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AN ANALYTIC COMPARISON OF READING IN TWO LANGUAGES

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By means of a series of tests all based on the same verbal material the reading process in each of bilinguals' two languages was broken down into seven components (1) perception of individual words, (2) perception of strings of words in grammatical sequence, (3) interpretation of individual words, (4) interpretation of syntactic structures, (5) articulation of individual words (6) articulation of words in grammatical sequence, (7) anticipation through the use of the transition probabilities in language *Ss* (French English bilinguals in Montreal) were selected who had native command of one language and little more than school knowledge of the other Comparisons were made between the corresponding components in the two languages Significant differences were found for (3), (4) (5) and (7), and these differences were shown to be distinct one from another Subsidiary findings relate to effect of truth value (true/false) and syntactic structure (passive/active, negative/affirmative) on performance Some of the theoretical and practical implications of these findings are discussed

The ability to read some language other than the mother tongue is demanded of many students throughout the world The reasons for this are numerous and range from the circumstance that no education is offered in the mother tongue all the way to the requirement of many universities that post-graduate students should be able to read a second language For many of these students the reading of the second language presents serious difficulties which can be shown to place a strain on their intellectual functioning (2, 5, 6) At first sight their difficulty might seem to lie solely in ignorance of vocabulary, idiom or syntax, but it has been found (2, 6) that some difficulty still remains even when they know the meaning of every word and expression in the passage which they have to read Clearly,

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the extent of this residual difficulty will be related to the extent to which they have mastered the reading of the second language, in other words, the difficulty is a matter of degree However, many such students seem to read a second language as though the meaning were only seeping through to them instead of leaping from the page as it does when most of us read our mother tongue Because of the place of reading in the life of a student it is important to inquire into the nature of this residual and less obvious difficulty The attempt to do so has the added advantage that, if successful, it should throw light on the whole process of reading even in the mother tongue

The studies which are reported below are based on an analysis of the process of reading into seven sub-divisions The first four are clearly related to the intake of information the perception of individual words, the perception of strings of words in grammatical sequence, the interpretation of individual words, and the interpretation of syntactic structures The remaining three subdivisions may perhaps be grouped together as being related to output (in reading aloud) articulation of individual words, the articulation of words in grammatical sequence (concatenation), and the ability to anticipate the sequence of words beyond the point at which one is reading (i e the use of the transitional probabilities in written language) Clearly, all seven subdivisions are not watertight compartments For instance, the ability to anticipate in reading aloud is likely to be related to the ability to interpret syntactic structures Nevertheless, the seven subdivisions can be roughly distinguished by means of a series of tests whose results must be permitted to speak for themselves

EXPERIMENT 1

Materials

Eighteen feminine French nouns were selected all naming common objects of which pictures could easily be drawn In English these nouns are bulb, car, cow, crown, door, dress, flower, girl, hen, house, lamp, leaf, leg, mouse, queen, tail, wheel, wing To these were added two other words in each language, *a* and *has*, so that the original words might be combined in sentences of which half were true and half were false e g *a hen has a wing* and *a hen has a door* Words and sentences were printed on cards Two filmstrips were also prepared, one with the English words printed beneath pictures and one with the French words printed beneath the same set of pictures In half of the combinations the word named the picture and in half it did not The sentences were also made into filmstrips, one English and one French Finally, by the addition of the word *and*, the true sentences were combined to make two different English paragraphs

and two different French ones of fifty words per paragraph Scrambled versions of each paragraph were also typed on cards

Subjects and procedure

Twenty-four English-speaking students from a woman's college in Montreal took part in the experiment All had taken French throughout their secondary schooling and one year of French at college level In the course of testing it became apparent that two *S*s did not know the meaning of some of the French words, and these *S*s were replaced by another two One half of the individual words and sentences, chosen at random, were presented to each *S* tachistoscopically and perceptual thresholds recorded A Dukane Projector (Model 576-47B), which completes the operation of presenting a fresh stimulus within one-twentieth of a second, was used to show the film-strips *S*s pressed a key marked (+) if the word matched the picture or if a stimulus sentence was true, otherwise they pressed a key marked (−) A clock, set in motion by the switch which operated the projector, was stopped by the key which *S* pressed Cumulative times for each task were recorded for each *S*

