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Specific subtype of fluency disorder affecting French speaking children: A phonological analysis

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ABSTRACT

Purpose: Clinicians working with fluency disorders sometimes see children whose word repetitions are mostly located at the end of words and do not induce physical tension. Prior studies on the topic have proposed several names for these disfluencies including "end word repetitions", "final sound repetitions" and "atypical disfluency". The purpose of this study was to use phonological analysis to explore the patterns of this poorly recognized fluency disorder in order to better understand its specific speech characteristics.
Methods: We analyzed a spontaneous language sample of 8 French speaking children. Audio and video recordings allowed us to study general communication issues as well as linguistic and acoustical data.
Results: We did not detect speech rupture or coarticulation failures between the syllable onset and rhyme. The problem resides primarily on the rhyme production with a voicing interruption in the middle of the syllable nucleus or a repetition of the rhyme (nucleus alone or nucleus and coda), regardless of the position in the word or phrase.
Conclusion: The present study provides data suggesting that there exist major differences in syllable production between the disfluencies produced by our 8 children and stuttered disfluencies. Consequently, we believe that this fluency disorder should be recognized as distinct from stuttering.

1. Introduction

Speech pathologists working with fluency disorders sometimes see children who present specific speech characteristics distinct from stuttering, specifically, disfluencies not present in the initial position of words and sentences (as in stuttering) and that remain relatively relaxed, without visible or audible tensions. The children with these disfluencies seem unaware of their pathology, such as in the case reports described in the literature by McAllister and Kingston (2005), MacMillan, Kokolakis, Sheedy, and Packman (2014), Rudmin (1984), and Van Borsel, Van Coster, and Van Lierde (1996) and therefore do not fear speech or adopt avoidance behaviors. Existing research on this form of presentation is scant and imprecise in its nomenclature, referring to "final" or "end" word disfluencies. Some researchers claim that these disfluencies are related to stuttering (e.g. Lebrun & Van Borsel, 1990; Stansfield, 1995) while others suggest there is a distinction between the two

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pathologies (MacMillan et al., 2014). This study aims to conduct a systematic, rigorous, analysis of this communication disorder in order to assist with its diagnosis and classification.

Existing research on this type of disfluency is primarily based on case-studies of patients with a neurological or genetic condition (Bijleveld, Lebrun, & Van Dongen, 1994; Lebrun & Van Borsel, 1990; Van Borsel et al., 1996), or a social skills communication disorder such as autism spectrum disorder (Scaler Scott, Tetnowski, Flaitz, & Yaruss, 2014; Scaler Scott & Sisskin, 2007; Sisskin & Wasilus, 2014; Sisskin, 2006; Sisskin & Scaler-Scott, 2007), mostly presenting a co-morbidity of stuttering.

Van Borsel et al. (1996) presented the disfluencies of a 9 year old Dutch speaker with a history of brain injury. They collected speech samples in different communication settings: spontaneous interaction, monologue, word repetition, reading and singing. Other than during repetition and singing, the disfluencies were present in all situations. They found that the repetition located at the end of lexical words was the primary type of disfluency, and that it affected mostly polysyllabic words. The majority of disfluencies were whole syllable repetitions on polysyllabic words but also repetitions of the nucleus and coda on monosyllabic words. Van Borsel et al. (1996) considered that the reiteration of the final part of the sentence could possibly be a type of palilalia, which is an acquired disorder of speech characterized by compulsive reiteration of utterances in a context of increasing rate and decreasing loudness (Boiler, Albert, & Denes, 1975). However, in the case of their disfluent subject, they argue that the word repetitions did not follow this pattern. Subsequent to this study, other case studies of final word repetitions suggested a link to cerebral lesion. However, the fact that locations of the lesions vary between studies (see Van Borsel, Geirnaert, & Coster, 2005, for detailed descriptions) indicates that no single region of the brain is implicated in the condition. According to the authors, there exists insufficient evidence to provide solid theories about whether the pathogenisis of final word repetitions is developmental or neurogenic.

Disfluencies concerning the final part of words have also been reported in cases of genetic syndromes, such as developed by Van Borsel and Tetnowski (2007) who reported in their review of literature cases of patients with the X fragile syndrome, Prader-Willi and Gilles de la Tourette. Lebrun and Van Borsel (1990) also described a case of final word repetitions in a 17-year-old girl with Down's syndrome. In these cases, the speakers presented typical stuttering-like disfluencies and other speech and language impairments as well. Reference to this disfluency disorder has also been presented in different studies concerning autism spectrum (Scaler Scott & Sisskin, 2007; Sisskin & Wasilus, 2014; Sisskin, 2006). Sisskin and colleagues described the speech of children with Asperger syndrome as stuttering-like disfluencies combined with "atypical disfluencies", which they refer to as final part of word repetitions that can be in middle-phrase position ("*Thomas the Tank-ank Engine is a train-ain that is sold in stores-ores everywhere.*").

