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The link between vocabulary knowledge and spoken L2 fluency

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In spite of the vast numbers of articles devoted to vocabulary acquisition in a foreign language, few studies address the contribution of lexical knowledge to spoken fluency. The present article begins with basic definitions of the temporal characteristics of oral fluency, summarizing L1 research over several decades, and then presents fluency findings from a corpus of oral productions in three different L2s. Investigation of disfluencies in the corpus (the distribution of long hesitations and two types of retracing) reveal the fundamental role of 'lexical competence' in spoken fluency, which should, it is argued, be taken more thoroughly into account in our language-teaching programmes.

Speech production, fluency and disfluency

Since Meara's call almost 30 years ago (Meara 1980) for new research investigating foreign language (L2) lexical acquisition and use, the area of vocabulary studies has gradually grown into a 'minor industry' (Cobb 2002, 173). Within the fields of Applied Linguistics and Second Language Acquisition (SLA) research, there are hundreds of scholarly publications every year, special conferences and workshops, and even a major new journal (*The Mental Lexicon*, launched by John Benjamins in 2006). And yet, among all of these publications, very few studies have attempted to investigate the obvious link between lexical knowledge, or 'lexical competence', and real-time spoken fluency, no doubt because of the complexities of analyzing just what *is* going on when an individual performs the complex task of talking in a foreign language.

The processes involved in human speech are multiple and complex. In very basic terms, we can summarize these processes as the linguistic and discursive packaging of the ideas the speaker wants to express. According to Levelt's thorough and scientifically rigorous 'blueprint of the speaker', conceptual and discursive planning precede lexical, grammatical, and phonological encoding (Levelt 1999). Psycholinguists describe conceptual and discursive planning as 'higher-order' (meaning-related) processes, and the more formal aspects of linguistic encoding (lexical selection, morpho-syntactic and phonological encoding, as well as articulatory routines) as 'lower-order' processes. When we speak in our native language (L1), these formal processes are highly automatic. In other words, they occur without taking up attentional resources. In everyday conversation in our L1, for example, we do not have to 'pay attention' to how we are going to articulate a word, conjugate a verb, or place an adverb in an utterance. We may occasionally find

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ourselves actively 'looking for' a word or language form that momentarily escapes us, but this is relatively rare, considering how many thousands of words we produce in our L1 every day. Although some native speakers are more gifted at putting their ideas into words than others, all native speakers can be described as 'fluent' in the language they have been processing since birth.

Many motivated foreign language learners presumably wish to become 'fluent' in the L2 they are studying. But what does this mean, exactly? Language teachers, students, and the general public tend to use the word 'fluent' as a synonym for 'proficient', but then we have a hard time specifying just what makes one speaker more 'fluent' than another. Scientific research on spoken fluency uses the word in a much more limited sense, and the precision of this scientific concept turns out to be quite useful for identifying key determinants of spoken L2 proficiency.

The 'narrow' (Lennon 2000, 25) concept of fluency concerns time-related aspects of oral production: the number and length of pauses and other hesitations, their distribution, and the temporal rate at which words are produced. Psycholinguistic research in spoken production (Goldman-Eisler 1968; Kowal and O'Connell 1980; Beattie 1980; Good and Butterworth 1980; Levelt 1989) has established baseline figures for L1 fluency and disfluency: native-speakers produce from 130 to 200 words per minute (2–3 words per second), and about one-third of production time is spent pausing. Pauses are necessary not only to give the speaker time to organize his/her thoughts, but also to give the listener time to process incoming speech; longer pauses have been found to occur at the beginning of utterances or clauses, but rarely exceed two seconds in length. Clinical disfluency is defined as a speech rate of fewer than 50 words per minute; in disfluent speech, there are more pauses, which are longer, and distributed differently – chopping the speech stream up into shorter, less-coherent 'runs', from a syntactic or content-oriented point of view (Marshall 2000; Pawley and Syder 1983). Speech production is considered to have stopped when a hesitation exceeds three seconds (Griffiths 1991, 346); in interactive speech, a conversation partner will tend to intervene once a pause stretches beyond two seconds (Rieger 2003). 'Retracings', repetitions, reformulations, and restarts (when the speaker abandons the original syntactic structure to start the utterance over) often accompany silent and filled pauses and are another sign of encoding difficulties during the speech production process.

