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Adaptation of the HINT (hearing in noise test) for adult Canadian Francophone populations

Adaptación del HINT (Prueba de Audición en Ruido) para poblaciones de adultos canadienses francófonos

Key Words
HINT
Speech intelligibility assessment
Speech perception in noise
Speech audiometry
Functional hearing assessment

Abbreviations
SNR: signal-to-noise ratio
SRT: speech reception threshold
HINT: Hearing in Noise Test
BKB: Bamford-Kowal-Bench
HRTFs: head-related transfer functions
HTD: hearing test device
DAT: digital audio tape
RMS: root-mean-square
FIR: finite impulse response
PI: performance-intensity

Abstract
The HINT provides an efficient and reliable method of assessing speech intelligibility in quiet and in noise by using an adaptive strategy to measure speech reception thresholds for sentences, thus avoiding ceiling and floor effects that plague traditional measures performed at fixed presentation levels. A strong need for such a test within the Canadian Francophone population, led us to develop a French version of the HINT. Here we describe the development of this test. The Canadian French version is composed of 240-recorded sentences, equated for intelligibility, and cast into 12 phonemically balanced 20-sentence lists. Average headphone SRTs, measured with 36 adult Canadian Francophone native speakers with normal hearing, were 16.4 dBA in quiet, −3.0 dBA SNR in a 65 dBA noise front condition and −11.4 dBA SNR in a 65 dBA noise side condition. Reliability was established by means of within-subjects standard deviation of repeated SRT measurements over different lists and yielded values of 2.2 and 1.1 dB for the quiet and noise conditions, respectively.

Sumario
El HINT aporta un método eficiente y confiable de evaluación de la inteligibilidad del lenguaje en silencio y en ruido, utilizando una estrategia de adaptación para medir los umbrales de recepción del lenguaje para frases, evitando así los efectos de techo y piso que influyen en las mediciones tradicionales realizadas a niveles fijos de presentación. La gran necesidad de una prueba así para la población canadiense francófona nos llevó a desarrollar una versión francesa del HINT. Aquí describimos el desarrollo de esta prueba. La versión en francés canadiense está constituida por 240 frases grabadas, ecualizadas para la inteligibilidad, y organizada en 12 listas de 20 frases fonénicamente balanceadas. Los SRT promedio con auriculares, medidas en 36 adultos hablantes naturaies del francés canadiense y con audición normal, fueron de 16.4 dBA en silencio, de −3.0 dB SNR en una condición de ruido frontal a 65 dBA, y de −11.4 dBA SNR in una condición de ruido lateral a 65 dBA. La confiabilidad se estableció por medio de la desviación estándar intra-sujeto de mediciones repetidas del SRT con diferentes listas, lo que produjo valores de 2.2 y 1.1 dB en condiciones de silencio y de ruido, respectivamente.

The ability to understand speech in noisy conditions is one of the most important skills for effective communication. However, hearing in noise represents a major challenge for hearing-impaired individuals and hearing aid users (Cox et al, 2001; Soli & Nilsson, 1994). For example, Plomp (1977) demonstrated that compared to normally hearing listeners, individuals with moderate to severe bilateral sensorineural hearing losses require, on average, 5 to 15 dB more in terms of signal-to-noise ratio (SNR) to understand speech. However, speech difficulties in noise are not the only problems reported. In order to fully appreciate the overall handicap experienced by these individuals, abilities such as identification, localization and perception of distance should also be evaluated during a comprehensive assessment of the individual's hearing abilities (Gatehouse & Noble, 2004). The development of evaluation tools to appropriately assess these abilities is of critical importance.

Traditional hearing assessment based on the measurement of hearing thresholds continues to be the most widely used method of quantifying hearing difficulties. Yet, it does not allow one to precisely predict speech intelligibility in noise (Killion & Niquette, 2000) or other difficulties encountered by individuals with hearing loss that strongly contribute to handicap (Gatehouse & Noble, 2004). Furthermore, most clinical intelligibility tests are administered in quiet conditions, using monosyllabic words as speech material. A survey conducted by *The Hearing Journal* revealed that word recognition in quiet was the most commonly used speech test (92%), followed by monosyllabic word recognition in noise (35%), and that only 6% of hearing aid dispensers used sentence-length materials to conduct aided speech testing (Mueller, 2001).

The use of monosyllables and spondees minimizes test time and facilitates test administration, factors that can account for

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their popularity in clinical settings (Nilsson et al, 1994). Nonetheless, the limited number of test items usually found in word materials may foster learning effects (Nilsson et al, 1994). Furthermore, the reliability of speech reception threshold (SRT) measurements using words is limited by the fact that the material is not typically of equal difficulty (Hirsh et al, 1952). Sentences, on the other hand, are far more representative of everyday communication since they include natural intensity fluctuations, intonation, contextual cues, and temporal elements that are associated with conversational speech (Nilsson et al, 1994). In addition, sentences being longer than words or spondees, they are more likely to activate the dynamic signal processing mechanisms found in current hearing aids, such as compression, in a natural way and thus yield better accuracy during testing (Nilsson et al, 1994).

