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Sensitivity to Sonority for Print Processing in Normal Readers and Dyslexic Children

- 1 Dyslexic children exhibit great difficulties in acquiring reading skills, despite adequate intelligence and instruction and in the absence of obvious neurological or sensory disorders. Subtle deficits in visual (Lovegrove, Martin, & Slaghuis, 1986 ; Stein & Walsh, 1997) or in auditory processing (Shulte-Körne et al., 1998 ; Tallal, 1980) are assumed to underly these disabilities in reading acquisition. According to another view, there may be a linguistic/phonological component to deficits in dyslexia (Rosen & Manganari, 2001). Cognitive deficits in the representation and use of phonology are assumed to entail poor phonemic awareness and deficient segmental analysis of verbal stimuli (Duncan & Johnston, 1999). This study assesses syllabic segmentation of printed stimuli in French dyslexic children.
- 2 Syllabic units have been supposed to have a major impact, especially in French (Kaye & Lowestamm, 1984). For instance, French speakers have been shown to segment English in syllabic units whereas English speakers do not use syllables for French word processing (Cutler, Mehler, Norris & Segui, 1986). Similarly, for French-English bilingual speakers, only French-dominant subjects exhibit a syllabic segmentation restricted to French (Cutler, Mehler, Norris & Segui, 1992). Additionally, syllable priming effects are common in speech production in French (Ferrand, Segui & Grainger, 1996), but neither in Dutch nor in English (Schiller, 1998, 1999). Nevertheless, other results challenged these claims about syllable effects and French specific sensitivity to syllables. Firstly, the importance of syllabic structure has been evidenced in other languages. Indeed, Content, Dumay and Frauenfelder (2002) emphasized the similarity between their syllable effects in French and other findings in Dutch and English. Additionally, despite English is said to have stress rhythmicity, experiments conducted in English about illusory conjunctions showed that, in two-coloured five letters stimuli, subjects tended to attribute the colour of the target letter in accordance with the colour of the syllable in which it was embodied (Printzmetal, Treiman & Rho, 1986). Secondly, the classical syllable effect reported by Mehler, Dommergues, Frauenfelder, and Segui (1981) for segment detection in French has not been replicated, except in case of accurate phonotactic syllable organisation (Content, Meunier, Kearns & Frauenfelder, 2001). The syllable onset seems more reliable in speech perception, probably as alignment point for lexical search in speech processing. Moreover, the onset appears independent from the preceding syllabic offset, since ambisyllabicity has been observed in French (Content, Kearns & Frauenfelder, 2001 ; Leclercq, Content & Frauenfelder, 2002). Therefore, the notion of unique juncture syllabic point (and of perceptual syllabic code) is questioned, and sub-phonemic characteristics such as sonority (and phonotactic rules) may guide the cognitive organisation of speech, and maybe of strings of letters.
- 3 In reading, sonority effects have still been evidenced in adult good readers. English readers exhibit sensitivity to sonority for the internal organisation of printed rimes within monosyllables (Gross, Treiman & Inman, 2000), whereas French readers exhibit this sensitivity only for bi-syllabic stimuli (Bedoin & Dissard, 2001). Sonority (or vowel-likeness) is a phonetic aspect of phonemes, correlated with the degree of articulatory opening (Selkirk, 1982) : liquid and nasal consonants are classified as sonorant, whereas stop consonants are obstruent. In English, high sonority of the postvocalic consonant in CVCC pseudowords enhances its cohesion with the vowel within the rime in speech perception (Treiman, 1984), speech production (Stemberger, 1983), short-term memory (Treiman & Danis, 1988), spelling (Treiman, Zukowski & Richmond-Welty, 1995), and reading. Indeed, the letter T is better

detected in *vult* (sonorant postvocalic /l/) than in *vuct* (obstruent postvocalic /k/) (Gross et al., 2000). In French, sonority is not used to process monosyllabic pseudowords (Bedoin & Dissard, 2001), but sonority structure of the syllabic boundary has been shown crucial for CVCCVs processing (Bedoin & Dissard, in press). For instance, the letter T is better detected in *vulti* than in *vucti*. This is in line with a phonotactic rule according to which syllable sequence is better when the end of the first syllable is more sonorant than the beginning of the subsequent one (Murray & Vennemann, 1983). Sensitivity to sonority organisation of polysyllabic stimuli is congruent with speech perception data showing better detection of CVCs if compatible with the initial syllable of the bearing-word, only if the coda is a liquid (Content, Meunier, Kearns & Frauenfelder, 2001).