Research into hesitation phenomena in L2 speech has found mean length of run (MLR), or the average number of words produced by the speaker between two pauses, to be the most significant indicator of L2 fluency (Towell, Hawkins and Bazergui 1996). Other measures that are frequently considered to reflect L2 skill are mean length of utterance (MLU; measured in words or morphemes), and rate of error (numbers of errors produced per 1000 words, for example).

A corpus of L2 speech

At the Université de Savoie (in Chambéry, France), we have put together an oral corpus of productions by learners in three different L2s: English, French, and Italian (Hilton et al. 2008). The corpus was designed to include samples of spoken language by learners at different levels performing comparable tasks in different languages and is therefore entitled *PAROLE* (*PARallèle, Oral en Langue Etrangère*). The overall objective of the *PAROLE* Corpus is to identify the linguistic characteristics of different L2 proficiency levels, in the three project languages. A corpus of productions by native speakers performing the same tasks has also been compiled, as a source of 'benchmark' figures for fluent L1 speech. In addition to the speaking tasks, all non-native subjects took a battery of tests, designed to measure both L2 knowledge (grammar and vocabulary) and skill (L2 listening level), as well as aptitudes that may play a role in L2 learning (phonological memory, and grammatical analysis). They also completed a motivation questionnaire and a language profile sheet, and were remunerated for the time devoted to the project. For details concerning the tests, see Appendix 1.

PAROLE is being transcribed and analyzed with the *CHILDES* software suite (MacWhinney and Spektor 1995–2008). Because of our interest in spoken fluency, we have coded all types of hesitation phenomena, following the *CHILDES* transcription conventions (adapted when necessary). All pauses of more than 200 ms in length have been marked and timed, and the position of each pause coded. Filled pauses ('um', 'uh', 'er') and various paralinguistic noises used to buy time for speech production (sighs, tongue clacking, 'ahem') have also been carefully transcribed. When filled pauses and/or paralinguistic noises alternate with silent pauses in hesitation sequences (uninterrupted by the articulation of words) we have grouped them together, and timed the whole sequence. In addition to timing each hesitation, we have also coded its location in the speech stream: at the beginning/end of an utterance, at the beginning/end of a clause, or inside a clause. All retracings have been coded in such a way that they, too, can be counted, grouped and studied.

Methodology for this study

This article summarizes the findings from two of the corpus tasks, in both of which our subjects described a short video sequence immediately after viewing, with minimal intervention from the interviewer. These productions constitute relatively artificial, monologue-type tasks; we will therefore not comment on the interactional competence of our subjects, but rather on more finely-tuned issues of L2 processing, focusing primarily on aspects of lexical encoding.

To date, productions by 56 non-native speakers have been transcribed (and triple-checked): 33 subjects speaking English as an L2 (24 Francophones and 9 Germanophones), 11 speaking L2 Italian (all Francophones) and 12 speaking L2 French (native speakers of various L1s). Unfortunately (but predictably, since the data collection process was lengthy and complicated), not all of the subjects whose productions have been transcribed completed the entire test battery, in addition, transcriptions for the L2 Italian group are lagging behind those of the L2 English and L2 French groups; I will therefore indicate the exact numbers of subjects involved in each of the analyses presented later. All of the subjects were young adults (average age 21.5 years) attending university; all of the non-native speakers learned the project L2 initially in a secondary school setting, with 8 years of L2 study on average (ranging from a low of 6 months, for two of the L2 French learners, to a high of 14 years for one of the L2 English learners).

Computerized analyses of the transcriptions have enabled us to establish certain basic calculations for each speaker: total production time, total time spent hesitating, total number of hesitations, total number of retracings, total number of words produced, number of utterances. These figures, in turn, enable us to determine the basic measures of temporal L2 fluency: speech rate (expressed as words per minute), MLR, mean length of hesitation, percentage of production time spent hesitating, average hesitation times at various locations in the speech stream, and rates of hesitation and retracing (number of hesitations per 1000 words, number of repetitions, reformulations and restarts per 1000 words). We have also calculated the two other classic indicators of spoken performance: MLU (in words), and error rate (errors per 1000 words).