Very few reports of children presenting these disfluencies without neurogenic or genetic syndromes can be found in the literature. Several decades ago, Camarata (1989), Mowrer (1987) and Rudmin (1984) presented isolated cases of children producing final consonant repetitions. More recently, Van Borsel et al. (2005) described a 12-year-old boy with repetitions of the final part of words, but with typical disfluencies of stuttering (word-initial repetitions, revisions, interjections). Van Borsel and colleagues noted that the speech of this boy had two characteristics: the disfluencies were more frequent on the lexical words than on function words and were more frequent on polysyllabic words than on monosyllabic words. They also found that the repetitions were more frequent at the end of a phrase than in the initial or medial position. Lebrun and Van Borsel (1990) described an 8-year-old boy presenting a tachylalic speech pattern where word-final disfluencies were associated with numerous phrase, word and sound repetitions, blocks and prolongations, often accompanied by facial tension. They noted that, in most cases, the consonants were involved and only the last sound of the word was repeated, whether the word ended by a consonant or by a cluster. McAllister and Kingston (2005) presented cases of two boys with normal intelligence and no neurological impairment. One was a 7-year-old boy who first developed a typical stutter at age 6 (initial syllable and whole word repetitions), after which the pathology spontaneously disappeared. A later assessment indicated a new pattern of disfluencies, with word-end repetitions. The second boy, age 6, also presented these non-stutterlike disfluencies since age 5. According to the authors, both children followed an individual but highly predictive set of rules. One of the subjects produced essentially repeated fragments consisting of the nucleus of the word followed by the coda (scientist-ist), the other mainly repeating the last syllabic element of the word (nucleus 'army-/i/' or coda "off-/f/"). The authors differentiated between broken words "involving cessation of airflow or phonation within a word (e.g., *I can te-ll*) from final part word repetitions, involving the reiteration of some portion of the end of the word." (p. 259). As in other studies, the children were unaware of their disfluencies and did not present any muscle tension or avoidance strategies.

More recently, MacMillan et al. (2014) studied a larger population, without cerebral injury, developmental neurological disorder, or genetic problems such as Asperger syndrome. Among the 12 children studied, 10 presented both stuttering and end of word disfluencies. They suggested that while the two conditions were associated, end of word disfluencies were distinct from stuttering.

Besides a few reports about therapeutic outcomes, no study has been specifically oriented towards rehabilitation of these disfluencies. Sisskin and Wasilus (2014) described a therapy protocol that was successful in reducing word-final repetition and phrase final repetition, labeled "atypical disfluencies", of a 7 year old boy with Asperger syndrome. They oriented therapy essentially towards self-monitoring, stuttering modification therapy and communication improvement. Following an 8-week treatment, the child significantly improved his speech. The authors suggested that traditional stuttering treatment can thus be successful in reducing atypical disfluencies in a child presenting Asperger syndrome. Van Borsel et al., 2005 also presented in their case-study a successful management program for a 12 year-old boy. They testified that therapy resulted in complete elimination of these repetitions. Concerning outcomes, according to the literature reporting end of word disfluencies with developmental origin and without co-morbidity, it would appear as if the problem mostly disappeared spontaneously.

It is likely that these specific disfluencies affect intelligibility less than stuttered disfluencies because they are located at the end of words and lexical access occurs primarily at the beginning of words (Grosjean, 1980). In stuttering, the distortion occurs as soon as the speaker begins his/her utterance, with the "fault line" described by Wingate (1988). According to him, one must consider stuttering as a syllabic phenomenon, or as an intrasyllabic event which never occurs at the end of syllables. Stuttering is not exclusively on the initial phoneme but is rather produced by a transition defect between the initial phoneme and the following one (the vowel or the syllable nucleus), the difficulty being not "on" or "with" the particular sound but rather in getting "off" or progressing "beyond" the sound (Wingate, 1969, p. 107). More specifically, the transition defect is characterized by a failure in the coarticulation process (Pfauwadel-Monfrais & Teitler, 1996). An overlap of muscle contractions between phonemes is necessary for the fluent production of a speech sequence. A failure to synchronize this motor production results in a disrupted transition between phonemes and the emergence of the fault line. According to Pfauwadel-Monfrais and Teitler (1996), when a person who stutters produces a word with a block (c-ar), a prolongation (l__et) or a repetition (b-bar), the difficulty is not located on the initial phoneme, correctly produced, but on the transition between the first phoneme, which the speaker cannot let go of, and the second. The phonological structure of the syllable is reorganized whatever type of stuttered disfluency occurs, should it be blocks, repetitions or prolongations. In the cases where the syllable onset is a vowel, the fault line will occur between a glottal onset and the vowel production.

While prior studies are informative and make the case that end of word repetitions are likely distinct from stuttering, a systematic assessment of these particular disfluencies is yet missing. The objective of this study is to provide a thorough analysis of the disfluencies to enable a better description of their specific characteristics.

2. Method

Ten monolingual French native children were video recorded during a spontaneous speaking task. Each had received a fluency assessment and some were followed by a speech pathologist during the time of our recordings. We recruited the subjects from fluency therapists who treated (or had treated) children or adults presenting repetitions concerning end of words, without a coexisting stuttering. A total of 122 therapists who had received special fluency training in France were contacted by email through lists of therapists having received special fluency training (provided by two French professors in fluency disorders). Among them, 20 therapists answered that they had seen this type of disfluency and referred their clients. Subjects were filmed at their house or in a speech clinic with a Nikon Coolpix S3100 camera placed one meter from the table where we interacted with the child. We conducted a phonetic and linguistic analysis based on the audio recording. Video recording allowed us to analyze physical tensions, pragmatic skills and eye contact so we could account for communication issues. Recordings lasted at minimum 35 min and our speech sample consisted of the first 30 min of conversation (after 5 min of patient orientation). The child was shown 7 sequential images and was asked to tell the story represented by the 9 cm x 9 cm images ("*Raconte* !" Schubi edition, Schaffhauen-Germany) after which we asked the child questions about his or her personal experiences related to the topics discussed in the images. The language sample was analyzed with the software CLAN and the CHILd Data Exchange System (CHILDES, MacWhinney, 2000). Acoustical analysis of the disfluencies was conducted with Praat (version 5.3.53, Boersma, 2002). Analysis was performed by the clinician administrating the test and a blind clinician trained in fluency disorders. If cases of non agreement were found, they were systematically discussed and decision was taken in the child's favour. Two children did not produce any abnormal disfluencies during the recordings and their samples were therefore excluded from our study. The remaining 8 children consisted of 2 girls and 6 boys, ranging from ages 4.2 to 10.3.