There were in all eight paragraphs, four in each language and each *S* read all eight of them *S*s were asked to read one paragraph of text and one scrambled passage in each language aloud, they read the other two in each language silently When reading silently they indicated the words they were reading with a pointer The time taken to read each passage was recorded with a stopwatch

Eight measures were obtained for each *S* in each of the two languages mean perceptual thresholds for (i) words, (ii) sentences, mean reaction times for (iii) words on the screen, (iv) sentences on screen, times for (v) text read silently, (vi) text read aloud, (vii) scrambled passage read silently, (viii) scrambled passage read aloud

Tasks (i) and (ii) were completely counterbalanced across all 24 *S*s, and so too were tasks (iii) and (iv) Twelve *S*s chosen at random completed the tasks (i) and (ii) first and twelve completed tasks (iii) and (iv) first Tasks (v) to (viii) were counterbalanced in the same manner as tasks (i) to (iv) Every *S* completed tasks (i) to (iv) before tasks (v) to (viii), but apart from this all effects due to order were either randomized or completely counterbalanced across *S*s

Results

The findings are set out in Tables 1 and 2 Since interest is confined to a comparison of performance in the two languages, in analysing the data the method of paired differences was used throughout That is, each *S*'s

TABLE 1

MEAN TIMES IN MILLISECONDS FOR TACHISTOSCOPE AND FILMSTRIP TASKS EXPERIMENT 1

	Tachistoscope		Film	
	Words	Sentences	Words	Sentences
English	69	236	1089	1448
French	75	270	1230	1740

TABLE 2

MEAN TIMES IN SECONDS FOR READING CONTINUOUS PASSAGES EXPERIMENT 1

	Reading silently		Reading aloud	
	Scrambled Passage	Text	Scrambled Passage	Text
English	12 01	7 37	17 70	9 64
French	12 92	10 00	20 54	14 80

time for a task in one language was subtracted from his time for the corresponding task in the other language, and the resulting mean difference was tested for significance This procedure has the effect of removing the influence of all factors which contributed equally to scores in the two tasks Further, where appropriate, one set of difference scores was subtracted from another set The second order difference scores which result provide data for testing the null-hypothesis that the two sets of first order difference scores can be interpreted as measuring the same factor

1 The mean difference between perceptual thresholds for individual words is not significant $t=1\ 52$, $df=23$, $p>05$

2 (a) Perceptual thresholds for English and French sentences differ significantly $t=2\ 49$, $df=23$, $p<05$ (b) However, when this difference is corrected for differences in thresholds for individual words it ceases to be significant, $t=0\ 95$, $df=23$, $p>05$

3 The mean difference between times for matching words and pictures (135 msec) remains significant even when corrected for the difference in the perceptual threshold for words $t=4\ 76$, $df=23$, $p<05$

4 (a) The mean difference in time taken to decide whether sentences were true or false (243 msec) remains significant when corrected for the difference in perceptual threshold for sentences $t=2\ 73$, $df=23$, $p<05$ (b) However, when times taken to decide whether sentences were true or false are corrected for times taken to match words and pictures, the resulting mean difference of 115 msec falls well short of significance $t=1\ 13$, $df=23$, $p>05$

The only significant difference between performances in the two languages, then, is in the speed with which *S*s determined the meanings of words and sentences These two speeds, however, are not significantly different

In analysing the times taken to read the sequences of text and scrambled passages, four components were isolated These may be loosely called (a) perception of individual words, (b) pronunciation of individual words, (c) use of transition probabilities, (d) concatenation (the ability to string words together when pronouncing them in sequence) The various reading times contain the following components