The fluency measures obtained for each speaker enable us to identify two extreme learner sub-groups (within the pool of all 56 non-native speakers): a disfluent sub-group, composed of our 15 most hesitant L2 speakers (those who spent more than 52% of their production time hesitating); and a fluent sub-group, composed of the 15 least hesitant learners (less than 33% hesitation). The performance of these two sub-groups will be compared with the 'benchmark' group of 23 native speakers, giving a range of temporal fluency values for spoken production.

Findings from *PAROLE*

Quantitative analysis of the relationship between language knowledge (as measured by our test battery) and the temporal features of our subjects' productions shows a clear relationship between what students know about the L2 and how fluently they are able to use this language in monologue-type productions. Table 1 presents the correlations between the language test scores and our fluency measures for the 47 non-native speakers who completed all the tests. The first three lines of results give positive fluency measures, and we see positive correlations here between language knowledge and spoken fluency: for example, vocabulary knowledge 'correlates positively' with speech rate, as measured in words per minute – the more words you know, the more fluently you are able to speak. The last five lines of the table present correlations between language knowledge and negative production measures (indicators of hesitation and error), and here the correlations are negative: grammatical knowledge 'correlates negatively' with error rate (since the more grammar you know, the less likely you are to make morpho-syntactic errors). In most cases, the correlations in Table 1 confirm what every language teacher knows intuitively – the more you know about the language, the better you speak it. It is, of course, nice to have quantitative corroboration of our professional hunches. What language teachers are perhaps less likely to appreciate, due to a centuries-old European tradition of grammar-centred language teaching, is the significant correlation between vocabulary knowledge and all of the measures of spoken productivity included in Table 1, in particular the temporal fluency measures – words per minute, mean length of run, percentage of hesitation, and rate of hesitation.

Table 1. Rank correlations (Spearman's rho) between language tests and fluency indicators of non-native speakers.

Fluency indicator (as measured in *PAROLE*)	Vocabulary test (DIALANG) $n = 47$	Grammar test (DIALANG) $n = 47$
Mean length of utterance (in words)	.425*	.512**
Words per minute	.581***	.679***
Mean length of run	.668***	.733***
% of speaking time spent in hesitation	−.551**	−.593***
Mean length of hesitation	−.390*	−.472*
Rate of hesitation (per 1000 words)	−.661***	−.728***
Rate of retracing (per 1000 words)	−.516**	−.566***
Rate of error (per 1000 words)	−.657***	−.696***

*$p < .01$; **$p < .001$; ***$p < .0001$.

If we look more closely at the same fluency measures for our sub-groups (disfluent learners, fluent learners, and native speakers), we can see that the productions by the two learner sub-groups display very different temporal characteristics. Table 2 presents the average value of the performance measures for each of the three sub-groups, as well as the minima and maxima, and the statistical significance of a one-way analysis of variance between the groups. Once again, the first three measures presented in the table constitute positive fluency indicators, and the last five measures are negative indicators.

The performance of the disfluent learner group recalls certain characteristics of clinical L1 disfluency: a median speech rate of just over 50 words per minute, and well over half of production time spent in hesitation, with pauses interrupting the speech stream every two words or so. The disfluent median for average length of pause is a full second longer than the native speaker median; six of our disfluent subjects exhibit an average length of hesitation exceeding two seconds (the discomfort threshold in normal L1 conversation). There is no overlap between the minima and maxima observed for the two learner sub-groups on the time-related measures, illustrating the very different temporal characteristics of their L2 speech. We do observe slight overlap on the non-temporal production measures: MLU, rate of retracing, and rate of error. These measures may be less clear-cut indicators of spoken fluency (in the narrow sense).