Children FRA and MIC (respectively ages 4;2 and 6;6) are brothers and presented normal communication skills. For both of them, disfluencies began two years prior to the study. REM was a 6;7 year old boy. According to his parents, onset of disfluencies was at age 5;5. He was very sociable and presented good communication skills. PAT was 9;2 years old and disfluencies began 6 months prior to our recordings. No communication impairment had been previously diagnosed, but he had few friends and avoided interactions with adults and peers. DID was a 9;4 year old boy who presented final word disfluencies since age 5. Besides the fluency issue, his communication was normal. REN was 9;6 years old and had presented disfluencies for 2 years at the time of our study. According to his parents, he had difficulties expressing his emotions and was easily frustrated. During the recordings, spontaneous interaction seemed difficult. The two girls, MAR (10;2) and ALI (10;3), had appropriate interactions and were described by their parents as socially well adapted. For both MAR and ALI, onset of disfluencies was around age 9.

3. Results

3.1. Descriptive analysis of the video recordings

Analysis of our video recordings was conducted by two separate judges (the clinician conducting the test and a blind clinician trained in fluency disorders). No reliability test was conducted, the descriptive data not being our primarily goal, but both judges noted that none of the 8 children presented motor tensions during speech. Facial physical tension was not observed during disfluencies and we found no sign of struggle or self repair during speech. We never observed any sign of self-

Table 1
Number and proportion of disfluent syllables per child, according to word length.

Child	Disfluences *(N = 128)*	% affected syllables *(N = 128/7441)*	% affected 1-syll words *(N = 58/4071)*	% affected 2-syll words *(N = 61/1256)*	% affected 3-syll words *(N = 5/194)*	% affected 4-syll words *(N = 4/77)*
FRA	11	2.9 *(11/382)*	3.1 *(8/257)*	5.2 *(3/58)*	0 *(0/3)*	0 *(0/0)*
MIC	18	1.8 *(18/1011)*	0.8 *(5/584)*	6.6 *(11/166)*	4.8 *(1/21)*	12.5 *(1/8)*
REM	12	1.0 *(12/1215)*	0.6 *(4/691)*	3.4 *(7/204)*	0 *(0/24)*	9 *(1/11)*
PAT	36	4.4 *(36/813)*	4 *(19/474)*	12.9 *(17/132)*	0 *(0/17)*	0 *(0/6)*
DID	11	0.7 *(11/1584)*	0.9 *(7/764)*	1.3 *(4/300)*	0 *(0/48)*	0 *(0/19)*
REN	7	0.7 *(7/958)*	0.2 *(1/488)*	3.3 *(5/151)*	3.1 *(1/32)*	0 *(0/18)*
MAR	11	1.0 *(11/1049)*	0.5 (3/593)	2.4 (4/169)	5.9 (2/34)	16.6 (2/12)
ALI	22	5.1 *(22/429)*	5 *(11/220)*	13.2 *(10/76)*	6.6 *(1/15)*	0 *(0/3)*
Mean	16.0	2.2	1.4	4.9	2.6	5.2
SD	9.4	1.8	1.8	4.6	2.9	6.9

awareness for any of the observed disfluencies. Eye contact was consistent through the disfluencies as well. One child (PAT) had difficulties maintaining eye-contact throughout the exchange but it did not worsen during disfluencies. Five children showed occasionally audible breath intake with visible breathing discoordination. Breath intake was not systematically located at expected syntactical boundaries and therefore contributed to the children's speech patterns.

3.2. Speech analysis

3.2.1. Number of disfluencies

According to the speech analysis of the 8 audio recordings, a total of 128 disfluencies were found. The quantity of disfluencies ranged from 7 to 36 per child. Only the disfluencies considered to be pathological were included in the phonological analysis. None of the subjects presented stutter-like disfluencies such as blocks, prolongations or repetition of the syllable onset. Among the disfluencies produced, 100% were repetitions, the vast majority (97%) being single repetitions. No repetition occurred more than twice.

The percentage of disfluencies was calculated, for each child, by dividing the number of syllables with disfluencies by the total number of syllables multiplied by 100. Percentages of disfluent syllables are presented in Table 1, according to word length.

Results show varying amounts of disfluencies among children, ranging from 0.7% to 5.1% of their speech production. The association between number of words affected and word length was not linear: 5.2% of disfluent words were 4-syllable words, followed respectively by words of 2, 3 and one syllable. The higher proportion of disfluencies among 4-syllable words is based on very few 4-syllable words in the speech sample. These findings suggest that the association between word length and disfluencies is at best weak.

3.2.2. Nature of disfluencies

Disfluency characteristics are presented in Table 2, with examples to illustrate each case. We precisely describe each type of disfluency to allow a fine-grained phonological analysis. We separated cases for each phonological context (e.g. when a word ended with a vowel or a consonant, or when the child produced or not the whole word before repetition of its end). We obtained 7 different cases, described regarding type of initial production (whole or partial word), and nature of repeated segment (vowel, consonant or whole syllable). We avoided combining processes, such as cases E and D described similarly in previous studies (MacMillan et al., 2014), or cases A, B and D. The goal of these distinctions is to ensure a differentiation between each type of production. If one considers that Cases A ("va-a") and D ("crache-ache") are similar and that cases A ("va-a") and B ("cra-ache") are similar, one would logically obtain similarity between B ("cra-ache") and D ("crache-ache") as well, which cannot be considered true. Distinction between these productions was hence considered necessary.

Table 2 indicates that the most frequent occurrence (close to half the disfluencies) is repetition starting from the final vowel following a whole-word production (case A). Production of only a part of the word, with repetition of the final vowel and consonant (case B) is also quite frequent (one quarter of disfluencies). Other cases include: partial word production and repetition of an internal vowel (case C); whole production with repetition of the last vowel followed by a consonant (case D); and less frequently (9 productions) repetition of the entire syllable ending by a vowel (case G), a consonant (case E) and a glide and vowel (case F).