The lack of routine measurements of speech intelligibility in noise might stem from the unavailability of reliable tools in various languages. Yet, there has been a growing effort to use sentence material in the assessment of speech intelligibility in noise, especially with regards to the evaluation of hearing aids (Mueller, 2001). Among these are the *Connected Speech Test* (Cox et al, 1987) and the *Speech Perception In Noise Test (SPIN)* (Kalikow et al, 1977; Bilger et al, 1984), in which percent intelligibility scores are usually determined at fixed speech and/or noise levels. One inherent problem with percent scores is that floor and ceiling effects limit their analytical and diagnostic value. The significance of measured changes in performance is invariably constrained by the lower and upper boundaries (0% and 100%) of percent scores (Nilsson et al, 1994; MacLeod & Summerfield, 1987). A more reliable and sensitive alternative is the measurement of SRTs. The SRT can be defined as the presentation level at which a listener can correctly identify 50% (or other specified percentage) of the speech material presented in quiet or noise (Nilsson et al, 1994). The later can consist of monosyllables, spondees, words, key words or sentences. When sentence material is used, a speech reception threshold for sentences is usually measured instead of word scoring. Other advantages of measuring SRTs instead of percent scores include the ease of administrating the test and its reliability, by effectively eliminating the need to calculate the number (or percentage) of words repeated correctly.

An adaptive method is typically warranted for the measurement of SRTs. Such an approach is useable over a wide range of speech perception ability, and displays efficiency and accuracy in estimating the SRT (Levitt, 1978; Nilsson et al, 1994). The first sentence in a list is presented at a level below the expected SRT of the individual. The level of this first sentence is then gradually increased in specified steps until the subject can repeat it correctly. For the remaining sentences, the level is dependent on the accuracy of the previous response: it is increased following an incorrect repetition and decreased after a correct response. The SRT is estimated as the average presentation level of sentences in the last part of the list (Plomp & Mimpen, 1979; MacLeod & Summerfield, 1990; Nilsson et al, 1994). Certain requirements must nevertheless be respected in order to measure adaptive thresholds with sentences. In addition to the different lists being of equal difficulty, the items within each list must also be of equal intelligibility (MacLeod & Summerfield, 1990; Nilsson et al, 1994).

An adaptive method has long been advocated by Plomp & Mimpen (1979) who developed a technique to measure SRTs for Dutch sentences. Their initial work set the foundations for the development of speech materials and protocols for determining SRTs in many other languages, including Swedish (Hagerman, 1982; 1984) and British English (Laurence et al, 1983; MacLeod & Summerfield, 1987; MacLeod & Summerfield, 1990). The SPIN sentences (Kalikow et al, 1977; Bilger et al, 1984) have also been used to measure SRTs in American English (Dubno et al, 1984; Gelfand et al, 1988). However, scoring based on the correct repetition of a single word in each sentence may reduce the test administration efficiency in clinical settings since much of the material within a sentence is not scored. Shortcomings in the available American English material (e.g. restricted number of lists and single word scoring) led Nilsson et al. (1994) to develop the Hearing in Noise Test (HINT), founded on the earlier work of Plomp and colleagues, in which scoring is based on the correct repetition of a sentence rather than a single word.

The HINT speech material was derived from a large corpus of short sentences previously designed for use with British children, the Bamford-Kowal-Bench (BKB) sentences (Bench et al, 1979), which were modified for uniformity in length and to make them more representative of American English by removing British idioms and usages. The HINT assesses functional hearing by adaptively measuring SRTs for sentences in quiet and in three conditions of masking noise: a) noise front (speech and noise in front at 0° azimuth), b) noise right (speech in front and noise at 90° to the right), and c) noise left (speech in front and noise at 90° to the left). The HINT stimuli consist of a 65 dBA speech spectrum masking noise and 12 20-sentence lists (adult version) or 13 10-sentence lists (child version). In the HINT adaptive procedure, 4 dB steps are used for adjusting the presentation level of the first 4 sentences, whereas 2 dB steps are used for the remaining sentences in a list. The SRT is estimated by calculating the average presentation level of sentences 5–11 in a 10-sentence list or sentences 5–21 in a 20-sentence list (Note: the 11th and 21st sentences are not presented, but their presentation level is know from the previous response).

The HINT can be administered in a soundfield or headphone protocol. Soundfield and headphone HINT thresholds have been shown to be comparable, as long as the soundfield measures are not affected by room acoustics (Nilsson et al, 1996; Lamothe et al, 2002). Soundfield administration requires that two loudspeakers be placed 90° apart, one meter from the centre of the listener's head, while headphone administration requires processing of signals by head-related transfer functions (HRTFs). English norms have been established for each HINT condition and demonstrate that speech is more intelligible, as expected, when it is spatially separated from the noise source. When compared to results obtained in a noise front condition, a 6–10 dB SRT improvement can be noted in normally hearing listeners when speech is spatially separated from the noise source by 90°, emphasizing the importance of binaural hearing for speech intelligibility in noise (Soli & Nilsson, 1994; Bronkhorst & Plomp, 1988).