Despite the differences between the fluent learners and the native speakers, there is overlap in the minima and maxima obtained by these two groups in all of the measures – illustrating the fact that the most fluent L2 speakers attain the temporal values and wider production characteristics of native speech. Many of the differences between these two groups are relatively small (100 ms or so in the mean length of hesitation, for example),

Table 2. Comparison of production measures for the *PAROLE* sub-groups (group medians, minima, maxima, and Kruskall–Wallis analyses of variance).

	Native speakers (n = 23)	Fluent learners (n = 15)	Disfluent learners (n = 15)	Between-group comparisons (Kruskall–Wallis analysis of variance)
Mean length of utterance (in words)	16.6	12.1	7.8	$H(2) = 30.98^{***}$
(*minimum–maximum*)	(*10.6–24.8*)	(*7.25–30*)	(*4.2–11.9*)	
Words per minute	165	130	52	$H(2) = 39.65^{***}$
(*minimum–maximum*)	(*131–245*)	(*91–173*)	(*18–71*)	
Mean length of run (in words)	8.1	5.3	2.4	$H(2) = 39.72^{***}$
(*minimum–maximum*)	(*5.3–13.6*)	(*4.3–9.4*)	(*1.5–3.4*)	
% speaking time in hesitation	21.9	29.3	61.9	$H(2) = 38.05^{***}$
(*minimum–maximum*)	(*9.2–33.2*)	(*19.7–32.5*)	(*52.1–83.2*)	
Mean length of hesitation (in seconds)	0.623	0.730	1.628	$H(2) = 36.74^{***}$
(*minimum–maximum*)	(*0.473–0.912*)	(*0.678–0.929*)	(*1.213–5.022*)	
Rate of hesitation (per 1000 words)	120	186	403	$H(2) = 40.02^{***}$
(*minimum–maximum*)	(*68–180*)	(*103–223*)	(*279–645*)	
Rate of retracing (per 1000 words)	38	45	129	$H(2) = 22.89^{***}$
(*minimum–maximum*)	(*6–96*)	(*13–138*)	(*49–241*)	
Rate of error (per 1000 words)	8.8	74.4	216.8	$H(2) = 34.46^{***}$
(*minimum–maximum*)	(*0–24*)	(*18–186*)	(*128–314*)	

Note: $^{***}p < .0001$.

and would probably go unnoticed or happily tolerated in a conversational exchange between native speakers and foreign acquaintances.

Now that we have quantitatively established the (somewhat obvious) fact that disfluent L2 speakers hesitate longer and more frequently than fluent speakers, we need to investigate the more interesting question of *why* our subjects, fluent and disfluent alike, pause where they do. We did not run a 'think-aloud' debriefing session with the subjects immediately after recording them (to get their impressions of why they hesitated at certain points in each task), so we can only answer this question by examining the hesitations in the corpus, and drawing careful conclusions from what we observe. The analysis of pause location, or *where* the speakers hesitate, is particularly revealing.

Chi-square analyses of the distribution of the hesitations produced by each sub-group of subjects ($n = 1952$ hesitations in all) reveal that the hesitations are not distributed in the same fashion among the three possible locations that have been coded in *PAROLE* (between utterances, between clauses, or within a clause), but vary according to sub-group: $\chi^2(4) = 74.6$, $p < .0001$. *Post-hoc* analyses show that the precise difference lies in the greater number of within-clause hesitations produced by the disfluent learners. Our native speaker subjects pause 72% of the time at utterance and clause boundaries – that is, between ideas or coherent syntactic units – and only 28% of the time within a clause. These percentages shift for the learner sub-groups, with over half (52%) of the disfluent sub-group's hesitations situated within a clause. Previous research has found that hesitations interrupting conceptual or syntactic units are perceived as disfluent (Pawley and Syder 2000, 170); more frequent clause-internal hesitations appear to be characteristic of L2 production, and particularly of disfluent speech. It is therefore important to try to identify what provokes these non-native-like breaks in spoken L2 production.

