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ABSTRACT

A study in an early French partial immersion program in a Melbourne (Australia) elementary school investigated participating children's performance in mathematics in English (their first language) and French. Mathematics testing in both languages has been undertaken regularly as part of a long-term evaluation of the program. In the first year of testing (1995), there were no significant difference in results of students taking the test in English or French. However, in 1996 a difference emerged, with grade 5 students taking the test in English doing significantly better than those taking the test in its French version. Item difficulty analyses were conducted to reveal the problematic questions, and a content analysis was performed on the aberrant items. The study revealed new information about how children process mathematics problems in their second language, and provides insights into the development of the students' language in a partial immersion program. (MSE)

Doing Math in French in Australia

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Paper presented at the 21st Annual Conference of the Canadian Association of Immersion Teachers, Victoria Conference Centre, November 6, 1997.

ABSTRACT

This presentation focuses on an early partial immersion program in Australia, in which children study Math in French. Testing of children's ability in Math in both their first and second languages has been undertaken on a regular basis as part of a long term evaluation of the immersion program.

In the first year of testing, 1995, there was no significant difference in results of students who took the test in English or French, however in 1996 a difference was revealed, with Grade 5 students taking the test in English doing significantly better than those who took the test in its French version.

Item difficulty analyses were conducted to reveal the misfitting questions, and a content analysis was subsequently conducted on the aberrant items.

The study reveals new information about how children process mathematical problems in their second language and provides insights into the development of the students' language in a partial immersion program.

DOING MATH IN FRENCH IN AUSTRALIA

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BACKGROUND TO THE PROJECT

This investigation developed from a pilot project which we conducted at Camberwell Primary School, in Melbourne, in 1995. The pilot consisted of the initial stage of an evaluation of the school's English-French bilingual program. The following were studied: parents' attitudes to the program, children's proficiency in the second language (listening and reading comprehension, speaking and writing) and success in maths tests, as mathematics learning in a bilingual setting was a concern for some parents. The findings of the pilot were reported in 1996 (Burston, de Courcy and Warren).

At CPS, instructional time for all children is approximately 45% in French and 55% in English, from Prep year to Year 6. The CPS program can therefore be considered to provide an 'early partial immersion' education. This type of bilingual program has not been as widely researched as total immersion programs, especially when mathematics-based (see for example the extensive Canadian and US immersion literature).

The specificity of the bilingual education provided by Camberwell Primary School (CPS) is that second language (L2) instruction there is focussed on mathematics. In the classroom, children study this subject exclusively in French, although their take-home exercises are occasionally written in English to allow parental supervision. They are also taught art, physical education and part of Study of Society and the Environment (SOSE) in French; English is used for all the other subjects.

Furthermore, the CPS program is not aimed at mother-tongue maintenance and development for French speaking children. No more than 10% of children have even one francophone parent. Similarly, the second language (French) is not intended to 'replace' the mother-tongue (Clyne 1986, 1995). Rather, the program aims at fostering 'additive' bilingualism (Lambert, 1975; Liddicoat, 1991; de Courcy ,1994). Thus although our research shares some of the concerns of migrant education research (Genesee, 1984; for mathematics, in Britain: Dawe, 1983; in the USA: Dale & Cuevas, 1987, Cocking & Mestre 1988, Spanos & Crandall, 1990 and in Australia, Clarkson and Dawe's work in progress; etc.), it is quite distinct from it. This project explores a different way of being bilingual in Australia and adds another facet to studies on bilingualism: moreover, it is unique in this country to examine mathematics-based primary programs.

The decision to teach such a key part of the curriculum in another language is unusual indeed, and to our knowledge, CPS and Telopea Park Primary School in the ACT are the only bilingual primary schools in this country to have taken this step. As Clyne (1986) notes, "there seems to be a taboo among principals and parents on teaching mathematics in a LOTE in Australia" (see also Clarkson 1995). It is a common view that learning mathematics in another language would be a disadvantage; that the subject is already difficult in English and that there is no need to complicate the child's task. However, the preliminary testing done in 1995 and 1996 at CPS has shown that children exposed to this type of instruction do in fact successfully learn mathematics and have the additional benefit of acquiring a second language.

We note that de Jabrun (1993, 1997) and Berthold (1992) found positive results with the secondary school immersion students with whom they conducted their research. However, it should be noted that learning mathematics in a second language at secondary school is a different proposition from learning maths in a second language at primary school. Students who commence an immersion program at secondary school already have developed their

mathematical concepts in their first language during the primary years. As well, these two researchers do not seem to have considered the effect of the language in which the children were tested, which is one of our primary focuses.

It should be recalled that in immersion schooling, L2 is not taught as an object, but is learned while serving as vehicle for a content subject. In a bilingual mathematics immersion class utmost attention is given to language. Firstly, teachers must ensure that children are presented with 'comprehensible input' (Krashen 1985). Secondly, the 'experiential' approach to language teaching, typical of immersion instruction, has to give way to a more analytical approach and more attention has to be paid to form-meaning relationships. As children progress to the middle and upper grades, the language used in the mathematics class has to become more informative and more formal in order to make reference to concepts and abstract relations. Precision and focus on form are of extreme importance for mathematics learning in a monolingual setting (MacGregor 1989), but in a bilingual situation, they are even more crucial.

Furthermore, the relationship between L1, L2 and mathematics (mathematical concepts and specific language) is intricate. The complexity of their interaction is immediately obvious to any classroom observer. With the help of the teacher, who uses only L2, children make successful and unsuccessful attempts at comprehending simultaneously the subject matter and its medium: in their speech, code switching (mixture of L1 and L2 in the same utterance) often occurs and interferences (influences of L1 on L2) are abundant.