- 4 First, this research further assesses the sensitivity of adult French readers to sonority in printed bisyllabic stimuli. As in many illusory conjunction experiments (Printzmetal, Hoffman & Vest, 1991 ; Rapp, 1992), subjects had to recall the colour of a target letter within a briefly presented two-coloured pseudoword. The distribution of colours was either compatible with the syllabic structure or not. Performances were predicted to be improved by colour-syllable compatibility, only if the syllabic boundary was clear in terms of sonority. When the coda of the first syllable is more sonorant than the onset of the subsequent syllable (e.g., *vulti*), the vowel-coda cohesion will be stronger, leading to a detect an inaccurate colour repartition. The second aim was to investigate dyslexic children sensitivity to sonority in reading.

Experiment

Method

Participants

- 5 Every subject was native French speaker, right-handed, and had normal or corrected-to-normal vision. 24 University Lyon 2 students composed the group of adult skilled readers. 15 dyslexic children (mean age = 8.6 years, $SE = 1.8$) have been tested in Lyon-Sud Hospital (53% suffered from phonological dyslexia, 40% from mixed dyslexia, and 7% from surface dyslexia). Their reading age was at least 18 months behind their chronological age (Lefavrais, 1967). Each one was paired in reading level and sex with a control child with average reading level (mean age = 7.8 years, $SE = 0.4$).

Material

- 6 The list of experimental stimuli contained 144 CVCCV bisyllabic pseudowords. Each stimulus contained five letters mapping onto five different phonemes. Target letter was third letter (i.e., the coda of first syllable). In 72 stimuli, it was a liquid (/l/ or /R/, respectively, L or R), providing optimum syllabic contact. In 72 stimuli, it was an obstruent (/p/ or /k/, respectively P or C), providing fuzzy syllabic contact. Bigram frequency of coda + onset (components of syllabic boundary) at the beginning of words was nil in both optimum and fuzzy contact conditions ; at the end of words, the bigram frequency of this letters pair was 45.3 ($SE=82.4$) in optimum contact condition and 24.7 ($SE=39.8$) in fuzzy contact condition ; in median position, it was 121.5 ($SE=136.3$) and 104.4 ($SE=153.6$) respectively in optimum and fuzzy contact conditions. The onset of initial syllable (/b/, /m/, /n/, /v/, /z/) and the vowels (/o/, /i/, /u/, /a/) were equally distributed among conditions. Mean orthographic neighbourhood was 0.22 in optimum contact condition and 0.08 in fuzzy contact condition. In half of stimuli, the first letters were printed in red and subsequent ones in green. In the other half, it was the opposite. The syllable boundary was respected by colour distribution in Compatibility condition (e.g., **VULTI**, **VUCTI**), but not in Incompatibility condition (e.g., **VULTI**, **VUCTI**). Therefore, the target was always concerned with colour boundary. Additionally, 288 filler trials were used, requiring to detect the colour of second or fourth letter.

Procedure

7 Each participant was tested individually and sat in front of a Macintosh iBook, at a distance of 57 cm from the screen. Each trial began with the presentation of five stars (*****), at the centre of the screen, for 800 ms, replaced immediately with the lower-cased two-coloured pseudoword, covering 4° of visual angle and remaining on the screen for 66 ms. Then, a black upper-cased target letter was presented 1.8° below the previous stimuli, until the subject pressed one of the response keys to indicate the colour of this letter within the pseudoword, as fast and as accurately as possible.

Results

8 A two within-subject factors (Coda sonority: sonorant, obstruent; Colour-syllable compatibility: compatible, incompatible) repeated measures ANOVA was conducted on mean response times (RTs) and on error rates (ERs) for each group. Data are summarized in Table 1.

9 *In adults*, colour-syllable compatibility improved performances on ERs, $F_1(1,23)=5.75$, $p=.025$, $F_2(1,70)=3.90$, $p=.052$ and on RTs, $F_1(1,23)=12.82$, $p=.002$, $F_2(1,70)=64.36$, $p=.0001$. Sonority X Compatibility interaction was significant on ERs, $F_1(1,23)=10.50$, $p=.004$, $F_2(1,70)=3.41$, $p=.069$. Colour-syllable compatibility decreased ERs only if the coda of first syllable is liquid, $F_1(1,23)=23.27$, $p=.0001$.