Lexical competence and fluency

It might be assumed that hesitations in spoken L2 production are generated in equal parts by various deficiencies in L2 knowledge and skill; this assumption, however, is not corroborated by the findings in *PAROLE*. Based on existing L1 research, we consider all hesitations lasting over three seconds as disfluent (Goldman-Eisler 1961, 234); in *PAROLE* to date, there are 166 hesitations of this type in all, 88 (53%) of which are situated within a clause. For each of these clause-internal disfluent hesitations, we have coded the syntactic location of the break, and the word immediately following it. Table 3 presents the extrapolated causes of all of the major fluency breakdowns within a clause based on the nature of the item immediately following the hesitation. This word might

Table 3. Probable cause of disfluent clause-internal hesitations in *PAROLE* (learner corpus).

Hesitation immediately followed by ...	n	%
a lexical error	28	78.3
an overt lexical search	26	
a probable lexical search	15	
combined lexical and morphological errors	3	3.4
a morphological error	6	6.8
a phonological error	2	2.3
a syntactic error	1	4.5
a syntactic reformulation	3	
unidentifiable	4	4.5

constitute a lexical, morphological, syntactic or phonological error (a key to the transcription symbols used can be found in Appendix 2):

> *002: #0_574 he's uh wearing the same <u:h # &=bouche> [#2_146] sweat [* lexical error for *sweater*] than [. . .] when he was a child.
>
> *008: #0_476 and uh [#0_336] the fridge <u:h #> [#3_280] fall [* morphological error for *falls*] [. . .].

The hesitation might also be followed by what we are calling an 'overt lexical search' – that is, an avowed incapacity to retrieve the necessary lexical item, or a direct request for the word:

> *002: a fridge #0_511 which <u:h # &=bouche #> [#7_664] +. . . (be)cause I [/] I don't know uh how [/] #0_383 how we say uh *monter*.

It might also be directly followed by a correct low-frequency L2 word – like *crane* or (elephant's) *trunk*, or a generic term in place of the more precise, low-frequency word that is used by our native speakers (*animal* and *machine* for the English *elephant* and *crane*, or *fête* [party] for the French *défilé* [parade]). Since we know that the retrieval of a low-frequency word takes longer than the retrieval of a high-frequency word (Beattie and Butterworth 1979), these hesitations are coded 'probable lexical search'. Other disfluent hesitations are followed by phonological, morphological, or syntactic errors, or syntactic reformulations. Table 3 illustrates the important fact that problems with lexical retrieval apparently account for 78% of the disfluent clause-internal pauses in our learner corpus.

The finding that long clause-internal hesitations are linked to problems with lexical encoding is not new; it was suggested by Maclay and Osgood back in 1959 (see also Levelt and Maassen 1981, 250). It is, therefore, quite surprising that studies of the impact of lexical knowledge on spoken L2 fluency have been almost completely absent from SLA research.

The remaining 47% of the disfluent hesitations in the *PAROLE* learner corpus are found at utterance or clause boundaries, that is, at boundaries between ideas. It is quite difficult to 'code' the sometimes complex chunks of speech that follow these breaks in production, and therefore difficult to interpret precisely the cause of these disfluencies. L1 research has traditionally considered utterance boundary hesitations as discourse-planning pauses, and clause boundary hesitations as reflecting both discursive and linguistic encoding processes (Goldman-Eisler 1968; Butterworth 1980); we hope that future coding of the propositional content of each subject's productions will help us understand the boundary hesitations in *PAROLE*. What we can observe concretely at the moment is that 30% of disfluent hesitations at utterance boundaries and 24% at clause boundaries could be related to lexical encoding difficulties since the ensuing phrases contain overt lexical searches or lexical errors with key content words.

If problems with lexical retrieval generate most of the disfluent hesitations in the corpus, what exactly happens when learners have problems with morphological, phonological, or syntactic encoding? Errors in these domains in fact generate less disfluency: 80% of the morphological errors in our fluent learner corpus are smoothly integrated into the speech flow, without any preceding pauses or retracings; this is the case for all but a few phonological errors, whatever the learner's level. When they do generate disfluency, morphological or syntactic 'searches' are characterized by retracings, some simple repetitions (coded [/]), but especially reformulations (coded [//]), accompanied by relatively short pauses:

> *020: <&=bouche #> [#0_563] and #0_383 the elephant actually slap [*] [/] #0_220 slap [//] slaps him #0_493 in the face [. . .].
>
> *406: eu:h [#0_836] <je vois> [//] uh [#0_250] j' ai vu [. . .]
>
> *027: [. . .] a:nd <# uh> [#0_842] you see [//] can see a little boy [. . .].