The HINT has been used in multiple applications and studies have clearly shown its value as a clinical and research tool. In recent studies, it has served to: 1) evaluate and compare the performance of different hearing aids (Valente et al, 1998); 2) evaluate and compare the performance of omnidirectional and directional microphones in different hearing aids and listening conditions (Valente et al, 1995; Preves et al, 1999; Valente et al, 2000; Ricketts & Dhar, 1999); 3) evaluate the performance of an adaptive, directional microphone hearing aid (Ricketts & Henry, 2002); 4) investigate the phenomenon of acclimatization to hearing aids (Saunders & Chenkowski, 1997); 5) evaluate and compare various cochlear implant signal processing strategies (Cowan et al, 1995); 6) evaluate and compare the speech recognition skills of cochlear implant patients and normally hearing individuals (Dorman et al, 1998); and 7) evaluate functional hearing abilities required for hearing-critical jobs (Laroche et al, 2003).

Within Canadian Francophone and other communities for whom English is not the preferred language, the same needs are encountered. Clinicians are concerned with their patients' speech comprehension skills in noise and research is being conducted in the fields of hearing aids and cochlear implants. Unfortunately, no reliable and efficient tools exist in many languages and dialects for the assessment of sentence-length speech intelligibility in noisy listening conditions. A simple translation of the English version of the HINT is not valid since it would lack naturalness.

The objective of the present article is to describe the various steps undertaken in the development of a Canadian French version of the HINT. The new version is expected to achieve the same goals as the English version by providing: a) a fast and reliable means of measuring SRTs for sentences with a known error of measurement; b) binaural measures in quiet and in noise; c) usability over a wide range of speech comprehension ability; d) a norm-referenced tool; e) soundfield and headphone administration; f) computerized administration; and g) multiple lists for repeated measures. Intended to be an efficient clinical tool, the test was designed to have the same format as the English version and to be controlled by the same software. The methodology was thus similar to that used by Nilsson et al (1994) and included: a) the development of a large set of sentences and validation of their naturalness as judged by native Canadian Francophone speakers; b) the recording of the speech material and synthesis of a spectrally-matched masking noise specific to the talker involved in the recording of the material; c) the determination of the performance-intensity function and equalization of sentence intelligibility; d) the generation of phonemically-balanced lists; e) the determination of acceptable errors in each sentence; f) the verification of list equivalency; and g) the establishment of SRT norms and test-retest variation among a sample of young, normally hearing, Canadian-Francophone adults for whom French was the first language.

Method

Subjects

A total of 95 French-Canadian adults participated at various steps in the study but did not all participate in any individual step. Subjects met the following common inclusion criteria, they: 1) were native French-Canadian speakers who used primarily French on a daily basis; 2) had completed post-secondary education in French; 3) were between 18 and 45 years of age; 4) had hearing thresholds equal to, or better than, 15 dB HL from 250 Hz to 8000 Hz; 5) presented no asymmetry between the two ears (defined as a difference of 15 dB or more at three frequencies or a difference of 25 dB or more at one frequency); 6) presented no difference greater than 20 dB between two adjacent frequencies for the same ear; 7) had a normal otoscopic examination; 8) had normal tympanograms and; 9) had a negative otologic history. The upper age limit was set in hopes of minimizing the possibility of reduced speech intelligibility with age attributable to central presbycusis (Hanks & Johnson, 1998; Weinstein, 1994). Using the Hughston-Westlake up-down technique (Hall & Mueller, 1997), hearing thresholds were measured with a portable audiometer (InterAcoustics AD25) and TDH-39P headphones, inside an IAC audiometric booth. The integrity of outer and middle ears was assessed with a WelshAllyn otoscope and a GS 1738 impedance bridge. Prior to their participation, all subjects were required to sign a consent form and fill out a hearing history questionnaire.

Further testing in the IAC audiometric booth was achieved with an IBM Pentium III computer coupled with a Hearing Test Device (HTD) from the House Ear Institute and MAICO Diagnostics TDH-39P headphones. A 6 cc coupler (artificial ear-B&K4152), a B&K2235 sound level meter and B&K1625 filter set, a B&K4144 microphone and a B&K 4228 calibrator were used to calibrate presentation levels.

Development of the speech material

No sentence corpus is available in French that is equivalent to the BKB corpus. As a result, a large number of sentences (524) were derived from a corpus of nouns and verbs associated with a grade-one (6–7 year old children) comprehension level (Leduc, 1997). To minimise memory effects, sentences were kept short and equal in length (5 to 7 syllables). They were also revised to eliminate regional idioms, proper names, and multiple repetitions of phonemes.

Following this initial screening, two independent groups of native speakers (n = 4 and n = 5) covering a wide range of ages, educational backgrounds and geographical origins throughout Canada took part in the verification of sentence naturalness. Group heterogeneity was desired to ensure the speech material would be considered natural for members of the general French-Canadian population, regardless of geographical origin.

Each sentence was read twice to subjects who were to rate the syntactic and semantic naturalness of the sentences on a scale of 1 to 7 (1 = 'artificial' and 7 = 'natural') and provide suggestions to improve naturalness, where needed. Sentences with a mean score of 6 or less were modified before being submitted to a second evaluation by the other group. Throughout this iterative process, 165 sentences were modified and 4 were eliminated, resulting in a final set of 520 sentences.