AIMS OF THE RESEARCH PROJECT

The particular section of the project we are reporting on aimed to explore further the process of acquiring mathematics and a second language at the same time - one subject being learnt through the medium of the other, during primary schooling. Testing earlier in the project showed that children exposed to this type of instruction learn mathematics successfully. CPS children tested in 1995 and 1996 (using the multiple-choice format PAT-Maths test) were above average when compared to Australian norms.

However, a number of questions emerged from these evaluations that required further investigation and called for a different type of research.. Research that is more process-oriented would complement the quantitative measurement of academic outcomes and would focus on learning strategies and development in bilingual immersion environments. We proposed, therefore, to investigate the interaction of content (mathematics), medium of instruction (L2: French) and mother tongue (L1: English), through the task of solving written problems containing a certain percentage of natural language (so called 'word-problems').

We aimed to address the following research questions in the project:

1) What strategies do immersion children use when they solve problems in the L2?

2) Are these strategies different from the ones used by monolingual children to solve a problem written in their first language?

3) In what language are the children thinking when their minds proceed through the cognitive steps involved in finding a solution to maths problems? Do they, as Cohen (1995b) suggests, essentially translate into their native language?

4) What bearing exactly has the language in which the problem is worded on the outcome of the solving task?

1) Confronted with a word problem in their second language (as in L1), the child applies various strategies to make sense of the problem at hand (basically the strategies of reading) and arrive at a solution. Examples of such strategies are reading (and re-reading) of the question, discrimination by skimming, sub vocalisation to match spelling with pronunciation or to help reasoning, inferences from linguistic cues concentration of attention (for example by

underlining) on specific words and formal/logical syntactic relationships, bridging (by paraphrasing or translating into L1), drawing of a picture, a diagram, etc. These strategies will be identified and categorised. We will draw here on the most recent work done on second language acquisition strategies (Cohen & Scott, 1996).

2) The second research question arises from the 'bilingual' method of testing we have adopted for the evaluation on the CPS children's mathematical skills: some groups of students sat the PAT-Maths test in the original English and others were given a French translation of the same test. The translation was done by a native speaker of French, experienced in translation, with the assistance of the classroom teachers, who checked the translations for mathematical language, and ensured they used a register as familiar as possible for the children.

Major causes of difficulties in solving maths word-problems in a monolingual situation (see for example Newman 1979) are:
(i) not understanding what the problem is about
(ii) not knowing what mathematical strategy to use or what operation to apply: whether to add, take away, divide, etc.
(iii) not being able to do the calculating correctly when needed.
A comparative study will indicate if on the same problems, worded in French for immersion children and in English for the others, there are marked differences in the frequency of sources of errors.

3) Cohen considers the issue of the language used to solve maths problems in his 1994 article, with Spanish L2 students, and only in the context of total immersion (i.e. where all subjects are taught in the L2) and not the partial immersion context that this project investigated.

(a) A longitudinal study will indicate the extent to which English and French are used during the interviews by each child, if it is the same from child to child and if it remains constant as he/she progresses in his/her primary studies. A substantial amount of language mixing was expected, as the input in the interviews was mixed (problem set in French/ 'think aloud' in French and English - and as language mixing is a normal behaviour when learning a language and expressing oneself in a situation of 'subordinate' bilingualism.

(b) In order to comprehend written problems, besides world knowledge and basic knowledge of the vocabulary and morphosyntax of L2, children need a familiarity with, and understanding of, text cohesion in L2: knowledge of the features of the word-problem genre, recognition of new/old information, mastery of co-reference (more specifically anaphora), identification of connectives. Clarkson 1991, for example, emphasises the importance of logical connectives for learning mathematics by any students, but crucially by bilingual children. We have made an initial exploration into which forms/conventions of L2 mathematical language interfere most with the comprehension of problems by bilingual children. Difficulties similar to those mentioned in MacGregor 1989 for English monolingual children are expected, but others will inevitably be caused by specific features of L2 (French) and by L1 interferences.

The theory of interdependence, according to which knowledge acquired at school relies on a cognitive pool which can be accessed in L1 or L2, provided that each language is sufficiently mastered (cf. the common underlying proficiency model of Cummins 1979; also Cummins and Swain 1986) has been amply verified for mathematics in Canadian early total immersion (Swain and Lapkin, 1984; Genesee, 1984) and for late partial immersion in Australia (de Jabrun, 1997). In early partial immersion however, much less is known: the information available is limited and research results are inconclusive (Swain & Lapkin 1984). They appear to indicate that, in lower grades (3 and 4), partial immersion students' achievement is on par with, or inferior to -- on certain sections of English maths tests -- that of the monolingual English comparison groups (Elgin County, Ontario), but they show equivalent performance in the upper grades (Edmonton Public Schools). It seems that the disadvantage disappears as the level of proficiency becomes higher in L2.

Contrary to what might be expected, pilot testing at CPS in 1995 (using the multiple-choice format PAT-Maths test) indicated that studying mathematics in French did not have a negative effect on performance, when compared to Australian norms. There was a small difference; not statistically significant. This interesting result seems to support Cummins' theory of interdependence and the notion that skills and higher order cognitive processes are transferred. The results of testing in 1996 will be discussed below.

One notable exception to this 'transference' was the 'Statistics and Graphs' section on the test, where the text of the questions was more wordy and where the 'French' groups obtained somewhat lower results. This seemed to indicate that Years 3 and 4 students had not acquired quite enough French - or at least 'academic' French - for their competence in mathematics to be accurately reflected in this component of the test (see Cummins 1991). This needs to be further investigated ((See Cummins's (1977) criticism of Macnamara 1966). Children in later years of the program will also be evaluated with respect to the language of testing.

As well as providing information as to outcomes, the wrong answers that children selected on the two versions of the PAT-Maths test provide clues to particular difficulties or misinterpretations. Items identified as difficult in either French or English, or in both, have been further investigated and errors triggered by linguistic factors carefully examined.

METHOD

The experimental program consisted of written testing of children in years 3-5 and interviews with a sample of these children.