Table 2
Nature of disfluencies according to loci and type (partial or whole word) of repetition (Total N = 128).

Cases	Description of the disfluence	Examples
A N = 60	whole production and repetition of last vowel	*garçon-on* [garsɔ˜-ɔ˜], *maman-an* [mamɑ˜-ɑ˜], *venu-u* [vœny-y] *mis-is-is* [mi-i-i], *après-ès* [apʁ ε-ε], *va-a* [va-a], *rêvé-é* [ʁ εve-e], *papa-a* [papa-a], *Tintin-in* [tε˜tε˜-ε˜], *jamais-ais* [ʒamε-ε], *regarderai-ai* [ʁ œgaʁ dœrε-ε], *parents-ents* [paʁ ɑ˜-ɑ˜]
B N = 31	partial production and repetition of last vowel followed by consonant	*ran-ange* [ʁ ɑ˜-ɑ˜ʒ], *parti-ir* [paʁ ti-iʁ], *marsei-eille* [maʁ sε-εj], *pleu-eure* [plœ-œʁ], *com-ompte* [kɔ˜-ɔ˜t], *do-onne* [dɔ-ɔn], *étique-ettes* [etikε-εt], *centi-imes* [sɑ˜ti-im], *bla-agues* [bla-ag], *perso-onne* [pεʁ sɔ-ɔn], *stalacti-ite* [stalakti-it]
C N = 16	partial production and repetition of an internal vowel	*arrê-êtez* [aʁ ε-εte], *mai-aison* [mε-εzɔ˜], *pa-arent* [pa-aʁ ɑ˜], *sou-ouviens* [su-uvjε˜], *dra-agon* [dʁ a-agɔ˜], *croi-arait* [kʁ wa-aʁ ε], *mon-ontréal* [mɔ˜-ɔ˜ʁ eal], *cau-auchemar* [ko-oʃmaʁ], *bé-ébés* [be-ebe], *fa-amille* [fa-amij]
D N = 11	whole production and repetition of last vowel followed by consonant	*crache-ache-ache* [kʁ aʃ-aʃ-aʃ], *commandes-andes* [komɑ˜d-ɑ˜d], *s'envole-ole* [sɑ˜vɔl-ɔl], *seul-eul* [sœl-œl], *regardent-ardent* [ʁ œgaʁ d-aʁ d], *partent-artent* , *jour-our* [ʒuʁ -uʁ], *avec-ec* [avεk-εk], *petite-ite* [pœtit-it], *donne-onne* [dɔn-ɔn]
E N = 1	whole production and repetition of last syllable ended by consonant	*madame-dame* [madam-dam]
F N = 1	whole production and repetition of glide/j/and last vowel	*avion –ion* [avjɔ˜-jɔ˜]
G N = 7	whole production and repetition of last syllable	*maman-man* [mamɑ˜-mɑ˜], *parti-ti* [paʁ ti-ti], *porte monnaie-naie* [pɔʁ tœmonε-nε], *trouvé-vé* [tʁ uve-ve], *rentrer-trer* [ʁ ɑ˜tʁ e-tʁ e], *couteau-teau* [kuto-to], *bougie-gie* [buʒi-ʒi]

Table 3
Type of disfluencies according to loci of repetition (Total N = 128).

Child	Disfluences (N)	Case A	Case B	Case C	Case D	Case E	Case F	Case G
FRA	11	10	0	0	1	0	0	0
MIC	18	4	0	2	6	0	1	5
REM	12	9	0	0	2	0	0	1
PAT	36	18	13	5	0	0	0	0
DID	11	4	5	0	2	0	0	0
REN	7	3	1	1	0	1	0	1
MAR	11	5	3	3	0	0	0	0
ALI	22	8	9	5	0	0	0	0
Total	128	61	31	16	11	1	1	7
MEAN	*16*	*7.63*	*3.88*	*2*	*1.38*	*0.13*	*0.13*	*0.88*
SD	*9.35*	*4.93*	*4.85*	*2.14*	*2.07*	*0.35*	*0.35*	*1.73*

Table 3 presents type of repetition for each child. Case A is generally the most frequently produced, followed by Case B. In both cases children begin their repetition starting from the last vowel, followed or not by a consonant. The greater occurrence of case A reflects characteristics of the French language, in which 80% of syllables are open (Delattre, 1966; Wioland, 1991), i.e. ending by a vowel (for example "tableau"/tablo/has two open syllables/ta/and/blo/).

All children tend to repeat the last vowel (followed or not by a consonant) (cases A & B). MIC is the only child behaving somewhat differently: his most common pattern is either the production of the entire word, followed by repetition of the last vowel, or repetition of the entire last syllable (with a consonant before the vowel).

Analysis of the position of the disfluent syllables shows that in most cases, repetition is located on the final syllable of words (cases A, B, D, E, F and G). In 12% of our productions, disfluencies occur on a mid-word position vowel (case C).

3.2.3. Phonological analysis of disfluencies

The phonological analysis of disfluencies allows us to consider three phenomena: the Gap, the Break point, and the Restart point, according to the traditional Onset (O)-Rhyme (R) syllable model.

The gap is the interval where the disfluency occurs, during which the speech (word or utterance) is interrupted, such as an involuntary pause. The gap is the central phenomena of the disfluence, present in every instance. The restart point, or right margin of the gap, is the syllable location where the speaker restarts his/her utterance. The restart point is mostly located before the syllable nucleus (cases A, B, C, D). More rarely, it occurs before a consonant, either at the head of onset (cases G and E), or at the branch of the onset (case F). The break point, or left margin of the gap, is where the speaker stops. It is mostly located after the nucleus, whether there is a coda or not, and whether there is a subsequent syllable or not (cases

Table 4
Disfluency Classification according to syllabic characteristics.