Processing of the material

The sentences were recorded digitally in ways identical to the procedures described by Nilsson et al. (1994). Briefly, the recordings were made in an audiometric room with additional sound absorption material on the interior surfaces. The talker was instructed to speak with a normal clear voice, using a standard dialect, while maintaining a normal rhythm of speech and avoiding placing emphasis on key words. Five researchers validated the choice of speaker by means of a telephone interview. A Quebec native French speaker who does post-synchronizing for recording studios was chosen. He was instructed to stop and preview each sentence before reading it aloud. Recordings were repeated for sentences misread or spoken with unusual pauses between syllables. The microphone (B&K 4144) was placed perpendicular to the talker at a distance of 1 meter. The sentences were recorded on a digital audio tape (DAT) with 16-bit resolution at 44 000 Hz. Following the recording session, the contents of the DAT were transferred digitally to a computer and down-sampled to 24 000 Hz.

The sentences were then edited into individual files, eliminating silent intervals before and after each waveform. The A-weighted root-mean-square (RMS) amplitude of each sentence was calculated and all sentences were scaled to the same level. After scaling, the long-term average spectrum of the entire set of sentences was computed. A 78-coefficient linear phase finite impulse response (FIR) filter was designed with an amplitude response that matched the long-term average speech spectrum with an RMS error of 0.6 dB over the 256 frequency points from 0 to 10 000 Hz. White noise was synthesized, filtered with the FIR filter and scaled to the same A-weighted RMS amplitude as the sentences. The resulting speech-spectrum noise, matched to the actual speaker, ensures that the SNR is kept, on average, approximately the same at all frequencies (Soli & Nilsson, 1994).

Group Performance Intensity (PI) Function

Using an adaptive method for SRT measurements demands that the intelligibility of sentences be relatively stable across the entire set so that different lists can be constructed that yield the same SRT. Equating the RMS amplitude of the sentence waveforms does not guarantee equal intelligibility in a fixed background noise. The phonemic content, familiarity of words, and variations in short-term level and intonation can all influence speech intelligibility in noise (Nilsson et al, 1994). One way of equating intelligibility is to adjust the level of each sentence until all sentences reach a similar target intelligibility score in the same reference noise. Before proceeding with this phase on a large number of subjects, two parameters needed to be identified: a starting SNR (the ratio of the Leq of the sentence and the Leq of the noise) and a general rule to guide the subsequent level adjustments to be made. These two parameters can be estimated by carrying out a group performance-intensity (PI) function with a small number of subjects.

The entire sentence set was divided into three groups of sentences, and a SNR (either −2, −4 or −7 dB) was assigned to each group. Sentence presentation order was counterbalanced between the subjects (n = 5) who were instructed to report every word that they heard in each sentence, and to guess if necessary. All sentences were presented over headphones in a 65 dBA masking noise. Only exact word repetitions were accepted and a percent intelligibility score was computed for each sentence from the number of words correctly reported within each sentence. As a validation of the scoring process, performance was evaluated independently by two researchers and yielded an inter-rater reliability score of 0.95 (number of words scored identically/total number of words).

For each SNR, a mean percent score was calculated. Overall group mean scores were used to estimate the slope of the PI function (10.3%/dB), as represented in Figure 1. This slope provided the adjustment rule for SNR adjustments during the equalization of sentence intelligibility and is compatible with previous research findings that a 1 dB SNR increase yields

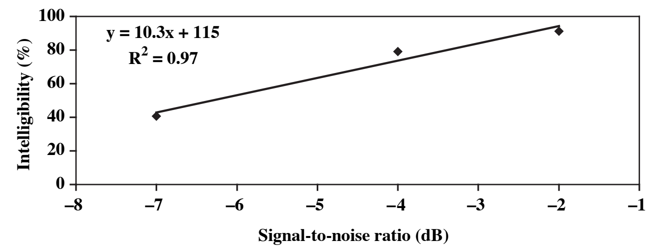

Figure 1. Group Performance-Intensity function: overall mean percent intelligibility scores as a function of SNR.

approximately a 10% improvement in speech intelligibility (Soli, personal communication). The group PI function also served to define a starting SNR. A target word intelligibility score of 70% (associated with a −4.5 dB SNR in Figure 1) was deemed appropriate to avoid floor and ceiling effects, and has also been associated with 50% sentence intelligibility – the SRT for sentences (Nilsson et al, 1991a,b).

Equating sentence intelligibility

Thirty-six subjects, distributed among 5 groups, participated in the equalization of sentence intelligibility. Sentences were presented over headphones in the speech-spectrum noise set at 65 dBA. Sentence presentation order was counterbalanced between subjects who were asked to repeat everything they heard, and to guess if necessary.

As an initial starting point with the first group of subjects (n = 5), all sentences (n = 520) were delivered at a fixed SNR of −4.5 dB. Only exact word repetitions were accepted and no feedback was provided. A mean percent intelligibility score was determined for each sentence based on the number of words repeated correctly. A distinction must be made between the percent intelligibility scores used in this phase and the scoring method in subsequent phases where calculations will be based on the correct repetition of entire sentences. These two scoring methods serve different purposes. Word intelligibility is used to equate the sentences, whereas sentence intelligibility is part of the adaptive measurement of SRTs.

In an attempt to bring the mean intelligibility scores closer to the target score (70%), the SNR of all sentences was decreased to −6.5 dB during testing with the second group (n = 7). For the remaining groups [group 3(n = 8); group 4(n = 6); group 5(n = 10)], individual SNR adjustments were applied, if needed, to each sentence according to the 10.3%/dB rule determined in the previous phase. The SNR of a sentence remained stable within a group but was increased (or decreased) between groups if its mean score was found to be lower (or higher) than the target score.