(a) Written testing

The ACER PAT Maths series of tests were used. These standardised multiple-choice tests come in two versions at each level, thus allowing administration of different forms of the test in two consecutive years.

Tests were given as part of the normal process of schooling, at the teachers' convenience, and the results for the class as a whole, not individual students, were communicated to the teachers. Half of the student population (chosen at random) took the tests in English, as they are published by the ACER; the other half were given French versions, translated/adapted from the English versions and revised beforehand by the mathematics teachers (to check for L2 vocabulary or structures that children may not have encountered yet).

Several analyses were conducted on the children's results on the maths tests. Firstly, results from CPS were compared with Australian norms, as provided by ACER. Secondly, a correlation analysis was conducted, comparing the results of students who had taken the test in French and in English.

An item difficulty analysis was conducted, in order to determine which questions provoked "aberrant" responses. These outliers were then analysed to determine what linguistic features had caused the anomaly in response pattern.

In preparation for the second aspect of the experimental program, a detailed study of the word-problem items contained in the PAT-Maths tests was undertaken. Children's responses, problematic grammatical structures and vocabulary were analysed. This gave the investigators an idea of the types of errors made on word-problems by the population tested and helped prepare problems appropriate for the second phase of the testing program.

(b) Think aloud protocol interviews

On the basis of the scores obtained on the written tests, a sample of students were selected for the interviews: some very able, some of average ability, and some less able.

These interviews were of the 'think aloud protocol' format described by Ericsson and Simon (1987), and used verbal reports as data. In contrast to other methods of assessing language learning and use strategies, verbal reports have the advantage of providing researchers with instances of actual strategy use They are the best way of obtaining mentalistic data. Information is given by the learners themselves about the cognitive operations they go through. They can report simultaneously or retrospectively on their language behaviour or disclose their thought processes by verbalising them ('think aloud') while performing the task (see Cohen 1995a; Cohen & Scott, 1996, for an up-to-date analysis of the advantages - and limitations - of verbal reports in second language acquisition research).

In these task-based interviews (conducted with the assistance of Helen Lew Ton), children solved a maximum of four problems. They were trained to 'think aloud' before the protocol proper commenced, by being asked to perform some operations in French, such as counting in sevens, and work out how many rooms there were in the school. Then as they worked through the problems and were asked questions about the strategies they used. From a methodological point of view, the 'think aloud' part of the interview was either concurrent with, or retrospective to, the activity of problem solving, depending on which procedure proved more effective with individual children. Investigators conducting the interviews intervened when necessary to provide scaffolding help to guide the children into 'think aloud' mode.

The interviews took place with two adults and one child. One of the interviewers addressed the child in English, and one in French. Field notes were taken by the researchers and the interviews were audio taped. These tapes were then later transcribed in full and results analysed for strategies (taxonomy, frequency of use, language choice, major causes of difficulties, etc.)

EFFECT OF LANGUAGE OF TESTING ON MATHS PERFORMANCE

Maths results of students in Years 3 and 4 in 1995 and the same students' maths results in Years 4 and 5 in 1996 were examined to determine whether language of testing had an effect on mathematical performance, and whether male and female students differed in achievement. The question of whether, and to what extent, the reported results from 1995 might predict 1996 results was also investigated.

70 students overall were involved in this study, 30 of whom were in Year 3, 1995, and 40 in Year 4. Of those in Year 3, 18 were girls and 12 were boys. In Year 4, there were 18 girls and 22 boys. The distribution of boys and girls tested in each language for 1995 and 1996 is as follows:

Distribution of students, 1995

YEAR 3	Test in French	Test in English	Total
Boys	6	6	12
Girls	13	5	18
Total	19	11	**30**
YEAR 4			
Boys	16	6	22
Girls	10	8	18
Total	26	14	**40**

Distribution of students, 1996

YEAR 4	Test in French	Test in English	Total
Boys	7	5	12
Girls	6	12	18
Total	13	17	**30**
YEAR 5			
Boys	13	9	22
Girls	9	9	18
Total	22	18	**40**

Students sat the following versions of the ACER PAT Maths tests:

1995 Years 3 + 4	PAT 1A
1996 Year 4	PAT 1B

Taking into account the potential problems involved in translation and testing in different languages, these versions of the PAT Maths are assumed to be equivalent (but see discussion under 'Item difficulty analysis'). Percentile ranks were the measurements used in each case.

As has already been noted, Burston, de Courcy and Warren (1996) found that students performed only marginally better sitting the tests in English than French in 1995. In 1996, the Year 4 students showed no statistically significant difference in maths ability whether they sat the test in English or French, whereas for Year 5 students, those who sat the test in English did significantly better (Mann-Whitney U test, p=0.0046).

This difference is also reflected in the comparison between students who remain in the same language treatment over 1995 and 1996, and those who change from French to English or from English to French. Results of statistical analyses show that those students who change from French to English are likely to see a significant improvement in achievement (dependent t-test (2-tailed), p=0.002) and those who change from English to French are likely not to achieve as well as in the previous year (p=0.0009).

Statistical analyses (using the Mann-Whitney U test) were made of boys' and girls' achievement according to year, grade, gender and language of testing. The results show that there is no statistically significant difference between boys' and girls' achievement, although in Year 5 in 1996, the difference between boys and girls taking the test in French approaches significance, in favour of the boys. It should be noted that, had there been a larger number of students, there would most likely have been a statistically significant result.

The third question addressed was whether the rank ordering of students in 1996 could have been predicted from the ranking in 1995. The results of statistical analyses show a significant correlation between rank ordering in 1995 and 1996 only when the language of testing changed—ie for students who took the test in English in 1995 and French in 1996, and vice versa (Spearman's rank order correlation (rho), alpha=0.05). These results are somewhat surprising, as we would expect a similar correlation for students who took the test in the same language in both years. The results could mean that there are other factors coming in to play, or they could be a simple reflection that some weaker students have improved over the two years or that some stronger students have fallen behind.