10 *In dyslexic children*, a Sonority X Compatibility interaction can be noticed on ERs, $F_1(1,15)=11.02$, $p=.005$, $F_2(1,70)=4.30$, $p=.042$. Colour-syllable compatibility improved performances if the coda of first syllable was liquid, $F_1(1,15)=6.70$, $p=.021$, whereas it decreased performances if the coda was obstruent, $F_1(1,15)=4.44$, $p=.052$. No effect was observed on RTs. No analysis was conducted on sub-groups of dyslexic children (phonological, surface and mixed dyslexia), because children were unequally reparted into these categories.

11 *In control children*, no effect was observed, neither on RTs nor on ERs.

Table 1 : Mean Response Time (RT) in Milliseconds and Percentage of Errors with Standard Errors (SE) in Adults, in Dyslexic Children and in Control Children

Group	Coda of first syllable in CVCCV	Colour-syllable compatibility			Colour-syllable incompatibility				
		RT	SE	% Error	SE	RT	SE	% Error	SE
Adult									
Skilled Readers	liquid	1185.62	41.02	8.33	1.25	1339.00	75.11	15.51	1.90
	obstruent	1193.66	45.40	12.50	1.56	1305.06	69.94	12.85	2.00
Dyslexic Children									
	liquid	1855.76	145.60	33.15	3.68	1853.33	145.53	40.62	3.48
	obstruent	1813.46	149.21	42.01	3.80	1802.41	133.51	35.93	3.76
Control Children									
	liquid	2198.55	183.76	38.71	3.88	2020.86	156.64	42.03	4.57
	obstruent	1844.74	169.98	39.43	3.88	2047.63	145.65	42.60	4.28

Discussion

12 In adult readers, the main finding in this experiment was a greater effect of colour-syllable compatibility in case of optimum phonotactic contact between syllables. This effect may be explained by the sensitivity of readers to the incompatibility between the colour distribution and a *strong* vowel-coda cohesion. Indeed, inaccurate colour distribution decreased the recall

of the colour of the coda, only when this vowel-consonant affinity was high enough to provide a clear offset for the first syllable. Therefore, in printed stimuli, the vowel-coda cohesion is enhanced when the coda is high in sonority (i.e., liquid), leading to a clear-cut syllable boundary. This may explain why bisyllabic stimuli, which respect the phonotactic rule about optimum syllable sequence seem to be spontaneously splitted into CVC.CV syllables, a segmentation that might be assessed as incompatible with the inaccurate colour distribution. This result argues for the importance of phonotactic rules in the organisation of printed stimuli, as previously demonstrated for speech perception (Content et al., 2001).

13 When phonotactic rules were not respected (i.e., the coda of first syllable was not higher in sonority than the onset of second syllable), the vowel-coda cohesion appears to be not strong enough to be perceived as incongruent with any colour distribution. This may explain why performances for such stimuli were affected by colour-syllable only for response times, but not for response accuracy. Taken together, data in adult good readers provide new evidence for the sensitivity of French readers to sonority in reading. This is in accordance with a previous experiment, in which subjects were required to detect the *onset* of the *second* syllable (Bedoin & Dissard, 2001 ; Bedoin & Dissard, in press), whereas they had to recall the *colour* of the *coda* within the *first* syllable in the present experiment. Despite special attention paid to digram frequency and orthographic neighbourhood in stimuli choice, it is difficult to pit phonotactic rules against distributional regularities, and the results require cautious interpretation. Nevertheless, results from both experiments converge in suggesting that adult French readers are affected by consonant's phonetic characteristics to organise the syllabic boundary within bisyllabic stimuli in reading.

14 In dyslexic children, colour-syllable compatibility affected performances in the same way as in adult skilled readers, for bisyllabic stimuli respecting phonotactic rules. These suggest that, like adults, they perceived the strong vowel-coda cohesion based on phonotactic characteristics. Although dyslexic children are assumed to have difficulties in phonological processing, they appear to be sensitive to phonetic characteristics of printed stimuli. On the contrary, colour-syllable compatibility did not affect control children's performances. Colé, Magnan and Grainger (1999) also failed to observe any syllable compatibility effect in first graders. Although mean age of our control children was an year higher than mean age in Colé et al.'s study, they were probably not trained enough at reading to allow much importance to phonotactic rules, to organise the string of letters. This is in line with Seymour and Duncan (1997), who claimed that the units used by young readers progressively grow from phonemes to larger units. Longer academic instruction and orthophonic reeducation in dyslexic children had probably developed their tendency to organise letters into a reduced number of units, that partly respect phonotactic rules.