We do see pauses in these lines (represented by the # symbol), but we can also see that groping about for the appropriate grammatical form, be it morphological or syntactic, generates disfluencies which are different from the hesitations accompanying problems with lexical retrieval. When L2 speakers search for proper morpho-syntactic forms, producing reformulations, filled pauses and short pauses, they do not stop talking. Therefore, we do not see with this type of error the extremely long hesitations (literal breakdowns in spoken production) that the lack of lexical knowledge seems to provoke. Table 3 shows a total of six disfluent pauses in *PAROLE* occurring before a morphological error (average length just over four seconds); it is interesting to note that in five of these cases, the ensuing error involves a morphologically 'irregular' English word (the verbs *to fall, to eat, to hit*, and the noun *child*). Pinker has, of course, hypothesized that such forms are stored and retrieved lexically, rather than generated analytically (Pinker 1999).

If we adopt Meara's (1996, 1999) definition of lexical competence as not only the quantity and structure of knowledge we have about an L2 lexicon but also our capacity to use these words in on-line language processing – the much-neglected concept of 'lexical access' (Meara 1999, 5) – we can see that our disfluent learners are sorely lacking in all three 'dimensions' of lexical competence (Henriksen 1999). Their L2 vocabularies are very small – 2800 words on average for the disfluent L2 English group (with a minimum of 1800 words) after seven years of study. Our most fluent English learners have vocabulary of close to 12,000 words, as measured by the English vocabulary-size test (Hever n.d.; unfortunately unavailable in the other project L2s). As we have seen, a word 'missing' from the L2 lexicon can severely impair spoken fluency, even causing a complete breakdown in the formulation of meaning.

It is true, of course, that the disfluent learners appear to be lacking not only in vocabulary, but in strategies they can use to compensate for missing lexical items. Eleven of the 15 disfluent speakers get 'stuck' over their gaps in lexical knowledge, and ask the interviewer directly for the word (as they probably would in a classroom situation):

> *207: sulla video vediamo <uh #> [#1_660] che [/] <u:m # &=bouche #> [#2_328] che una [//] #5_544 uno [//] <um # &=rire #> [#2_764] +. . . une machine comment on dit ? [*How do you say* '*machine*?']

This is, of course, an acceptable strategy if your interlocutor happens to speak your native language, but it is time-consuming, and unrealistic in many communication situations. Our more competent speakers have learned how to get around the problem – although compensation strategies also interrupt the speech stream:

> *027: <&=bouche #> [#0_841] so we can see u:m [#0_667] some men #0_354 trying to: [/] #0_372 to get a fridge into the house.
>
> <&=bouche #>[#0_401] an(d) <it's like> [/] <yeah it's like> [//] u:m [#0_429] it's a machine <to get it &u> [/] to get it up #0_354 to the: [/] to the room. [12.8 seconds]

This is a strategically effective paraphrase for *crane*, but it takes almost 13 seconds for the speaker to encode her idea. Compare the time it takes two other speakers (one fluent learner, one native-speaker) to summarize the same video sequence, with the right words available:

> *025: <&=bouche # um> [#1_196] so &th the fridge was lifted by #0_279 a crane or whatever it was. [5.265 seconds]
>
> *N01: <&=bouche #> [#0_685] there's a #0_372 crane manoeuvring a fridge up to a window. [3.922 seconds]

Proponents of a strategy-based approach to L2 skills work argue that the best solution for the problem of missing lexical knowledge is teaching the students useful compensation strategies; this has certainly been the view in much communicative-based methodology, as summarized by Dörnyei and Thurrell (1991): 'The lack of fluency or conversational skills that students often complain about is, to a considerable extent, due to the under-development of strategic competence' (16). Although we acknowledge the importance of strategic 'meta-skills' in L2 production and reception, we would maintain that time-consuming compensation for missing lexical items simply cannot compare with the extreme communicative efficiency of having the right word accessible at the precise moment of encoding (either receptive or productive). Once again, we can compare the temporal fluency of two attempts at encoding the same idea. The process is extremely laborious for a disfluent learner, who takes 41 seconds to encode a single, relatively simple idea, relying heavily on lexical support from the interviewer:

> *002: and<u:h # &=bouche> [#2_415] the result is<e:r #> [#0_981] that uh the fridge <# &=bouche #> [#8_203]+ ….
>
> *002: I uh don't know uh […] uh &=rire *tomber*.
>
> *INV: falls down.
>
> *002: *tomber* ?
>
> *INV: mhmm falls down.
>
> *002: falls down.
>
> *INV: mhmm.
>
> *002: <e:r # u:m> [#6_242] falls down <u:h # &=bouche> [#2_182] *sur*<# &=bouche #> [#5_912]+ …
>
> *INV: onto.
>
> *002: on [/] on the: [/] the car.

A fluent learner, with the appropriate L2 lexical items available for effective on-line encoding, can formulate the same idea in 5.8 seconds:

> *025: #0_582 and in the end <# uh> [#0_395] the fridge fell #1_138 on a car &=rire.

Compensation strategies can certainly be helpful for L2 learners, but they cannot replace a solid L2 'mental lexicon' – with lots of words, readily accessible for on-line language processing.

We have not yet undertaken the analysis of another extremely important aspect of linguistic competence in *PAROLE*, the use of 'formulaic' language (Wray 2000) by our native and non-native speakers. Formulae are those groups of words that co-occur regularly in a language, ranging from idiomatic expressions and clichés, through collocations, to simple recurring sequences, such as 'turn off the light', or 'fall on + noun' (in the example above). The relationship between formulaic knowledge and spoken fluency was attested to long ago in L1 studies:

> Fluent speech was shown [in our experimental results] to consist of habitual combinations of words such as were shared by the language community and such as had become more or less automatic. Where a sequence ceased to be a matter of common conditioning or learning, where a speaker's choice was highly individual and unexpected, on the other hand, speech was hesitant. (Goldman-Eisler 1958, 67)

Knowing the collocational behaviour of L2 words is an important dimension of lexical competence (Pawley and Syder 1983, 215; Schmidt 1992, 378; Wood 2004), yet researchers are just beginning to develop methods of researching this crucial aspect of L2 proficiency. Using MLR as a rough indicator of the presence or absence of formulae in our corpus, we can hypothesize that disfluent learners, and especially those exhibiting a MLR of fewer than two words, are severely lacking in formulaic knowledge: by definition, runs of two words or fewer must be non-formulaic. One of the next important steps in SLA research will be identifying which types of pedagogical activities help learners to increase their productive use of L2 formulae and the relationship between this knowledge and aspects of spoken fluency such as MLR.

Conclusions for language teachers

Throughout our discussion of fluency features in *PAROLE* we have touched on the issue, clearly stated by Goldman-Eisler in the earlier quotation, of the importance of automatic processes in competent language processing. Ever since the Communicative Approach turned its back on the behaviourist precepts of the Audiolingual Method, the words 'automatic' or 'repetition' have been more or less absent from the language-teaching classroom, and even considered by some as pedagogical heresy; repetitive exercises being just the sort of 'learning' activities that Krashen frowned on as being 'inefficient' and artificial, compared with the powerful processes of 'natural' 'acquisition' (Krashen 1981; Krashen and Terrell 1983). Recent memory-based accounts of second-language acquisition and processing (for example, Hulstijn 2002; Segalowitz 2003; Ellis 2006) have inevitably rehabilitated these fundamental cognitive principles: there is no memorization without repetition (in any domain, including L1 development), and much of language (the L1 mental lexicon, for example) is declarative information efficiently stored in long-term memory. Memory-based accounts of language processing can help us understand important aspects of language fluency: 'Fluency can ... be described as the control of mostly automatic processes by selective attention in the service of intentional goals' (Schmidt 1992, 366). If a speaker's attention is monopolized at the 'lower' (formal) level, where processes of lexical selection, morphological formulation, or even articulatory gesture have not been automatized through extensive repetition, the fluent exchange of 'higher'-level meaning will be impossible, or at least time-consuming, and laborious.

