explained**
Global MA	F (1,21) = 95.90, p<0.0001	82.08 %
Nonwords	F (2,20) = 3.75, p<0.05	15.84 %
CA	F (3,19) = 0.25, NS	1.25 %
Global MA	F (1,21) = 95.90, p<0.0001	82.08 %
Word span	F (2,20) = 3.10, NS *	13.40 %
CA	F (3,19) = 0.25, NS	1.25 %
Global MA	F (1,21) = 95.90, p<0.0001	82.08 %
Digit span	F (2,20) = 1.23, NS	5.76 %
CA	F (3,19) = 0.25, NS	1.25 %

Table 2. Percentage of variance explained by CA, global MA and memory measures - F of the stepwise regression and statistical level of signification (significant level accepted: p<0.05).

* In order to be significant, the F value should have been ≥ 3.49

The part of variance explained by the digit span and word span is not significant.

But:

→ variance explained by word span = $p<0.01$ (a little bit higher that the accepted significative level $p\leq0.05$)

The part of variance explained by nonwords repetition is significant → Nonwords repetition explained 15.84 % of the variance in lexical knowledge.

3] We realized stepwise regressions in order to determine the real part of variance in lexical knowledge explained by memory performance once the influence of non-verbal MA and AC have been eliminated (Table 3).

	F of the stepwise regression	**% of variance explained**
Nonwords	F (1,21) = 39.39, p<0.0001	59.29 %
CA	F (2,20) = 25.36, p<0.0001	8.41 %
Non-verbal MA	F (3,19) = 1.08, NS	0.64 %
Word span	F (1,21) = 10.85, p<0.005	13.69 %
CA	F (2,20) = 25.36, p<0.001	20.25 %
Non-verbal MA	F (3,19) = 9.60, p<0.005	13.69 %

Digit span	F (1,21) = 36.17, p<0.0001	59.29 %
CA	F (2,20) = 33.89, p<0.0001	13.69 %
Non-verbal MA	F (3,19) = 0.13, NS	0.64 %

Table 3. Percentage of variance explained by CA, non-verbal MA and memory measures - F of the stepwise regression and statistical level of signification (significant level accepted: p<0.05).

If MA = the explicative factor → memory measures (especially nonwords repetition and digit span) are the best explanation of the variations observed in lexical knowledge.

4] It is of great interest to constat that taking non-verbal MA or global MA out of the model leads to different results:
→ nonwords repetition explains 59.29 % of the lexical variance if we take non-verbal MA out of the model
→ nonwords repetition explains 15.84 % of the lexical variance if we take global MA out of the model.

If we look at Table 1, we can see that MA and nonwords repetition are linked (r = 0.77, p<0.0001) as well as MA and lexical knowledge (r = 0.81, p<0.0001).

We can represent the evolution of lexical knowledge according nonwords repetition abilities and MA in the following way (Figure 1):