Overall, the results suggest that being tested in French can have an adverse effect on students' achievement in Maths. Our hypothesis is that a lack of French vocabulary and the higher cognitive demands of reading in French are preventing some students from understanding the more wordy problems in the tests. In order to investigate this hypothesis, we undertook an item difficulty analysis of the English and French tests given to Years 3, 4 and Year 5 children in 1996.

ITEM DIFFICULTY ANALYSIS

Two methods were used to calculate the relative difficulty of items on the French versions of the tests and the English versions. The first method was a simple calculation of the number of items on each version of the test which were answered correctly by fewer than 40% of the children. The second analysis involved the use of the Quest Interactive Test Analysis System, which uses Rasch analysis to reveal differences on two versions of the same test. Based on these analyses, the following results were found:

Year 5, 1996

The Year 5 students sat version 2a of the PAT Maths test, which is considerably longer at 57 questions than the test they sat in the previous year in Year 4. The questions shown in Table 1 below appeared to cause more difficulty for the French group than for the English group:

Table 1 Questions more difficult for French, Year 5, 1996

Question	English group % correct	French group % correct
10	65	33
19	70	12
21	65	37
25	65	33
41	55	29
46	45	33
47	65	21
50	60	25
52	55	21
53	85	29
54	70	29
55	60	29
56	60	29

Results on questions 50 and above were affected by the number of students in both groups who did not complete all the questions on the test. This was taken into account by the second analysis.

In order to obtain more information than was possible by using this rather simple first analysis, the Quest Interactive Test Analysis System was used for a more thorough analysis of the data, taking into account incomplete tests. This analysis confirms that question 19, highlighted in Table 1, is very much more difficult in the French version of the test than in the English. As well, questions 43, 47, 50 and 53 were easier for students who took the test in English. Interestingly, there were also several questions which were slightly easier for students who took the test in its French version: questions 33, 35 and 42. The difference was too slight to warrant further analysis below.

A second analysis, also using the Quest system was conducted. We noted once again the appearance of question 19 on the French version of the test. We also note that item 27 caused difficulty for both groups of students, and was most difficult for the English group. This question involved algebra and fractions.

The linguistic features of the "aberrant" questions, which may have led to the differences, will be discussed later in this paper.

Year 4, 1996

The Year 4 students took version 1b of the PAT Maths test in 1996 as they had taken version 1a in the previous year and we wished to avoid problems of reliability associated with the test-retest phenomenon. As with the Year 5 group, firstly, a hand calculation was made of the comparative difficulty of the two versions of the test. The results of this analysis are displayed in Table 2 below.

Table 2 Relative difficulty of items, Year 4 1996

Question	English group % correct	French group % correct
8	53	16
27	53	42
37	37	37
41	89	42
47	37	63

You will note that these results are quite different from those obtained for the Year 5 group. Indeed, there are several questions which appear to be of equal difficulty to both groups, and some which were easier for the French group than for the English group.

Again, the Quest analysis adds information to the hand analysis, showing that questions 37 and 41 are the outliers, with 37 showing as easier for the French group and 41 being easier for the English group. The item estimates also showed that question 8 was more difficult for the French group than for the English, though it was still quite difficult for the English group. Question 35 also shows up as a problem question for the French group.

The nature of questions 8, 35, 37 and 41 will be analysed later in this paper.

Year 3, 1996

The Year 3 students took version 1a of the PAT Maths test, as this was their first time to be tested in the evaluation project. As with the previous two year groups, an initial analysis was conducted by hand. The questions shown in Table 3 below appeared to pose more difficulty for the children who took the test in French.

Table 3 Year 3 1996, comparative difficulty

Question	English group % correct	French group % correct
10	**100**	**37**
27	44	16
36	**83**	**26**
37	**67**	**16**
42	72	16
46	67	31
47	61	26

We note that many students in the French group did not complete items 46 and 47, indicating perhaps that they needed more time to actually read the questions than did those in the English group.

As with the Years 4 and 5, the Quest system was used to analyse the differences between students who took the test in French and those who took the test in English. Items 36 and 37 were the outliers, being much easier for the English group.

The item estimates indicated that items 27, 42 and 37 caused great difficulty for the French students. Item 27 was also the most difficult item for the English group, but was much less difficult for them than for the French group. As with the other classes, the main difficulty faced by the French students with the final questions on the test was lack of time in which to finish. These later analyses reveal that the problem with question 10 was that it was simply not completed by many of the French group.

Questions 10, 27, 42 and 37 will be analysed in the next section to determine the linguistic difficulties posed by these questions.

ANALYSIS OF QUESTIONS MORE DIFFICULT IN ONE LANGUAGE

Year 5

The questions which have been chosen to explore the difficulties the children may have had are questions 19, 47, 50 and 53.

You may remember that question 19 was the real 'outlier' in all our analyses. When we examine the question we can perhaps see why - it is one of the 'word problems' mentioned in the background to the study. It is precisely the type of question which we anticipated would cause the most difficulties for the children at CPS. Here is the question in its two versions:

19 English original	19 French translation
A man left $5000 in his will so that his widow received $1000, each of his four daughters $550 and each of his sons $600. How many sons did the man have? A 1 B 2 C 3 D 4 E It is impossible to tell from the information given.	Après sa mort, un homme a laissé $5000 à sa famille: $1000 à sa femme, $550 à chacune de ses quatre filles et $600 à chacun de ses fils. Combien de fils a cet homme? A 1 B 2 C 3 D 4 E On ne peut pas savoir

The correct answer was C.