RESTART POINT				
		before the nucleus*(cases A, B, C and D)*	before the head of onset *(cases E and G)*	before the branching onset *(case F)*
BREAK POINT	after the nucleus	garçons-ons [garsɔ˜-ɔ˜] *(A)* parti-ir [paʁ ti-iʁ] *(B)* fa-amille [fa-amij] *(C)* adu-ulte [ady-ylt] *(C)*	bougie-ie [buʒi-ʒi] *(G)*	avions-ions [avjɔ˜-jɔ˜] *(F)*
	after the end of the word with a final C	seul-eul [sœl-œl] *(D)*	madame-dame [madam-dam] *(E)*	

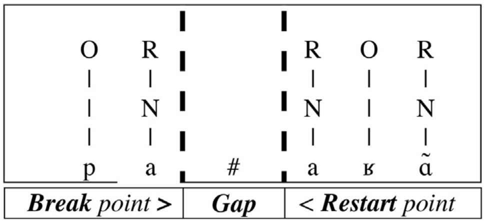

Fig. 1. Formalisation of the disfluencies'classification (O = Onset, R = Rhyme, N = Nucleus), example: 'parents' [pa-aʁ ɑ˜].

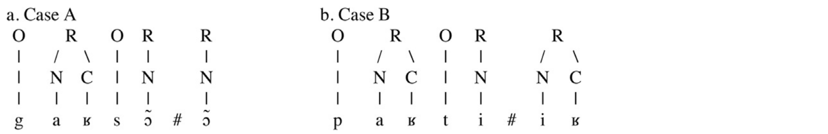

Fig. 2. Syllabification of disfluencies before nuclei in word final position: cases A and B (O = Onset, R = Rhyme, N = Nucleus, C = Coda).

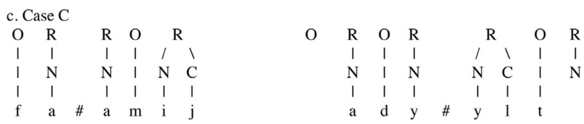

Fig. 3. Syllabification of disfluencies before nuclei in internal position: case C[3] (O = Onset, R = Rhyme, N = Nucleus, C = coda).

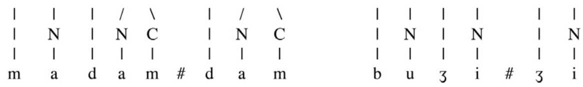

Fig. 4. Syllabification of disfluencies before onset: cases E and G (O = Onset, R = Rhyme, N = Nucleus, C = coda).

A, B, C, F and G). In cases D and E, the break point is located after the end of the word (with final consonant). Table 4 shows the cross-classification of the disfluencies (Fig. 1).

The most frequent disfluencies (89% of the total amount of disfluencies for all speakers, cases A, B and C) are those where the restart point is located before the syllable nucleus and the break point is located after the nucleus. The vowel is therefore produced twice. The cases where the break point is located after the end of the word (cases D and E) are relatively rare, representing respectively 8% and 0.7% of the disfluencies produced by all speakers. There are no occurrences of repetition of the isolated coda or final consonant with break and restart points after the nucleus, as we would see in a production such as [paʁ tiʁ -ʁ] or [adyl-lt].

The most common syllable structure of disfluencies is shown in Figs. 2 and 3, using the traditional Onset (O)-Rhyme (R) syllable. Syllabification for this type of disfluency is identical for cases A, B and C, in the sense that each of these cases present primarily the repetition of the nucleus, eventually followed by the end of the syllable (case B) or word (case C).

In the cases where the restart point is before the syllable onset (E and G), the entire syllable is repeated (onset and rhyme) (Fig. 4).

The other cases lie, structurally, between the first cases (Fig. 5).

[3] In the example [ady-ylt], the final/t/is considered as a part of a new syllable, because the coda is already filled by the/l/(the coda is not allowed to have a branch). This disfluency is thus in an internal position. The last nucleus remains empty, i.e. no vowel is produced in that position.

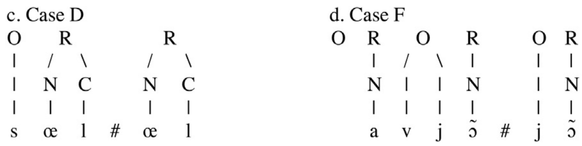

Fig. 5. Syllabification of disfluencies in other contexts: cases D and F (O = Onset, R = Rhyme, N = Nucleus, C = coda).

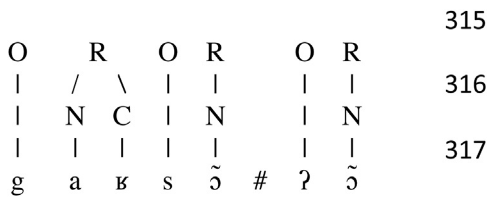

Fig. 6. Syllabification of an hypothetic disfluency with the production of an obstruant during the gap.

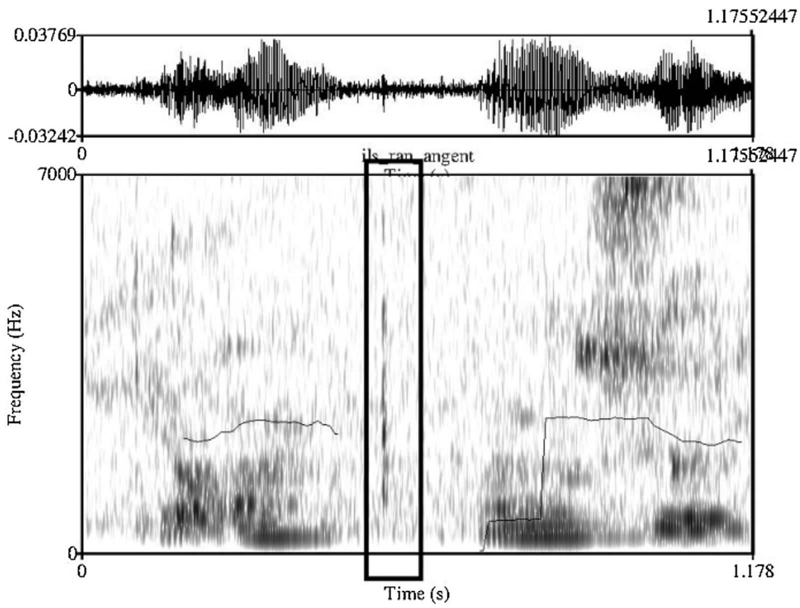

Fig. 7. Waveform and spectrogram for the disfluency “ils ran-angent” [ilʁɑ˜ɔ˜ #ɑ˜ʒə].