15 Dyslexic children clearly differed from both control children and adult skilled readers for fuzzy syllable boundary processing, since CV.CCV colour distribution improved their performances. Therefore, dyslexic children exhibited sensitivity to sonority organisation of syllable boundary in reading, but anomalies in the application of phonotactic rules can be noticed. First, the phonotactic rule about optimum syllabic contact is too strictly respected, preventing dyslexic readers from binding any consonant with the preceding vowel if this might result in a sharp sonority difference between vowel and coda (i.e., case of an obstruent post-vocalic consonant). Secondly, they prefer optimum coda than optimum onset, in terms of sonority. Optimum onset cluster is described as progressively growing in sonority toward the vowel, whereas optimum coda must be close in sonority to the preceding vowel (Clements, 1990). Since dyslexic children systematically associated the post-vocalic obstruent consonant with the onset of the subsequent syllable, they seem to be strongly guided by the phonetic quality of the coda to the detriment of phonetic quality of the onset (i.e., clusters of obstruent consonants do not progressively grow in sonority toward the vowel). This is in contrast

with the syllable onset hypothesis (Content, Kearns & Frauenfelder, 2001), that claims the prominence of the onset in speech processing, whereas dyslexic children give greater importance to syllable offset.

16 It must be kept in mind that effects in dyslexic children require cautious interpretation, both because effects are marginally significant and their performances are close to random level. The presentation was probably too rapid for young and poor readers, and further experiments will propose presentation times fitting more precisely their reading level. Nevertheless, since these data pointed out the sensitivity of dyslexic children to phonotactic rules in reading, they may have implication for reeducation, aiming at improving implicit organisation of printed stimuli, a key process in skilled reading.

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Bibliography

Bedoin, N., & Dissard, P. (2002, in press). Sonority and syllabic structure in reading: Differences between French and English readers. *Current Psychology Letters: Behaviour, Brain and Cognition*.

Bedoin, N., & Dissard, P. (2001). Intrasyllabic structure and sonority of consonants in printed stimuli: Differences between French and English readers. *European Society of Cognitive Psychology (ESOP XII)*. Edinburgh: Scotland.

Clements, G.N. (1990). The role of the sonority cycle in core syllabification. In J. Kingston & M.E. Beckman (Eds.), *Papers in laboratory phonology 1: Between the grammar and physics of speech* (pp. 283-333). Cambridge: Cambridge University Press.

Colé, P., Magnan, A., & Grainger, J. (1999). Syllable-sized units in visual word recognition: Evidence from skilled and beginning readers of French. *Applied Psycholinguistics*, 20, 507-532.

Content, A., Dumay, N., & Frauenfelder, U.H. (2002). The role of syllable structure in lexical segmentation: Helping listeners avoid mondegreens. *XXIVèmes Journées d'Etude sur la Parole*. Nancy.

Content, A., Kearns, R.K., & Frauenfelder, U.H. (2001). Boundaries versus onsets in syllabic segmentation. *Journal of Memory and Language*, 45, 177-199.

Content, A., Meunier, C., Kearns, R.K., & Frauenfelder, U.H. (2001). Sequence detection in pseudowords in French: Where is the syllable effect? *Language and Cognitive Processes*, 16, 609-636.

Cutler, A., Mehler, J., Norris, D., & Segui, J. (1986). The syllable's differing role in the segmentation of French and English. *Journal of Memory and Language*, 25, 385-400.

Cutler, A., Mehler, J., Norris, D., & Segui, J. (1992). The monolingual nature of speech segmentation by bilinguals. *Cognitive Psychology*, 24, 381-410.

Duncan, L.G., & Johnston, R.S. (1999). How does phonological awareness relate to nonword reading skill amongst poor readers? *Reading and Writing: An Interdisciplinary Journal*, 11, 405-439.

Ferrand, L., Segui, J., & Grainger, J. (1996). Masked priming of word and picture naming: The role of syllabic units. *Journal of Memory and Language*, 35, 708-723.

Gross, J., Treiman, R., & Inman, J. (2000). The role of phonology in a letter detection task. *Memory and Cognition*, 28(3), 349-357.

Kaye, J.D., & Lowestamm, J. (1984). *De la syllabicit e [On syllabicity]*. In F. Dell, D. Hirst, and J.R. Vergnaud (Eds.), *Forme sonore du langage*. Paris : Hermann.