The breakdown of distractors chosen across the two groups was as follows:

English group	French group
A 1	A 0
B 1	B 0
C 14	C 3
D 1	D 1
E 3	E 17
- 0	- 2

Thus we can see that the majority of the English group chose the correct answer, C (3), but the majority of the French group chose E - not enough information to say. In the think aloud protocols it was revealed that the words "chacun/chacune" (each) were the cause of the comprehension problems with questions such as this. Professor Alan Davies suggested at our seminar that the children could have interpreted "*on ne peut pas savoir*" (one cannot tell) as "I don't know".

Question 47 in its two versions is shown below:

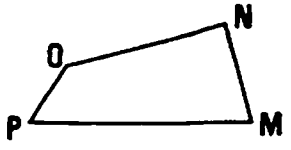
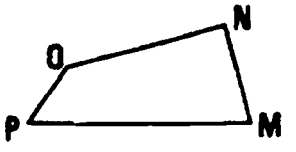
47 English original	47 French translation
At 5 o'clock a pole 5 metres tall casts a shadow of 10 metres, while a nearby building casts a shadow of 40 metres. How high is the building? A 20 metres B 25 metres C 35 metres D 50 metres E 80 metres	A 5 heures un arbre de 5 mètres de hauteur fait une ombre de 10 mètres et un bâtiment voisin fait une ombre de 40 mètres. Quelle est l'hauteur du bâtiment? A 20 mètres B 25 mètres C 35 mètres D 50 mètres E 80 mètres

The correct answer was A, 20 metres.

The breakdown across the two groups is shown below:

English group	French group
A 13	A 4
B 0	B 4
C 0	C 0
D 3	D 8
E 3	E 4
- 1	- 2

There is not as clear a pull away from the correct answer as with question 19, but answer D attracted several of the French students. There would seem almost to be guessing in operation with the French group for this question. The translators note that they had great difficulty in translating this question. They feared it would contain too many unfamiliar words and phrases.

50 English version	50 French version
 **One of the angles in this figure is a right angle. Which is it?** **A** ∠ ONM **B** ∠ PON **C** ∠ MPO **D** ∠ NMP	 Un des angles de cette figure est un angle droit. Lequel? **A** ∠ ONM **B** ∠ PON **C** ∠ MPO **D** ∠ NMP

The correct answer was A.

The breakdown across the two groups is shown below:

English group	French group
A 12	A 6
B 0	B 1
C 2	C 2
D 4	**D 11**
E 0	E 3
- 2	- 1

Thus angle D was almost as attractive a distractor for the French group as the correct answer, A, was for the English group. At our seminar, Dr Dominique Estival suggested that the reason for this may have been that the children read "*l'angle droit*" (the right angle) as "the angle on the right", not recognising in writing the difference between *droit* and *droite*, which is how these two different meanings of "right" are expressed in French.

Question 53 in the two versions is shown below:

53 English original	53 French translation
If there are never any stars to be seen on a cloudy night, how many stars will be seen on four cloudy nights?	Si on ne peut jamais voir d'étoiles, une nuit où le ciel est couvert de nuages, combien d'étoiles peut-on voir en 4 nuits où le ciel est couvert de nuages?
A 0 **B** 1 **C** 4 **D** many **E** an infinite number	**A** 0 **B** 1 **C** 4 **D** plusieurs **E** un nombre infini

The correct answer was A, none.

The breakdown across the two groups is shown below:

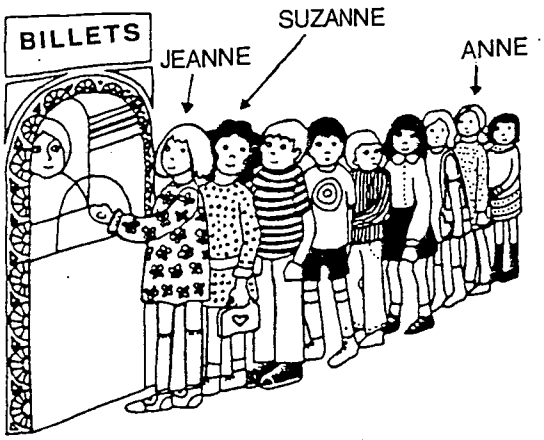
English group	French group
A 17	A 7
B 0	B 5
C 0	C 2
D 0	D 4
E 0	E 2
- 3	- 4

This question shows that for the English group, the answer was clear and easy to find. The French group seems once again to be guessing at the answer, as there is such a wide spread of scores, though the mode is A. The translators again noted their difficulty in translating this question for the children. The think aloud protocols indicated that the children had difficulty with negation in French, so "ne ... jamais" would have been the cause of their problems with this question.

Year 4

Questions 8, 35, 37 and 41 will be discussed. Questions 8, 35 and 41 were easier in English, and question 35 was easier in French. Explanations of these differences will be put forward.

Question 8 in its two versions is shown below. Accompanying this question was a picture of several children forming a queue to buy tickets at the cinema.



8 English original	8 French translation
Some children are going to the pictures. If Jane and Sue get their tickets and go in, where is Ann in the line then?	Ces enfants vont au cinéma. Ils font la queue pour acheter leurs billets. Jeanne et Suzanne achètent leurs billets et entrent dans la salle. A quelle place dans la queue est Anne maintenant?
A second B fifth C sixth D eighth E none of these	A deuxième B cinquième C sixième D huitième E aucune des réponses n'est correcte

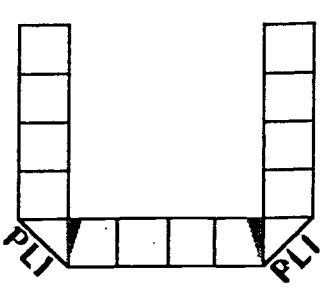
The correct answer was C, sixth.

The breakdown across the two groups is shown below:

English group	French group
A 0	A 0
B 0	B 0
C 10	C 4
D 9	D 11
E 0	E 0
- 0	- 3

Children in the English group were almost equally divided between sixth - where Anne is now, and eighth, where she was at the start of the question. However the children in the French group seem to have skimmed the long word question and just used the picture to find out Anne's position. Unfortunately, most of them chose where she WAS, not where she IS.