3.2.4. Acoustic analysis

The most frequent syllabic structures produced in our disfluencies (Case A) raise the question of whether there is strict repetition of the syllable nucleus or production of an entirely new syllable starting form a reduced consonant, such as a stop or fricative glottal onset. Fig. 6 illustrates this type of production.

Within the same subject’s occurrences (PAT), three patterns appear: a glottal stop[1] in the middle of the gap while producing the utterance “ils ran-angent’ [ilʁɑ˜ɔ˜#ɑ˜ʒə]” (Fig. 7);

The release of the closure occurs in the middle of a pause, and not immediately before the beginning of the voicing: this distance between the end of the burst and the onset of the vowel does not appear in typical speech production, where voicing starts just after the release of the closure. It seems here as if glottal stop and vowel were not linked.

A glottal voiced fricative[2] immediately before the repeated vowel in the sequence “des étique-ettes [dεzetikε # hεt]” (Fig. 8);

And no sign of glottal obstruant (stop or fricative) between both productions of the vowel, such as in “la fi-ille’ [la fi#ij] » (Fig. 9).

In sum, there is no articulatory procedure behind the produced disfluencies (a child can produce different sounds in the gap). There is no systematic filling of the consonantal syllabic position when they repeat the end of the word from the vowel.

[1] A glottal stop is characterized by a spectrographic burst with an abrupt onset, generated by the articulatory release of the closure.

[2] A glottal voiced fricative [ɦ] is characterized by noise and can show formants linked to the following vowels.

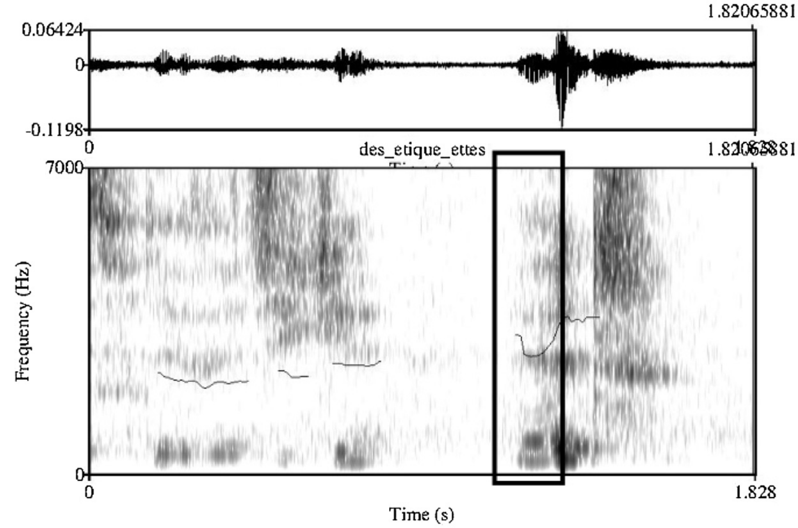

Fig. 8. Waveform and spectrogram for the disfluency "des étique-ettes" [dɛzetikɛ # hɛt].

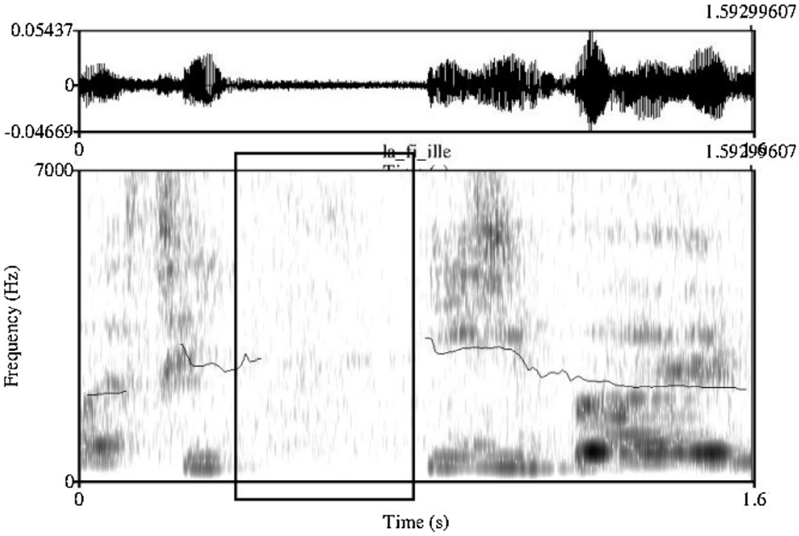

Fig. 9. Waveform and spectrogram for the disfluency 'la fi-ille' [la fi#ij].

3.2.5. Phonetic analysis

No pattern emerges from the phonetic context of the disfluencies produced by our 8 subjects. More specifically, no particular type of consonant induces more repetitions. The onset can be a stop, a fricative, a sonorant, or a nasal. We observed simple and branching onsets (with a sonorant or glide). As previously shown, the disfluencies were found before another consonant in a coda position or as the onset of the following syllable.