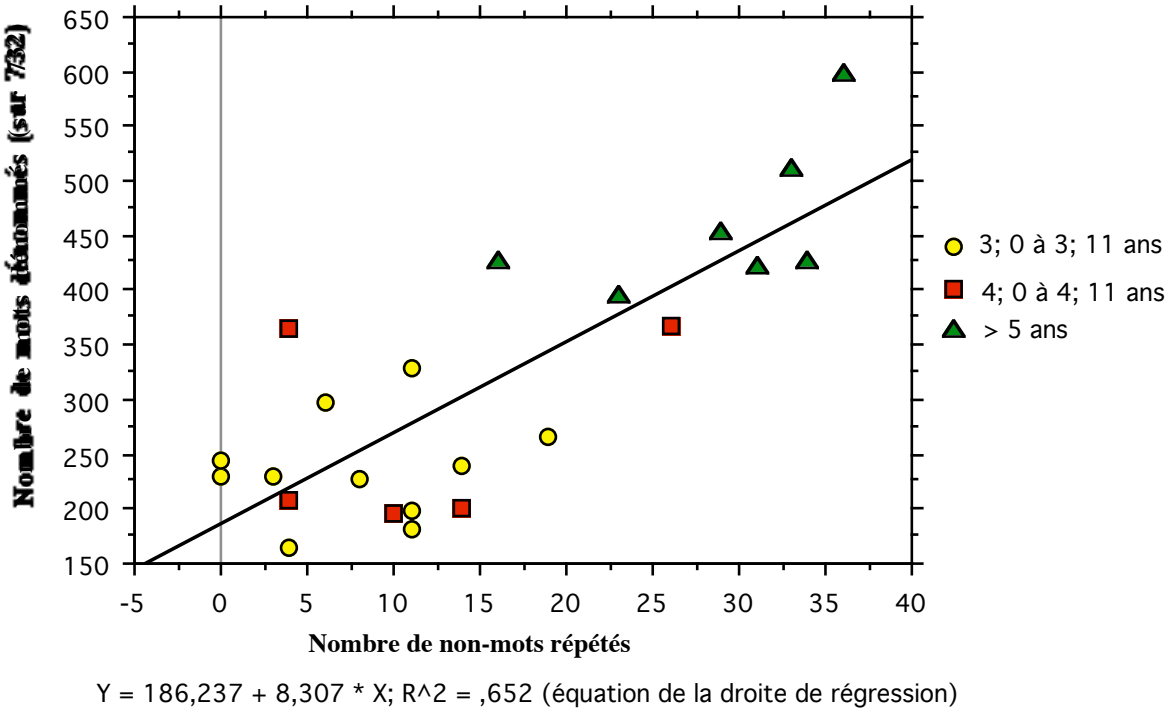

Figure 1. Lexical knowledge development regarding nonwords repetition and global MA.

Can we really use global MA in this kind of study ?

→ global MA is partly constituted of verbal measures (especially lexical measures - the E.D.E.I. contain a naming task and a definition task -) → it is normal that global MA and lexical knowledge are linked.

This remarks is relevant BUT:

- None of the measure used is "pure" → if lexical knowledge is a part of the global MA, we can assume that verbal short-term memory also play a role in global MA assessment.

→ when one take global MA out of the lexical variance, we can assume that one take also out a part of the variance due to the verbal short-term memory abilities.

→ we can see (Table 2) that nonwords repetition (for exemple) explain 15.84 % of the lexical variance but we can supposed that this percentage is underevaluated → we surely have to add to this percentage the variance explained by the mnesic component contained in global MA.

CONCLUSION

- The correlation analysis conducted on our data seem to confirmed Gathercole & Baddeley (1993) hypothesis:
  - Phonological short-term memory abilities young children directly influence lexical acquisition.
  - Children who exhibit the higher phonological memory skills produce higly discriminable and stable phonological memory traces.

  → Down's syndrome subjects with the higher verbal short-term memory abilities are also the one who exhibit the higher vocabulary scores.

- The fact that the global MA is not a "pure" measure justify the high percentage of lexical variance that it explains regarding the little percentage of lexical variance explained by verbal short-term memory abilities.

→ to have a more correct estimation of the percentage of lexical variance explained by the verbal short-term memory abilities, we surely have to add to this percentage the variance explained by the mnesic component contained in global MA.

→ this hypothesis seems to be reinforce by the fact that the influence of non-verbal MA on lexical knowledge is inferior to the one of global MA.

- At this stage of the research, we cannot reject Gathercole and Baddeley 's hypothesis. However, we want to point out that this study (as the one of Gathercole & Baddeley) is mainly based on correlation analysis and that correlation does not mean causality but only reflect a link between two variables.

- We also want to point out that all the studies we have described do not take into account an important point in children lexical development: the period of fast lexicon acquisition around 24 months. To our knowkedge, any research have been held on so young children (on relationship between lexical knowledge and verbal short-term memory abilities) Æ If there is a real link between both variables, we must find a link at this age.

- Finally, if verbal short-term memory ability of Down's syndrome subjects and normal children can be considered as a cue of lexical learning ability, we must limit learning to the phonological form of words. Current data do not allowed us to conclude about the acquisition of semantic features associated to the words.

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