Scrambled passage read silently =(a)
Scrambled passage read aloud =(a)+(b)
Text read silently =(a)−(c)
Text read aloud =(a)+(b)−(c)−(d)

Note that (c) and (d) which contribute to a reader's speed are entered as negative quantities The value of each component in each language can be arrived at by simple arithmetic, analyses were made of the differences between corresponding pairs of components

5 The mean difference associated with (a), 0 91 secs, is not significant $t=1\ 57$, $df=23$, $p>05$

6 The mean difference associated with (b), 1 94 secs, is significant $t=2\ 19$, $df=23$, $p<05$

7 The mean difference associated with (c), 1 72 secs, is significant $t=2\ 19$, $df=23$, $p<05$

8 The mean difference associated with (d), 0 59 secs, is not significant $t=0\ 66$, $df=23$, $p>05$

Summary

A consistent finding throughout is that the differences associated with perception are not significant – see results 1, 2 (b) and 5 A second consistent finding (results 2 (b) and 4) is that differential grasp of syntax in the two languages did not produce significant differences in the use of syntax in the tests The probable explanation of this (verified in Experiment 2) is that, as only one syntactic structure was employed, *S*s could ignore syntax once they had determined what it was

Significant differences were found in the interpretation of words (and sentences), in the articulation of words, and in the ability to anticipate (make use of the transition probabilities) when reading text

EXPERIMENT 2

To us the most surprising result in Experiment 1 was the absence of a significant difference associated with syntax We decided that we would

test the explanation given above of our failure to find it, i e , that since only one very simple structure had been employed, *S*s could ignore it once they had established what it was In effect, the explanation suggests that, for example, once *S*s had discovered that all sentences were of the form, *a hen has a wing*, they could determine their truth value by simply picking out the two nouns and comparing them for a part-whole relationship Our prediction was that if we were to vary the syntax in such a way that the truth value of each sentence could not be determined without reference to its syntax, then we would find a difference between performance in the two languages For purposes of the second experiment we composed new sentences of varying syntax from the list of nouns we had used in the first experiment We also wanted to anchor the second experiment to the first, and this we did by repeating test (iii) (words and pictures) in conjunction with the new sentences We also thought it advisable, as a check, to try our tests on *S*s who were native speakers of French and see if the results would, as expected, form a mirror image of those obtained with native speakers of English

Materials

The filmstrips of words and pictures were those which had been employed in the first experiment The new sentences were of four syntactic types active affirmative (AA), active negative (AN), passive affirmative (PA), and passive negative (PN) In composing these sentences we did some violence to both English and French syntax For example, one set might read as follows a hen possesses a wing, a hen does not possess a wing, a wing is possessed by a hen, a wing is not possessed by a hen The corresponding set of French sentences would be une poulle possede une aile, une poulle ne possede pas une aile, une aile est possedee par une poulle, une aile n'est pas possedée par une poulle * In all, thirty such sentences were prepared in each language, fifteen of which were true, and fifteen false The English sentences in random order were combined in one filmstrip and the French ones were combined in another

Subjects and procedure

Twenty-four English-speaking students and twenty-four French-speaking students, all of college age, acted as *S*s Each *S* had spoken only his

*In the course of testing it was pointed out to us that one French sentence was further complicated by the use of the word *jambe* in a context where the appropriate word was *patte* However, as only a few *S*s mentioned this, and as we were working on each *S*'s average for a particular type of sentence, no correction was made for this error For reasons described below it did not appear to make any material difference

native language before going to school and had been educated exclusively through the medium of that language Each *S*, however, had acquired a school knowledge of the second language All *S*s knew the meaning of all the words in both languages In these respects both groups were similar to *S*s in Experiment 1, they differed from *S*s in Experiment 1 in that about half the students in each group were men, and in that they were drawn from a variety of sources However, as each *S* acts as his own control, these differences are not of great importance