Question 35 will now be discussed. Its two versions are shown below:

35 English original	35 French translation
This is a long strip of paper which has been folded twice.	Voici un long ruban de papier plié en 2 endroits. 
[ ] is the unit. The area of the paper strip when it is **unfolded** is **A** 12 units **B** 13 units **C** 14 units **D** 16 units **E** 17 units	L'unité de surface est [ ]. Quelle est l'aire du ruban de papier quand on le déplie? **A** 12 unités **B** 13 unités **C** 14 unités **D** 16 unités **E** 17 unités

The correct answer was C, 14 units.

The breakdown across the two groups is shown below:

English group	French group
A 4	A 3
B 1	B 6
C **12**	C 7
D 0	D 0
E 0	E 0
- 1	- 3

Once again, we see a clear choice being made by the English students, but a spread across several responses by the French group. The question was not terribly wordy, but we identified through questioning the students that the word 'aire' was problematic. They understood it very well when they heard it, but they had problems with seeing the word on paper.

The next question to be discussed is the one for which it was easier to find the correct answer in French than in English. Here is the question in its two versions:

37 English original	37 French translation
Which unit would be used to measure how far a car travelled in one day? **A** kilograms **B** kilometres **C** litres **D** hours **E** kilometres per hour	Quelle unité de mesure utilises-tu pour mesurer la distance parcourue par une voiture en un jour? **A** des kilogrammes **B** des kilomètres **C** des litres **D** des heures **E** des kilomètres à l'heure

The correct answer was B, kilometres.

The spread of responses across the two groups, shown below, reveals an interesting phenomenon:

English group	French group
A 0	A 0
B 6	B 9
C 0	C 0
D 1	D 3
E 11	E 4
- 0	- 3

The children in the English group found the question ambiguous - "how far is it to X" can be answered in distance or in time taken. They chose the time taken option. The French group, on the other hand, had a clear clue in their question that it was **distance** that was required.

Question 41 is a question which , in its alternate form on version 1a also caused problems for the children in 1995 and 1996. The alternate form will be discussed below under Year 3. Here are the two versions of this question:

41 English original	41 French translation
The batsmen in a cricket team score the following runs: 21, 17, 18, 13, 18, 2, 17, 17, 2, 1, 1 Which score was hit the most often? A 2 B 11 C 17 D 18 E 127	Les batteurs d'une équipe de cricket on fait les scores suivants: 21, 17, 18, 13, 18, 2, 17, 17, 2, 1, 1 Quel score a été fait le plus souvent? A 2 B 11 C 17 D 18 E 127

The correct answer was C, 17.

The breakdown across the two groups is shown below:

English group	French group
A 1	A 0
B 1	B 1
C **16**	C 9
D 0	D 1
E 0	E 5
- 0	- 3

Once again we see that the children in the English group found this an easy choice to make, with only two children giving a wrong or incomplete answer. However, with the French group, we find five children choosing option E, which involved totalling all the scores presented. They were unable to actually read and decipher a question of this length and simply skimmed and decided that they needed to add up all the scores. Think aloud protocols revealed that the word "souvent" (often) was unknown in its written form.

Year 3

For year 3, questions 10, 27, 37 and 42 will be discussed.

Question 10 in its two versions is shown below:

10 English original	10 French translation
If [ ] < 16 and [ ] > 7, then [ ] may be A 2 B 6 C 12 D 17 E 23	Si [ ] < 16 et [ ] > 7, alors [ ] est A 2 B 6 C 12 D 17 E 23

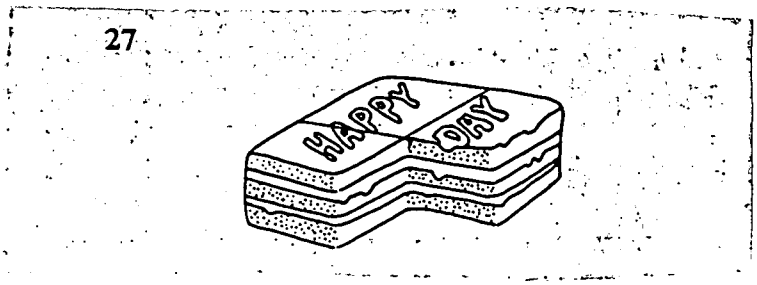
The correct answer was C. The breakdown across the two groups is shown below:

English group	French group
A 0	A 1
B 0	B 0
C 16	C 7
D 0	D 0
E 0	E 0
- 1	- 11

There is a clear difference between the response patterns on this question. The following is the explanation: the invigilator for the English version of the test was asked by so many children about the greater than and less than symbols on the test, that she decided to explain that > meant bigger than, and < meant less than, and wrote the explanation on the board. The invigilators of the French test were faced with just as many questions from their test subjects, but, as the maths teacher was present, they told the children "you have done those; you should know what they mean; we are not allowed to give you any help".

It is clear, however, from the response pattern, that the children in the French group did NOT understand these symbols. We note from classroom observations conducted this year that these symbols are still problematic even for the Year 6 students. A large poster of the symbols and their meanins is hanging on the wall of the maths room, so that the children can refer to it.

The next question which was problematic was question 27, whose two versions are shown below. This question also caused problems for the original cohort who sat test 1a in 1995. The question is accompanied by this picture of a birthday cake with one quarter missing.



27 English original	27 French translation
Tom cuts a cake into four equal pieces and eats one of them. What part of the whole cake will be left? A 1/4 B 1/3 C 1/2 D 2/3 E 3/4	Pierre coupe un gâteau en quatre morceaux égaux. Il mange un morceau. Quelle fraction du gâteau tout entier reste-t-il? A 1/4 B 1/3 C 1/2 D 2/3 E 3/4

The correct answer was E, three quarters.