All sentences that did not follow the expected outcome after an adjustment (e.g. an increase in intelligibility following a reduction in SNR) were eliminated. Sentences were also eliminated if they had a mean accuracy score greater than 90% or less than 50%, or a high standard deviation (> 35%). From the initial set (520 sentences), 240 sentences were adequately adjusted for equal intelligibility and their SNR distribution is illustrated in Figure 2. The SNR of the majority of these sentences falls between −7 and −2 dB. More precisely, the average (or nominal) SNR is −5.0 dB, with 47% of the sentences

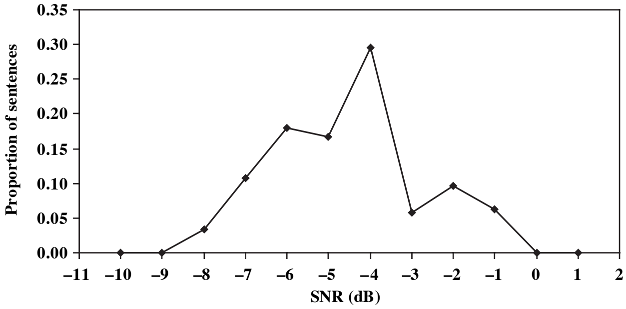

Figure 2. Signal-to-noise ratio distribution of the 240 sentences equalized for intelligibility (~70% word intelligibility)

falling within ±1 dB of the average. These results are comparable to the English HINT, where 51% of sentences fell within ± 1 dB of the average (Nilsson et al, 1994).

Creation of 10-sentence lists

Ideally, each list should yield the same SRT. List equivalency depends on equal sentence intelligibility and phonemic equivalency, and is essential to make comparisons between SRTs measured with various lists. To generate phonemically balanced lists, sentences were first transcribed in the International Phonetic Alphabet, using the Nouveau Petit Robert dictionary (Robert, 1995) as a guide. The transcriptions of 60 randomly chosen sentences were compared to those of two individuals not involved in the study and an inter-rater reliability score of 0.90 (number of sentences transcribed identically/total number of sentences) was achieved. Based on these transcriptions, the distribution of the various phonemes that make up the entire set of sentences was determined and is found in Table 1.

This phonemic distribution served to determine how many times each phoneme should theoretically occur within each list to generate balanced lists. 24 lists of 10 sentences with a phonemic distribution similar to that of the entire sentence set were created by trial and error. The difference between the target (predicted by the global distribution) and the actual count of each phoneme inside a list was then calculated and the distribution of differences is illustrated in Figure 3. Across the lists, a difference of ±1 phoneme was obtained in 75% of the phoneme counts, a finding that is again comparable to, and indeed better, than results obtained during the development of the English HINT, where a difference of ±1 phoneme was found in 58% of the counts.

Determining acceptable substitutions

After the lists were compiled, scoring criteria were relaxed to include substitutions for non-keywords in each sentence. Substitutions that sounded the same with minimal effect on meaning were accepted as correct repetitions. To determine which substitutions would be deemed acceptable, a review of the English HINT material was undertaken, followed by a discussion among researchers regarding the substitutions most frequently made during previous testing trials. Acceptable substitutions, mostly consisting of pronoun gender variations (e.g. il/elle) and article variations (e.g. ma/ta/sa/la), were then incorporated in the written scoring form of the speech material, as found within parentheses in Appendix A.

Table 1. Percent frequency of occurrence of the various consonants (20) and vowels (16) found in the French version of the HINT

CONSONANTS		*VOWELS*	
Phoneme	*Frequency of occurrence (%)*	*Phoneme*	*Frequency of occurrence (%)*
p	2.9%	ɛ̃	1.1%
t	4.5%	ɑ̃	2.9%
k	2.6%	ɔ̃	3.0%
b	2.3%	œ̃	0.4%
d	3.5%	ə	3.3%
g	0.9%	ɛ	8.3%
m	2.9%	a	7.1%
n	2.1%	i	4.3%
ŋ	0.1%	ɔ	1.9%
s	5.0%	u	2.2%
ʃ	1.7%	ø	0.4%
f	1.9%	œ	0.5%
z	1.4%	a	1.5%
ʒ	2.4%	e	2.2%
v	2.1%	o	1.6%
r	7.5%	y	2.3%
l	10.7%		
j	1.9%		
w	1.0%		
ɥ	0.2%		

Verifying list equivalency

Before the lists could finally be considered ready for SRT measurements and normative studies, their equivalency had to be verified. The underlying principle of this verification is that equivalent lists should all yield similar SRTs. All 24 lists were presented under headphones to a group of subjects using the HINT for Windows software and an adaptive method to determine list-specific SRTs in a simulated 65 dBA noise front condition. Pre-processing of the signals with generic KEMAR HRTFs allows simulating the effects of azimuth on the speech and noise stimuli reaching both ears (Burkhard & Sachs, 1975).