The materials were presented by means of the projector which had been used in Experiment 1 and *S*s responded by pressing keys marked (+) and (−) as outlined above in describing the first experiment The order in which the tests were presented was completely counterbalanced across each set of twenty-four *S*s Each *S*'s response time for each item was recorded separately and the following mean times were obtained for each *S*

Words and Pictures		*Sentences*		
English	French		English	French
		AA	true	true
match	match	AA	false	false
mismatch	mismatch	AN	true	true
		AN	false	false
		PA	true	true
		PA	false	false
		PN	true	true
		PN	false	false

Results

The data for words and pictures are summarized in Table 3 Comparison with Table 1 shows that the English-speaking *S*s' times in the

TABLE 3

MEAN TIMES IN SECONDS FOR MATCHING WORDS AND PICTURES EXPERIMENT 2

	Native English *S*s		Native French *S*s	
	Match	Mismatch	Match	Mismatch
English	1 35	1 43	1 34	1 34
French	1 58	1 72	1 21	1 26

second experiment are somewhat slower than the corresponding times in the first experiment This is probably due to the fact that *S*s in the second experiment, since they underwent fewer tests, were less familiar with the

words The results, however, are in the expected direction, each group performed better in its native language

Separate analyses of variance were made of the data for each of the two groups represented in Table 3 In each case the analysis was of the form, language × truth value (match/mismatch) × *S*s For English *S*s both language and truth value are associated with significant mean squares $F=8\,29$, $df=1,23$, $p<01$ and $F=16\,10$, $df=1,23$, $p<01$ respectively The interaction of language and truth value falls short of significance $F=3\,14$, $df=1,23$, $p>05$ The analysis for French *S*s, made in a slightly different manner, yielded only one significant variance ratio, that associated with language $F=11\,61$, $df=1,69$, $p<01$ The other two ratios are less than unity The difference between the two sets of findings cannot be explained by means of our data and will not be made the subject of further comment

The findings for sentence tasks are set out in Tables 4 and 5 The

TABLE 4

MEAN TIMES IN SECONDS FOR DETERMINING TRUTH VALUE OF SENTENCES NATIVE ENGLISH *S*s, EXPERIMENT 2

	AA	AN	PA	PN
English *true*	2 13	2 56	2 31	2 82
English *false*	2 08	2 20	2 51	2 84
French *true*	2 77	2 81	3 09	2 88
French *false*	3 56	3 99	3 93	3 82

TABLE 5

MEAN TIMES IN SECONDS FOR DETERMINING TRUTH VALUE OF SENTENCES NATIVE FRENCH *S*s, EXPERIMENT 2

	AA	AN	PA	PN
English *true*	2 70	3 63	3 16	3 71
English *false*	2 96	3 69	3 06	4 01
French *true*	2 29	3 12	2 47	3 28
French *false*	2 42	3 02	2 70	3 42

greatly increased times in these tables, compared with the corresponding sections of Table 1, probably reflect not only a lesser degree of familiarity with the materials in the second experiment, but also the increased complexity of the task due to the variation in syntax

Separate analyses of variance were made of the data for each of the two groups These analyses are of the mean times represented in Tables 6 and 7, that is, sentence times corrected for individual times in the words and pictures task In other words, each *S*'s time on the sentence tasks was corrected for his time on the appropriate words and pictures task

The analyses, thus, will reveal whether differences in the sentence tasks are significantly different from the differences observed in the words and pictures task, i e whether syntax contributed significantly to the differences observed in the sentence tasks The analysis for English *Ss* was of the form, language (L) × syntactic type (ST) × truth value (TV) × *Ss* and yielded five significant *F*-ratios

for L	$F=17\,6$,	$df=1,23$, $p < 01$
for ST	$F=\ 8\,5$,	$df=3,69$, $p < 01$
for TV	$F=24\,1$,	$df=1,23$, $p < 01$
for L×ST	$F=\ 3\,57$,	$df=3,69$, $01<p < 05$
for L×TV	$F=31\,82$,	$df=1,23$, $p < 01$

In view of the significant interactions it is necessary to look at the data, which are presented in Table 6 It is evident that while TV is a significant