The phonetic analysis of the disfluent vowels suggests that all French vowels are subject to disfluencies, whether oral or nasal. The most disfluent vowel is [ɛ], which is repeated in 1.9% of total productions of [ɛ] (15/799), followed by [ɔ] (2/156), [œ] (1/80) and [y] (3/224), each at a frequency of 1.3%, and [a] (32/2603) and [i] (14/1142), both at a frequency of 1.2%. All other vowels are disfluent in less than 1% of their productions. According to these results, we cannot establish a relationship between the vowel's phonetic nature and the frequency of its disfluent productions.

3.3. Position and nature of disfluencies

As the primary aim of this study was the phonological analysis of specific disfluencies, our methodology was not designed to study the influence of syntax on these productions. However, we were able to assess whether common characteristics emerged from the children's spontaneous speech by transcribing the utterances and localizing the position of the disfluent words in the sentence. We classified disfluencies at the beginning of the utterances when they occurred on the first word or on the second word if the first word was an article or pronoun, e.g. '*une fa-a-mille qui part en voyage en avion*'. Disfluencies were classified as middle of the utterance if they occurred between other lexical words, e.g. "*C'est au cas où l'avion-on est en détresse*". Finally, disfluencies were classified as end of utterances if they occurred on the last word, e.g. "*il y a aussi le bureau des comman-andes*". 55.5% of total disfluencies were located in middle positions, the rest being equally distributed in the beginning (21.9%) and at the end (22.6%).

Our data allowed us to look into the nature of the children's affected words and determine their categories. Among all adjectives, nouns, verbs and adverbs, we calculated the percentage of disfluent words and obtained 6.2% for the adjectives, 4.4% for the nouns, 3.3% for the verbs and 2.4% for the adverbs. Disfluencies among prepositions, articles, conjunctions and pronouns were rarer (0.7%, 0.4%, 0.3% and 0.2% occurrences, respectively). No word category was immune to disfluency and all children produced disfluencies in at least 3 word categories.

4. Discussion

4.1. Phonetic and phonological aspects

The purpose of this study was to analyze the speech of 8 children with a fluency disorder presenting speech characteristics different from typical stuttering. Based on acoustic and phonological analysis, we identified specific patterns of disfluency distinct from stuttering, suggesting that there exists a previously under-diagnosed, ill-recognized, and possibly inadequately treated disorder.

The major characteristics of the disfluencies studied here relate to their phonetic and phonological nature. First, as opposed to stuttering, we found no blocks or prolongations. The term "broken" words (Johnson, 1959) was used by McAllister and Kingston (2005) to describe words inside which there is cessation of airflow or phonation. MacMillan et al. (2014) also provide examples of silent gaps between onset and nucleus. They suggest that these broken words occur only with end-word disfluencies and question whether they can be characterized as end-word disfluencies, "consisting of fixed posture without audible airflow before the production of the rest of the syllable" (p122). In our study, we did not observe broken words, that is, silent ruptures between onset and nucleus. However, we found instances of fixed posture without audible airflow between the two productions of repeated vowels and some ruptures in syllabic rhyme with an interrupted voicing of the vowel in its middle. These observations support MacMillan et al.'s (2014) argument that these types of broken words are similar to end-word disfluencies. In fact, they may be considered the same phenomenon, expressed at a different position in the word.

The fact that we did not observe multiple repetitions also suggests a phenomenon distinct from stuttering, where phonetic repetitions are much more common. In this specific pathology, severity appears to be related to the frequency of repetitions rather than their individual characteristics, disfluencies being very similar to each other. Although the syllable structure varies, the disfluency is consistent within and between speakers in terms of exhibiting repetitions without tension and produced generally only once.

The phonological analysis allowed us to differentiate between the end-of-word disfluencies and stuttering. The disfluencies we studied never show a transition defect between the syllable's onset and rhyme, as Wingate's (1969) fault line described in the stuttered speech. Like stuttering, these disfluencies could be classified as syllabic phenomena or intrasyllabic events, but unlike stuttering, they mostly appear at the end of syllables, and more precisely on the rhyme.

Our findings also indicate that in end-of-word disfluencies, unlike in stuttering, vowel repetition is the most common pattern regardless of the position in the word: final vowel position (papa-a), final vowel followed by consonant (perso-onne), and mid-word vowel (pa-arent). The situation of the entire production produced with repetition of the rhyme and coda is also somewhat observed (commande-ande). Unlike reports from prior studies (Camarata, 1989; Mowrer, 1987; Rudmin, 1984; Van Borsel et al., 1996; MacMillan et al., 2014), none of our subjects produced a repetition of the coda or of the final consonant alone. The inconsistent observations could be due to differences between French and other Germanic languages such as Dutch and English, which differ in terms of syllabification, particularly regarding the frequency of open vs. closed syllables (e.g. 80% of French syllables are open whereas only 32% of English syllables are open (Delattre, 1966; Wioland, 1991).

The phonetic analysis of our data suggests that laryngeal impairment is one of the possible causes of the disfluencies. Repetition of isolated vowels was implicated in the majority of cases, and this could possibly be linked to some laryngeal coordination dysfunction in the middle of the vocal production. The presence of an atypical breathing pattern in 5 of our 8 subjects is consistent with this hypothesis. The high variability of what is produced during the gap within the same subject (either nothing, voiced or unvoiced glottal obstruants), and the fact that the obstruants are not immediately produced before the vowel suggests independent articulatory movements, more consistent with laryngeal contractions than phonemes.

4.2. Preliminary conclusions about word length, complexity and position

Unlike Van Borsel et al. (2005) who find that disfluent syllables are more present on polysyllabic words than on monosyllabic words (as in the case of stuttering), our results suggest that word length does not impact fluency. Phonetic complexity and phonological context also are not associated with incidence of disfluencies.