We hope that our inventory of fluency and disfluency features in a spoken L2 corpus has illustrated just *where* communication breaks down, and why: 'Hesitations are especially useful in showing us where it is easy to move on [in speech production] and where it is difficult' (Chafe 1980, 171). The findings from *PAROLE* would suggest that lexical knowledge is the greatest impediment to spoken L2 fluency, at least from a temporal point of view, since lack of lexical knowledge, or of access to this knowledge would appear to be the primary cause of the most serious disfluencies in the *PAROLE* corpus (those long breaks in the production of L2 speech that our interviewers felt quite uncomfortable about leaving unfilled). These results underscore the importance of an ambitious lexical syllabus in all L2 classrooms. It appears crucial for spoken production (and certainly for L2 listening as well), to encourage our learners to build up the biggest possible L2 lexicon, organized for optimal access during on-line encoding. In agreement with Meara (1980), we feel that secondary language classes should target the acquisition of at least 1000 words per year (Meara proposes 2000). This should be no great hardship for a human brain which is extremely good at lexical acquisition, as attested by the 'lexical explosion' in which children between the ages of 2 and 11 years acquire tens of thousands of L1 words. Instruction in strategic meta-skills (such as lexical compensation) is certainly a part of the language-teaching curriculum that is here to stay, but perhaps a more fundamental part of fluency training is making sure that automatic access to appropriate language knowledge is functional, so that heavy reliance on time-consuming compensation strategies will not be necessary.

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Appendix 1. Complementary tests and questionnaires completed by all non-native subjects, *PAROLE* corpus.

Type of test	Name of test	Remarks
Computerized listening test (all languages)	DIALANG *Listening Test* (www.dialang.org)	Static test version used
Computerized grammar test (all languages)	DIALANG *Structures Test*	Static test version used
Computerized vocabulary test (all languages)	DIALANG *Vocabulary Test*	Static test version used
Computerized vocabulary size test (French and Italian)	DIALANG *Placement Test*	Yes–no vocabulary test
Computerized vocabulary size test (English)	B. Hever (n.d.), *General English Vocabulary Test*, ForumEducation	'Ordinary level' used; test available only in English
Phonological memory (administered individually)	Tests adapted from: Casalis, S. 2000. *Répétition de logotomes*. Lille, France: Université de Lille	Used as an L1 test with French learners of English and Italian; as an L2 test with contributors to the French learner corpus.
	Gathercole and Baddeley. 1996. *The Children's Test of Nonword Repetition*. London: Psychological Corporation	Used as an L2 test with contributors to the English learner corpus.
	Sartori, G., R. Job, P.E. Tressoldi. 1995. *Batteria per la valutazione della dislessia e della disortografia evolutiva*. Firenze, Italy: O.S.	Used as an L2 test with contributors to the Italian learner corpus.
Computerized grammatical analysis test	Meara, Milton and Lorenzo-Dus. 2001. Test C, *Language Aptitude Tests*. Express Publishing	
Motivation questionnaire	Adapted from Gardner. 2004. *Attitude & Motivation Test Battery*. University of Western Ontario.	
Linguistic profile sheet	Created by the Université de Savoie for this (and other) projects.	Available upon request.

Appendix 2. Key to transcription symbols.

#	indicates a silent pause
#0_743	silent pause lasting 743 ms
#1_208	silent pause lasting 1.208 s
&=bouche	paralinguistic noise (such as a tongue clack, or sigh of frustration)
<# &=bouche um #> [#5_912]	chains of hesitation phenomena are 'scoped' as one hesitation group, and total time elapsed coded in brackets
:	indicates vowel lengthening (a 'drawl')
&f	phonological fragment or stutter
[/] [//]	retracings are coded with a variety of slash symbols between brackets
[*]	indicates an error (immediately preceding the symbol)
&=rire	a laugh/laughter
+...	'trailing off' (utterance may be left unfinished)