TABLE 6

MEAN TIMES IN SECONDS FOR DETERMINING TRUTH VALUE OF SENTENCES CORRECTED FOR WORD AND PICTURE TIMES NATIVE-ENGLISH *Ss*, EXPERIMENT 2

	AA	AN	PA	PN
English *true*	77	1 21	96	1 48
English *false*	65	78	1 09	1 42
French *true*	1 19	1 23	1 51	1 30
French *false*	1 84	2 27	2 21	2 11

TABLE 7

MEAN TIMES IN SECONDS FOR DETERMINING TRUTH VALUE OF SENTENCES CORRECTED FOR WORD AND PICTURE TIMES NATIVE-FRENCH Ss, EXPRIMENT 2

	AA	AN	PA	PN
English *true*	1 37	2 30	1 83	2 38
English *false*	1 61	2 35	1 71	2 66
French *true*	1 08	1 89	1 26	2 07
French *false*	1 16	1 76	1 44	2 17

factor in the French responses, it makes little difference to the English ones, hence the significant L×TV interaction Since the triple order interaction, L×ST×TV, is not significant, the two truth values within each language can be combined for the purposes of examining the L×ST interaction When this is done it becomes apparent that, while in English responses to both types of passive sentence take longer than responses to the two corresponding types of active sentence, in French only responses to PA take longer than those to AA Throughout the table, too, responses

for L	$F=13\ 56$,	$df=1,345$,	$p<01$
for ST	$F=42\ 33$,	$df=3,345$,	$p<01$
for TV	$F=\ 2\ 56$,	$df=1,345$,	$p>05$

to negative sentences are slower than responses to the corresponding affirmatives, with the exception of those to PN in French which are slightly faster than responses to PA

Nevertheless, despite the obscuring effects of the interactions, the main result is abundantly clear French responses are very much slower than English ones, and this difference in response rate is significantly larger than that obtained in the words and pictures task Furthermore, variation in syntax does affect response rate significantly, though it does so differentially in the two languages

The analysis of data for French *Ss*, made along slightly different lines from the one described, yielded two significant *F*-ratios associated with two of the main effects, none of the interaction *F*-ratios reached unity The results, then, are clear cut Responses to French sentences are faster than to English ones The main effect of syntax breaks down into two separate ones responses to active sentences are faster than to passive ones ($t=6\ 22$, $df=345$, $p<01$) and responses to sentences in the affirmative are faster than to those in the negative ($t=15\ 02$, $df=345$, $p<01$) The absence of significant interactions indicates that these tendencies are constant throughout the data

DISCUSSION

In interpreting the findings it is important to bear in mind that the same limited vocabulary was employed throughout and that all *Ss* understood every word that was used The findings, then, are relevant to the area we delimited for examination – difficulties experienced in reading a weaker language even when every word and every syntactic structure is understood It is also necessary to bear in mind that only two languages were studied in one particular setting, the findings, then, cannot be immediately generalized This point applies particularly to the absence of significant differences associated with perception We interpret this as due to the high level of familiarity with the materials which was engendered by the testing session itself Both French and English, however, employ the same script, it is not surprising that Crothers *et al* (1) found that English-speakers who had learned some Russian reacted more slowly to the Cyrillic characters of Russian than to English letters We imagine that there was some difference in the speed with which our *Ss* in the first experiment were able to perceive English and French words, but that it was not marked enough to withstand the effect of repeated testing with

the same words On the other hand, where significant differences were observed, the associated effects must have been robust enough to withstand the effects of such testing