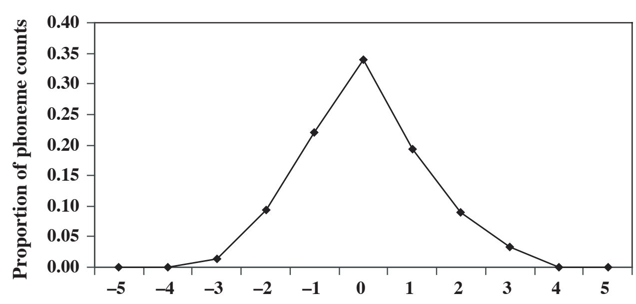

Figure 3. Distribution of the differences between the target and obtained phonemic count for the 36 French phonemes that make up the 240 sentences of the French HINT.

Nine native French speakers were instructed to report every word that they heard in each sentence. Based on correct sentence repetition, rather than word repetition, list-specific SRTs were computed for each subject. A mean list SRT across all subjects and an overall mean SRT across all lists and subjects were computed. The overall mean (−3.3 dB; s.d. =0.5 dB) is similar to results obtained with the English HINT (mean = −2.9 dB; s.d. =0.8 dB; Nilsson et al, 1994). List-specific SRTs can be expressed in terms of a deviation score from the overall mean, as illustrated in Figure 4. As shown, all list SRTs fall within ±1 dB of the overall mean. An analysis of variance found no significant effect of list [$F(23,192) = 0.96$, $p = 0.52$], indicating that results obtained with one list are comparable to those obtained with other lists.

Generating 20-sentence lists

Plomp & Mimpen (1979) and Nilsson et al. (1994) have demonstrated that statistical power (sensitivity of SRT measurement) and measurement error (reliability) improve with the number of sentences per list. More specifically, Nilsson et al. (1994) found that 20-sentence lists are needed to reliably measure SRT differences of 1.5–2.0 dB. Although longer lists require additional time to administer, the prudent choice for the French HINT was to use 20-sentence lists.

To obtain the most equivalent set of 20-sentence lists, the 10-sentence lists were paired using the deviation scores depicted in Figure 4 in the following manner: the list with the biggest negative deviation score was paired with the list associated with the largest positive deviation score, and so forth for other lists. List standard deviation scores were also taken into consideration to ensure that lists with high standard deviations were not consistently matched together. The resulting 20-sentence lists are found in Appendix A.

Establishment of headphone norms

Lists of 20 sentences were presented to 36 subjects under headphones to simulate 4 free-field conditions using the KEMAR HRTFs: 1) quiet (speech at 0° azimuth); 2) noise front-NF (speech and noise at 0° azimuth); 3) noise right-NR (speech at 0° azimuth and noise at 90°); and 4) noise left-NL (speech at 0° azimuth and noise at 270°). The speech-spectrum noise was fixed at 65 dBA, while sentence levels were adaptively adjusted for SRT measurement according to the standard procedure (4 dB steps, then 2 dB steps for sentences 5–21). The HINT software randomly chose lists and testing always began with the quiet condition. Presentation order for the remaining conditions was counterbalanced between subjects. Two SRTs were measured in each condition to determine if there were practice effects and to measure test-retest reliability.

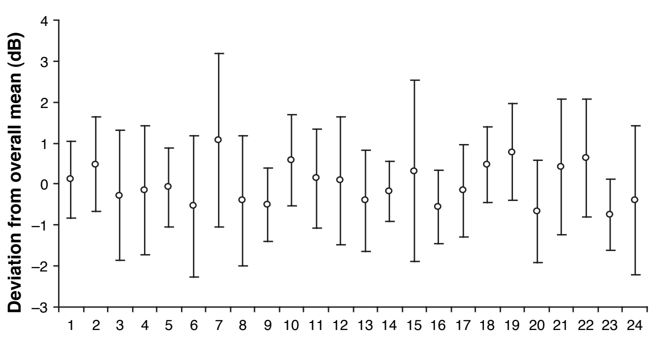

Figure 4. Deviation of individual mean list SRTs (open circles) from the overall mean SRT (−3.25 dB) across all lists and participants. Error bars depict ±1 standard deviation.

Overall mean SRTs and standard deviations across all subjects and lists are found in Table 2. Scores are expressed as the speech level at threshold (in audible noise the SNR rather than the speech level determines threshold). Threshold is defined as 50% sentence recognition. As shown in Table 2, variability was greater for the quiet condition, a result also noted with the English HINT. Nilsson et al. (1994) attributed this variability to differences in hearing sensitivity among subjects. Indeed, some subjects had hearing thresholds at the screening limit (15 dB HL) while others exhibited thresholds between −10 and 0 dBHL, differences that would not affect SRT measures in noise since these are performed at suprathreshold levels.

A repeated-measures ANOVA of noise conditions, with factors of conditions and test number, was performed to determine if there were any significant differences between the mean SRTs and if testing repetition influenced performance. A significant effect of noise condition was revealed [$F(2,70) = 1983.6$, $p < 0.001$]. In other words, the position of the noise source with reference to the speech source had a significant effect on SRTs, a finding consistent with other studies (Soli & Nilsson, 1994; Lamothe & al, 2002). No effect of trial was found [$F(1,70) = 2.5$, $p = 0.1$]. By means of a t-test for paired comparisons and a Bonferroni adjustment for multiple comparisons (Duncan, Knapp & Miller, 1983), post-hoc analyses were performed on the following pairs: NF—NR, NF—NL and NR—NL. In accordance with the English HINT normative data (Soli & Nilsson, 1994), a significant difference was revealed between the NF and the 2 noise side conditions, but not between the noise side conditions.