The breakdown across the two groups is shown below:

English group	French group
A 2	A 2
B 5	B 11
C 0	C 1
D 2	D 0
E 8	E 3
- 0	- 2

Only **three** of the children in the French group chose the correct answer for this question, while 8 from the English group did. **Eleven** of the French group chose answer B, one third. Why? Just looking at the picture and the second sentence and guessing at what is required, one would say, yes, he ate one piece, that is one third of what I can see. With these longer word problems, the children choose a "use the picture and the easiest sentence and guess" strategy.

The next aberrant question was item 37. The question in its the two versions is shown below:

37 English original	37 French translation
DUTCH **BLUE-VEIN CHEESE** **$9.00 KG**	**FROMAGE** **$9.00 le kilo**
What would a quarter of a kilogram of blue-vein cheese cost? A $2.25 B $2.50 C $3.00 D $4.00 E $36.00	Combien coûte un quart de kilo de fromage? A $2.25 B $2.50 C $3.00 D $4.00 E $36.00

The correct answer was A, $2.25.

The breakdown across the two groups is shown below:

English group	French group
A 12	A 3
B 1	B 2
C 0	C 1
D 0	D 3
E 0	E 5
- 2	- 5

Why did so many of the French group choose to multiply 9 by 4 and come up with $36.00? And why did just as many not put an answer for this question? The answers of the English group indicate that they understand the **process** very well, yet the question written in French caused the children to **multiply** rather than **divide** by four. "Un quart", a quarter, is a familiar term to them in the oral language of the classroom.

The explanation was found during the think aloud protocols. When the children arrived at the word "quart", the pronounced it as in English, and had no understanding of what it meant or what they were meant to do. When they were prompted with the French pronunciation of the

word, they were able to easily complete the problem. Once again, the sound-letter correspondence problem is in evidence.

The last question we will examine is the"golf" question, which caused so many problems for the students who took 1a in the previous year. It is a very long 'word problem' and is the companion problem to item 41 on test version 1b.

42 English original	42 French translation
Eight golfers made the following strokes on the seventh hole: 3, 4, 6, 5, 4, 8, 5, 4 Which score was made the most often? A 3 B 4 C 6 D 7 E 8	Huit enfants jouent au golf. Au septième trou, ils ont frappé la balle comme ceci: Joueur No 1: 3 fois Joueur No 2: 4 fois Joueur No 3: 6 fois Joueur No 4: 5 fois Joueur No 5: 4 fois Joueur No 6: 8 fois Joueur No 7: 6 fois Joueur No 8: 4 fois Quel score a été fait le plus souvent? A 3 B 4 C 6 D 7 E 8

The correct answer was B, 4.

The breakdown across the two groups is shown below:

English group	French group
A 0	A 0
B 13	B 2
C 0	C 6
D 0	D 0
E 0	E 2
- 4	- 9

Thus we can see that there were effectively no distractors for the English group; the answer was clearly B, four. For the French group, however, the largest category was no response. Eight children failed to complete the last six questions or more. The load of reading the questions in French simply took them more time than the English group.

Once again, the translators note that there was some difficulty in translating this question for the young children. They held a long discussion in 1995 with the French mathematics teacher about this question. She was convinced that the children would not know "frapper" (to strike/hit) and maybe not "trou" (hole), but no alternative way of translating the question was found, so we went ahead and used it as you see it.

We can compare the 1996 results on this question with those obtained in 1995, which are set out below:

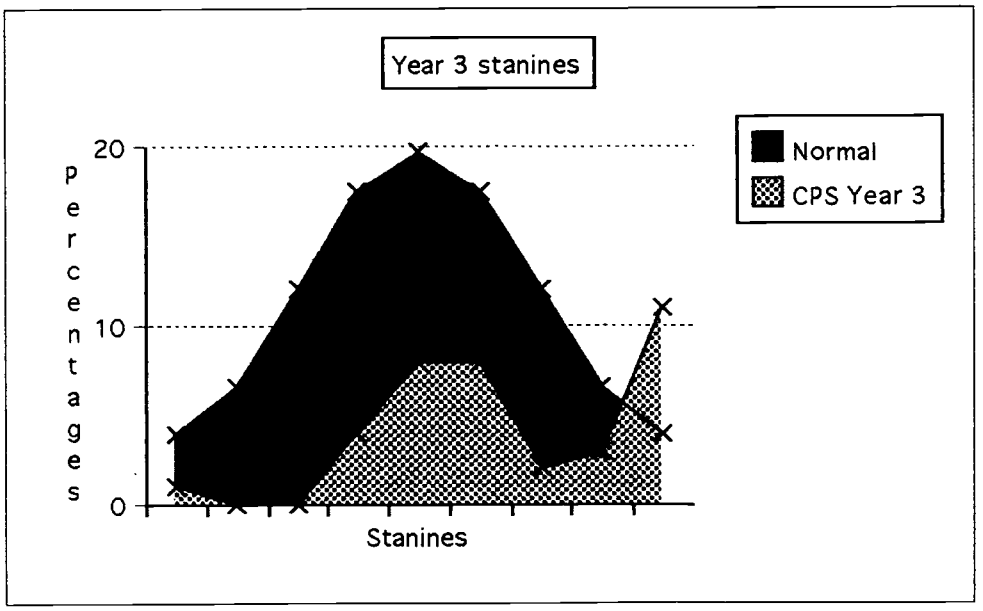
Question 41 results

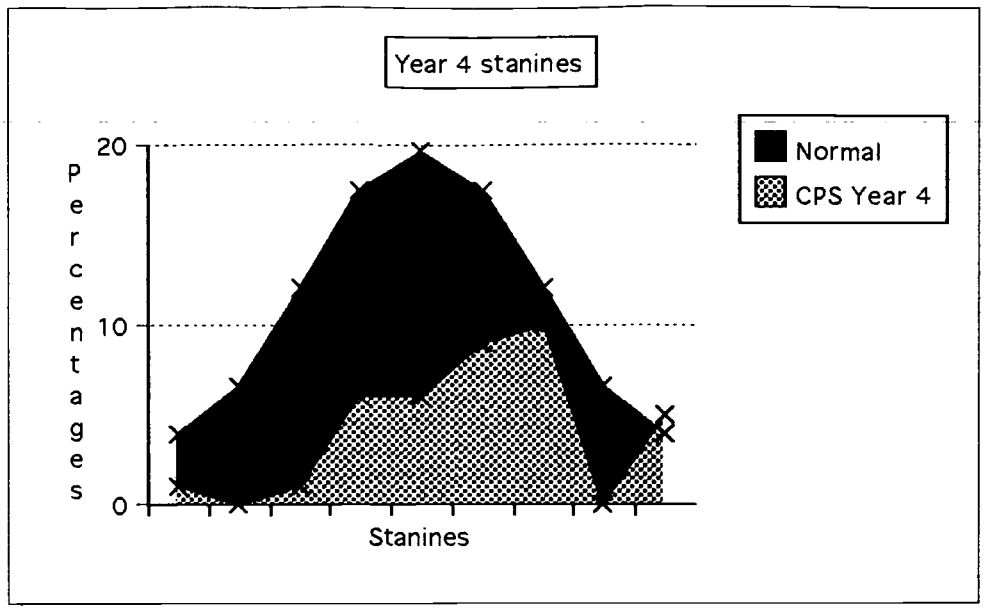
Yr 3 Eng 1995	Yr 3 Fr 1995	Yr 4 Eng 1995	Yr 4 Fr 1995
N=13	N=22	N=18	N=32
A 0	A 6	A 0	A 7
B 12	B 9	B 18	B 13
C 0	C 2	C 0	C 5
D 0	D 0	D 0	D 1
E 1	E 2	E 0	E 4
- 0	- 3	- 0	- 3

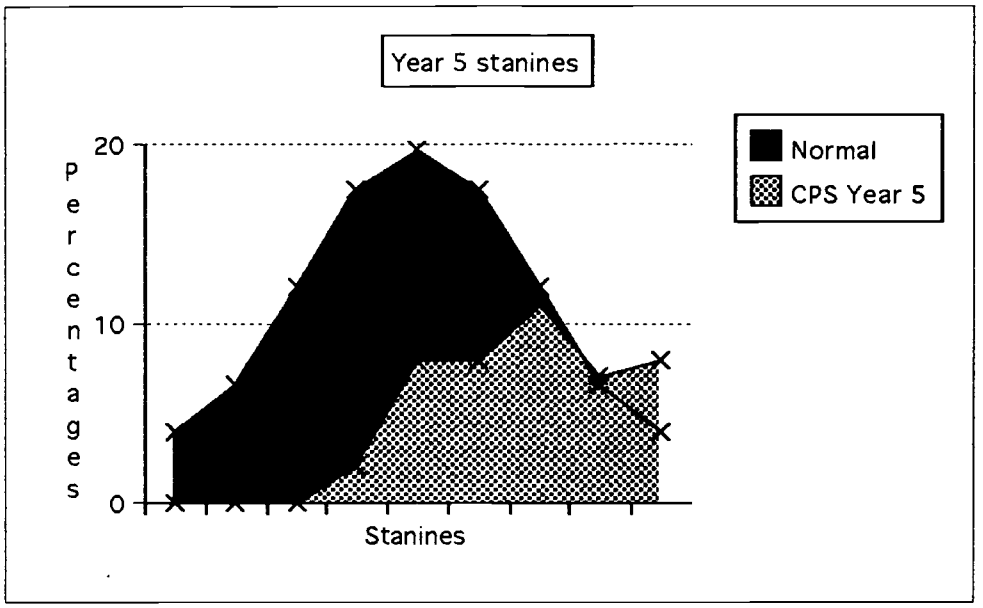
We can see from the above table that the children who took the test in French in 1995 had less difficulty with this question than did those who took the test in French in 1996. We are unable to explain this difference. There were only 3 children in 1995 who failed to complete the test, compared with more than 8 in 1996. Results on all questions for 1995 can be found in the Appendix.

Thus, from these analyses, we can see that the questions which caused the children in the French group the most problems were, as we expected, 'word problems'. When faced with several sentences of French, the children take a guess as to which mathematical operation they need to perform. This conclusion is backed up by our classroom observations, where we have seen children reading the question quickly, looking at the numbers and ignoring most of the words, and providing an answer based on inference from the numbers and the words they recognise in the question. This is similar to the results found by Cohen (1994) in Spanish immersion classrooms.

We would, however, like to stress again here that the children are doing marvellously well at maths. When compared to Australian norms, they are well above average. The graphs below show the results of the CPS year groups as a whole in terms of 'stanines', which are grouped, standardised scores, useful for comparing two groups. The 'normal' curve refers to the population on which the ACER PAT Maths tests have been normed. The graphs illustrate that the CPS children as a whole perform higher than the norm - ie, Australian children of a similar age. The further to the right, the better the students have performed.







It is obvious from these results that there is no question that the children have developed a sound foundation in mathematical concepts, which can be transferred to their first language from their second, and vice versa. This has been transferred via the oral mode from their classes conducted in French.

However, the maths classrooms we have observed over the past three years at CPS have been largely focussed on oral language. What is written on the board tends to be numbers, with the mathematical terms being **heard** rather than **read**. Indeed, many of the problems children are set for homework are written in English, as material is often simply not available in French, and teachers do not have the time to translate the set problems into French. The unfortunate result of these two factors is that the children do not seem to be building up the necessary sound-letter correspondences to enable them to read and solve word problems in maths independently of the scaffolding provided in the classroom by the teacher. We believe our results show that a largely oral focus is not preparing the children to deal successfully with mathematical problems written in their second language.

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