A consistent finding in both studies is that *Ss* determined the meanings of individual words more rapidly in their native than in their second language In the first experiment this effect was seen to be independent of any differences in perceptual threshold for the same words It might at first appear that in matching words and pictures *Ss* employed different strategies in French and English When responding to the French series, for example, English-speaking *Ss* might have recalled the French word which named the pictured object and then seen whether it matched the word printed beneath the picture On the other hand, when responding to the English series they might simply have read the English word, decoded it, and compared the semantic value thus obtained with their interpretation of the picture However, the findings of Experiment 1 for speed in determining the truth value of sentences makes this interpretation improbable The difference between French and English speeds for the latter task ceases to be significant when corrected for individual differences in speed of matching French and English words and pictures In other words, the two tasks seem to involve very similar skills It would be impossible to perform the sentence task without decoding both nouns in each sentence and testing for a part-whole relationship Because of the close similarity between this and the task of matching words and pictures, it is unlikely that *Ss* employed different stratergies in the two tasks Thus, the most satisfactory interpretation of the data is that suggested earlier *Ss* decoded the semantic value of words in their second language more slowly than those of words in their mother tongue This conclusion has the support of some studies carried out by Lambert and his collaborators (3, 4) who required *Ss* to press keys in response to written directions in French or in English, and found that response times were slower when the directions were in a *S*'s weaker language

The findings for speed of determining the truth value of sentences are, in the light of Experiment 2, reasonably clear cut The main result needs no qualification *Ss* perform the task more rapidly when the stimulus is in their native tongue This result was shown to be independent of the speed with which they determine the meanings of the words employed in the sentence, in other words, the interpretation of syntax is performed more rapidly in the native tongue The fact that the main findings for French-speakers form a mirror image of those obtained for English-speakers is particularly consoling, because of the artificiality of some of the structures employed, especially in French

Two general tendencies observed in the analyses of response times for sentences, though not fully consistent throughout all sections of the data, merit brief comment Firstly, responses to negative sentences are slower than to affirmative ones, and secondly, responses to passive sentences are slower than to active ones Both tendencies are consistent with the interpretation that the relevant information for determining the truth or falsehood of sentences such as we employed is stored by *S*s in an active affirmative form For example, it is likely that *S*s store the fact that a hen has a leg in the form *a hen has a leg* rather than in the form *it is not the case that a hen has no leg*, or in any other more cumbersome form Hence *S*s can make a direct comparison between sentences of the AA type and the relevant stored information, whereas for sentences of the other types they must transform either the stimulus sentence or the stored information before making the comparison The task of making the necessary transformations, which presumably takes time, would explain tendencies noted in the data The fact that these tendencies are not fully consistent throughout the data does not seem to be explicable in the light of the present studies

The first finding in the analysis of times for reading the longer sequences (Experiment 1) is in keeping with the rest of the study the perception of individual words as determined by speed reading of scrambled passages silently, does not differ significantly from French to English The finding that individual French words are articulated more slowly than the corresponding English ones is not unexpected (2) However, the observed difference is slight, coming to about 40 msecs per word On the other hand, in the simple texts on which they were tested, *S*s appeared to string words together in articulation as effectively in French as in English Finally, they made less use of the transition probabilities in French sentences than of those in English ones, thus adding about 30 msecs per word to their French reading times In other words, they were less able to avail themselves of the redundancy (7) in French in order to anticipate the sequence of words beyond the point at which they were reading These findings have the support of a similar set of findings for Irish-English bilingual children in Dublin (2)

In all, four of the seven main components in our initial analysis of reading yielded significant differences in the expected directions It would be foolhardly to place much confidence in the exact quantities in which these differences are expressed, except perhaps to observe that of the four the difference between times taken to determine the meanings of individual words in the two languages is the largest (in Experiment 1 it was 110 msecs) It is important to realize, however, that the four significant

findings are independent of each other That is, they are not several measures of the same difference between performance in the two languages, they are separate estimates of distinct difficulties Thus, in overall performance, the effect of these difficulties is cumulative, and in combination, they amount to a very substantial difference between performance in the two languages In assessing their importance, however, it is necessary to keep in mind the fact that *S*s were selected in such a manner as to highlight these difficulties We make no claim about the universality of the size of the differences, our only claim would be that where persons experience difficulty in reading a second language, the factors we have isolated are likely to be at work in producing the difficulty

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