A paired t-test comparison for the quiet condition, revealed that the mean SRT was significantly higher in the first trial ($t = 4.8$, $p < 0.001$), suggesting the presence of a learning effect. Given this difference between repetitions, the mean SRT for the second trial was used in the specification of norms for young French Canadian adults with normal hearing. Clinically, this requires the administration of a practice list to minimize the learning effect in quiet.

Table 2. Mean SRTs and standard deviations for 2 separate testing trials with 36 adult native French speakers

Listening condition	*Trial*	*Mean {dB(A) or S/N ratio}*	*Standard deviation (dB)*
Quiet	1	18.4	4.1
	2	16.4	3.8
Noise front (0°)	1	−3.0	1.1
	2	−3.5	1.1
Noise right (90°)	1	−11.5	1.2
	2	−11.5	1.4
Noise left (270°)	1	−11.3	1.4
	2	−11.5	1.1

The norms in Table 3 were established by adding two standard deviations to mean SRTs in order to cover 95% of the normal-hearing population. The norm for the HINT composite score $[(2 \times NF + NR + NL)/4]$, a score often used as a single descriptor of noise conditions, is also reported in Table 3 (mean = −7.2; s.d. = 0.8).

Reliability of SRT measures (measurement error)

The reliability of SRT thresholds with the French HINT can be calculated as the within-subjects standard deviation of repeated measurements, σ_w, as follows:

$$\sigma_\omega = \sqrt{\frac{\sum_{i=1}^{n}\sum_{j=1}^{k}(x_{i,j} - \mu_i)^2}{n(k-1)}}$$

where $x_{i,j}$ is the j^{th} threshold of the i^{th} subject, μ_i is the mean of the thresholds provided by the i^{th} subject, k is the number >of trials ($k = 2$ in this study for test and retest), and n is the number of subjects. This measure is consistent with that used by Plomp & Mimpen (1979) for the total measurement error.

A within-subjects standard deviation σ_w of 2.2 and 1.1 dB is obtained in this study for the quiet and noise conditions (NF, NR or NL), respectively, and 0.6 dB for the composite score. As expected, the composite score is a more reliable measure since it is based on three independent SRT measures. The standard deviation associated with the noise conditions is only slightly higher than that obtained by Plomp & Mimpen (0.9 dB), whereas the quiet measurement error is substantially greater for the French material than their Dutch material (1.1 dB).

The within-subject standard deviation σ_w includes two sources of errors: (1) a constant error due to systematic biases like practice effects between test and retest, and (2) a variable error due to random effects such as list choice, guessing, etc. The first can be estimated as the average difference in test-retest scores among subjects, while the second can be estimated by removing the systematic error from the total error. Variable errors of 1.0, 1.1 and 0.6 dB can be estimated in this manner for the quiet condition, the noise conditions and the composite score, respectively. This method of reporting measurement error is consistent with Nilsson et al. (1994), who found variable errors of 1.0 dB for the quiet condition and 0.8 dB for the noise conditions when using 20 sentences. In the case of noise conditions and composite scores, variable and total errors are identical in the present study and reflect the fact that no significant difference was found for SRTs measured in the various noise conditions during repeated measures. In quiet, the variable error (1.0 dB) is significantly lower than the total error (2.2 dB), due to a systematic difference between the two repetitions (Table 2).

The measurement errors associated with the HINT provide very valuable information to interpret single and repeated SRT measurements. There is a probability of 0.95 that a single measured threshold will fall within 1.96 σ_w of the "true" threshold. Likewise, SRTs that differ by more than 1.96 σ_w can be considered to differ significantly ($p < 0.05$).

Discussion

Important considerations for the French HINT

This paper described the development of a French HINT directly applicable and validated for French Canadians. Before measuring SRTs with French listeners from other countries, native speakers should validate the material since variations in the form, content and use of French in other dialects could influence the perceived naturalness of sentences. Should the sentences be judged natural, accent differences between Canadian and other types of French could still preclude using the existing recordings. In that case, sentences would need to be recorded by a native speaker of the target country or dialect and the various steps in the development of the HINT would need to be reiterated.

The HINT's value is not limited to adult populations. A children's version, the HINT-C (Nilsson & al, 1996) is also available in English and is currently under development in French. Other future research activities should include the comparison of performance on the HINT for French unilingual and bilingual individuals. Lamothe et al (2002) found no significant difference between their unilingual and bilingual subjects on the English HINT, provided English was learned before the age of 10. When this occurs, the same reference norms can be used with both populations.

The normative study revealed a statistically significant difference between testing trials for the quiet condition, suggesting a possible practice effect. Interestingly, this finding was not observed in the Lamothe et al. (2002) study on the standardization of the English HINT with bilingual and unilingual individuals. It is nonetheless highly recommended that a HINT testing session be preceded by a practice list to minimise the possible influence of learning. Two practice lists, found in Appendix B, have been created based on sentences excluded during previous phases of this project.