Leclercq, G., Content, A., & Frauenfelder, U.H. (2002). *L'effet syllabique dans les mots et les pseudomots en fran ais*. XXIVèmes Journées d'Etude sur la Parole. Nancy.

Lovegrove, W., Martin, F., & Slaghuis, W. (1986). A theoretical and experimental case for a visual deficit in specific reading disability. *Cognitive Neuropsychology*, 3, 225-267.

- Mehler, J., Dommergues, J., Frauenfelder, U.H., Segui, J. (1981). The syllable's role in speech segmentation. *Journal of Verbal Learning and Verbal Behavior*, 20, 298-305.
- Murray, R.W., & Vennemann, T. (1983). Sound change and syllable structure in Germanic phonology. *Language*, 59, 514-528.
- Prinzmetal, W., Treiman, R., & Rho, S.H. (1986). How to see a reading unit. *Journal of Memory and Language*, 25, 461-475.
- Prinzmetal, W., Hoffman, H., & Vest, K. (1991). Automatic processes in word perception : An analysis from illusory conjunctions. *Journal of Experimental Psychology : Human Perception and Performance*, 17(4), 902-923.
- Rapp, B.C. (1992). The nature of sublexical orthographic organisation : The bigram trough hypothesis examined. *Journal of Memory and Language*, 33, 33-53.
- Rosen, S., & Manganari, E. (2001). Is there a relationship between speech and nonspeech auditory processing in children with dyslexia ? *Journal of Speech, Language, and Hearing Research*, 44, 720-736.
- Schiller, N.O. (1998). The effect of visual syllable primes on the naming latencies of words and pictures. *Journal of Memory and Language*, 39, 484-507.
- Schiller, N.O. (1999). *Masked syllable priming of English nouns*. *Brain and Language*, 68, 300-305.
- Selkirk, E.O. (1982). The syllable. In H. van der Hulst and N. Smith (Eds.), *The structure of phonological representations*, (pp. 337-383). Dordrecht : Fusts.
- Seymour, P.H.K., & Duncan, L. (1997). Small versus large unit theories of reading acquisition. *Dyslexia*, 3, 125-134.
- Shulte-Körne, G., Deimel, W., Bartling, J., Deimel, & Remschmidt, H. (1998). Attenuated hemispheric lateralization in dyslexia : Evidence of visual processing deficit. *NeuroReport*, 9, 337-340.
- Stein, J., & Walsh, V. (1997). To see but not to read : The magnocellular theory of dyslexia. *Trends in Neuroscience*, 20, 147-152.
- Stemberger, J.P. (1983). The nature of /t/ and /l/ in English : Evidence from speech errors. *Journal of Phonetics*, 11, 139-147.
- Tallal, P. (1980). Auditory temporal perception, phonics and reading disabilities in children. *Brain and Language*, 9, 182-198.
- Treiman, R. (1984). On the status of final consonant clusters in English syllables. *Journal of Verbal Learning and Verbal Behavior*, 23, 343-356.
- Treiman, R., & Danis, C. (1988). Short-term memory errors for spoken syllables affected by the linguistic structure of the syllables. *Journal of Experimental Psychology : Learning, Memory and Cognition*, 14, 145-152.
- Treiman, R., Zukowski, A., & Richmond-Welty, D. (1995). What happened to the “ n ” of sink ? Children's spelling of final consonant clusters. *Cognition*, 55, 1-38.

References

Electronic reference

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Abstract

We investigated sonority effects on letters cohesion and possible implicit segmentation for printed CVCCVs in French. Adult readers, dyslexic children and control children had to recall the color of target letters in briefly presented two-coloured pseudowords. The distribution of colours was either compatible or not with the hypothesized underlying CVC.CV structure. Sonority either did or did not obey the phonotactic rule for optimum syllable sequence (higher sonority for the end of the first syllable than for the beginning of the subsequent one). Data showed that CVC.CV repartition was respected by adult readers (and, to a lesser extent, by dyslexic children) if this phonotactic rule was obeyed. Only dyslexic children associated the two consonants as an onset cluster (CV.CCV) if this rule was not obeyed. Therefore, dyslexic children exhibit sensitivity to sonority for implicit syllabification in reading, but the phonotactic rule about syllabic sequence is too strictly applied and CVC syllables with obstruent coda are refused.

Keywords : reading, dyslexia, phonetics, sonority, syllable