Based on our findings, disfluencies can affect syllables in any word position. Indeed, no major characteristic emerged from our data relative to syllable position, which is dissimilar to stuttering affecting mostly first syllables. Hence, when analyzing polysyllabic words, we found rhyme repetitions in first syllables (Mon-ontreal), second syllables (arrê-êtez) and third syllables (stalacti-ite), without any specific pattern emerging. These findings are different from those of Van Borsel et al. (2005) who maintain that this type of disfluency always affects the end of words.

Concerning the position of disfluencies in the sentence, we observed that, as opposed to stuttering, first words are less affected than those at the middle or end of utterances. This is consistent with Van Borsel et al. (2005) who found more frequent repetitions at the end of a phrase than in an initial or medial position. A specific characteristic is that repetition of the last production can very well be attached to the start of the following sentence. Our study did not measure duration between repeated utterances but it was sometimes clear that rather than being produced immediately after the word it belonged to, the repeated production was emitted immediately before the following sentence, and after a pause. More precisely, a first sentence is fluently articulated and followed by a normal end-of-phrase pause. The problem occurs at the time of the second sentence initiation, when the speaker will repeat a segment of the last word produced, as if a stepping stone was needed to begin the new phrase. Also, the fact that the last segment of the target phrase is repeated in a relatively relaxed manner contributes to an "echo" aspect of the disorder.

4.3. Lack of awareness

Prior studies of end word disfluencies have reported that subjects lack awareness of their speech pathology (MacMillan et al., 2014; McAllister & Kingston 2005; Rudmin 1984; Van Borsel et al., 1996). Our study subjects also were unaware of their disfluencies. The end of word disfluencies produced no noticeable speech withdrawals or apprehension. The children of our study were conscious about having a fluency disorder only because their parents and therapists had mentioned the problem. Also consistent with MacMillan et al. (2014), none of the tested children showed signs of struggle or facial tension. One could assume that the absence of self-awareness protects children from associated negative emotions or reactional attitudes (unlike in the case of stuttering). It also minimizes attempts at self-repair and verbal reactions to disfluencies. Thus, not only are dysfluency patterns distinct from stuttering but their impact on children differs greatly.

4.4. Therapeutic issues

Until today, therapy techniques conducted with children presenting end word repetitions or atypical disfluencies have rarely been documented (Sisskin & Wasilus, 2014; Van Borsel et al., 2005) and did not concern children with this fluency disorder in isolated cases. Also, no cases of therapy concerning adults have been reported. The fact that there exist very few reports of adults presenting this fluency disorder and *none*, to our knowledge, without co-morbidity suggests that the condition may resolve itself without intervention by adulthood. If spontaneous recovery is the norm, in this case therapy seems unjustified at least when disfluencies do not interfere with communication. Treatment might be necessary if communication is distorted and/or if the impairment presents a co-morbidity of stuttering or Asperger syndrome. When stuttering or cluttering is present, it is possible that therapeutic effects of these fluency disorders also benefit these specific disfluencies. How do they respond to fluency modification, self monitoring and self awareness programs, rate control, pausing and other techniques used with stuttering? Should new specific techniques be developed for this specific fluency disorder? These remain open questions.

4.5. Specific fluency disorder identification: definition and diagnostic

The purpose of this study was to analyze the speech of children with specific disfluencies which we were able to characterize and distinguish from stuttering. Previous research suggested this condition was a form of stuttering. Based on our findings, we think it is likely that the cases reported previously had a stutter combined with these other disfluencies rather than a particular presentation of stuttering. Borrowing from Curlee (1999) who noted that "Cluttering is related to stuttering but is not stuttering" (p. 223), we suggest that this fluency disorder is related to stuttering but is not stuttering. It is related to cluttering as well, in the sense that it is another fluency disorder that children do not recognize as problematic.

Since reported cases of this speech impairment are not uncommon, it is important to provide clinicians with clear diagnostic criteria. To this end, we define this pathology as a specific fluency disorder affecting mostly, but not solely, the end of words and inducing mainly syllable rhyme repetitions. There is absence of struggle and poor self awareness. It can present itself in isolated form or co-occur with stuttering.

The primary diagnostic element is the phonological characteristic of the syllable – an absence of transition difficulties between syllable onset and rhyme. Finally, contrary to its frequent classification as an "atypical disfluency", the speech pattern is common and is quite easy to recognize, precisely because of its very typical characteristics. We think it is helpful to precisely and accurately refer to this disfluency disorder to increase awareness of it, facilitate diagnosis, and encourage research on treatment. The terms employed such as "Final part word repetition" (McAllister & Kingston, 2005), "Final sound repetitions" (Stansfield, 1995; Lebrun & Van Borsel, 1990), "Repetition in final position" (Van Borsel et al., 1996), "Word final disfluencies" (Humphrey & Van Borsel, 2002; Van Borsel et al., 2005; Stansfield, 1995), "End word disfluencies" (MacMillan et al., 2014) are not entirely consistent with the disfluency. Disfluencies can very well be located at the beginning or mid position of a word. In addition, the variety of terms employed definitely does not help its diagnosis. French clinicians and researchers have opted for a term that more precisely defines the condition: *Echodysphemia ("Echodysphémie"). Echo* refers to the auditor's subjective impression when hearing the disfluencies, which are primarily (but not solely) located at the end of syllables, and "dysphemia" refers to the greek etymology of speech defect. We endorse the adoption of Echodysphemia, which we believe can help clinicians recognize and diagnose the condition.

To conclude, we hope that the phonetic and phonological analysis of the fluency disruptions concerning our 8 subjects will enable clinicians and researchers to develop their knowledge about this specific speech pathology, inconsistently referred to in prior studies. We agree with MacMillan et al. (2014) that end of word disfluencies be considered a subgroup of developmental disfluency. Hopefully, our description will help promote clinicians' awareness and facilitate its diagnosis. The description will inevitably be refined when knowledge in the field develops as many questions remain unanswered.

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