Use of the HINT

The HINT can be administered under headphones or in a soundfield protocol. In most cases, headphone testing is

Table 3. French HINT headphone norms established with 36 adult French speakers, and limits for 95% confidence interval

Condition	*Mean {dB(A) or S/N ratio}*	*Lower limit (2.5th centile)*	*Upper limit (97.5th centile)*
Quiet*	16.4	8.8	24.1
Noise front	−3.0	−5.2	−0.8
Noise side	−11.4	−14.0	−8.8
Composite score	−7.2	−8.8	−5.6

*Applicable after one practice list

more reliable and easier to administer than soundfield testing, and norms are applicable to all test sites. However, soundfield protocols may be a better choice for certain applications, especially with hearing aid users, but site-specific norms need to be established for each test site. Indeed, the sound pressure level of the signals reaching both ears can differ significantly due to differences in sound wave reflections that are dependent on the configuration of the testing chamber (reverberation time, reflections, objects acting as obstacles to sound propagation, etc.). For example, Lamothe et al. (2002) showed a significant difference between SRTs for the noise right and noise left conditions, a difference that can be explained by the influence of room acoustics in soundfield testing.

The importance of the HINT has been demonstrated through many clinical and research applications, and is being developed in many languages. One advantage of such a multilingual system is the rapid dissemination of research findings and the possibility of cross-language studies (Laroche et al, 2003). The speech material developed for purposes of the HINT can also serve as a large set of phonemically balanced sentence lists (Beukelman et al, 2002; Hustad & Cahill, 2003).

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Appendix A

List 1

1. (Le/Ce) clown est vraiment drôle.
2. (Le/Ce/Les) coq réveille (le/ce) village.
3. (Le/Ce) marchand vend (des/les) bonbons.
4. (Le/Ce/Les) chien dormait dehors.
5. (Son/Ton/Mon) veston est troué.
6. (Les/Ces) grenouilles sont vertes.
7. (Il/Elle) vit dans la jungle.
8. (Il/Elle) doit prendre (ses/des/les) vitamines.
9. (Les/Des/Mes/Tes/Ces/Ses) enfants courent dehors.
10. (Le/Ce) camion est rouge.
11. (La/Ma/Ta/Sa) fille lave ses mains.
12. (Les/Ces) grenouilles plongent dans l'eau.
13. La salle était vide.
14. (Ce/Le/Ces) garçon pédale très vite.
15. L'arbre est bien décoré.
16. (Il/Elle) mange avec une fourchette.
17. L'oiseau est sur une branche.
18. Tous les chats sont gris.
19. (Elle/Il) va perdre (son/ton/mon) temps.
20. (Le/Ce) sac est plein de billes.

List 2

1. (Elle/Il) a compté jusqu'à dix.
2. (Il/Elle) loue un film d'horreur.
3. (La/Ma/Ta/Sa) fenêtre est ouverte.
4. Tout (le/ce) monde est en classe.
5. L'éléphant a une longue trompe.
6. (Le/Ce/Les) serveur apporte (la/ma/ta) crème.
7. (La/Sa/Ta/Ma) soupe était délicieuse.
8. (Mes/Les/Tes/Ces/Ses) frères jouent au base-ball.
9. (Ils/Elles) vont à la plage.
10. (Il/Elle) nage dans la rivière.
11. J'aime (les/des) couchers de soleil.
12. Maman épluche une orange.
13. Papa tirait (le/ce/les) chariot.
14. (Les/Mes/Tes/Ses/Ces/Des) enfants jouent dans (le/ce) sable.
15. (Ce/Le) casse-tête est difficile.
16. (Il/Elle) (s'est perdu/est perdu) dans (la/ma/ta/sa) ville.
17. (Elle/Il) écoute (la/ma/ta/sa) radio.
18. (Elle/Il) était très (patiente/patient).
19. (Son/Mon/Ton) sac était très lourd.
20. (Il/Elle) m'a lancé (la/sa/ta/ma) balle.

List 3

1. L'écureuil grimpe dans l'arbre.
2. (Ce/Le/Ces) musicien joue du piano.
3. La marmotte creuse un trou.
4. (Elle/Il) achète (des/ces/les) légumes frais.
5. L'homme est très poli.
6. (Cette/Ces/Sa) femme joue du piano.
7. (Ses/Mes/Tes) cheveux sont blonds.
8. (Son/Mon/Ton) cerf-volant est jaune.
9. (Le/Ce) mulot vit dans (les/ces/des) champs.
10. (Ils/Elles) étaient très malades.
11. (Le/Ce/Les) chien ramène (le/ce/les) jouet.
12. La souris mange du fromage.
13. (Elle/Il) boit du jus d'orange.
14. (Le/Ce/Les) petit garçon chante bien.
15. (Les/Ces/Ses/Mes/Tes/La) batteries ne fonctionnent plus.
16. (Il/Elle) mange de la crème glacée.
17. (Il/Elle) a caché (la/ma/ta/sa) plume.
18. (Elle/Il) lui tire les cheveux.
19. (Tu as/T'as) caché (mon/ton/son) jouet.
20. (La/Ma/Ta/Sa) mère berce (son/ton/mon) enfant.

List 4

1. (Elle/Il) prend un bain chaud.
2. Cette église est très vieille.
3. (Les/Le/Ces/Des) dragons crachent du feu.
4. (Ton/Mon/Son) jus est sur la table.
5. (Ils/Elles) prennent une marche.
6. (Elle/Il) prend soin de (sa/ma/ta) mère.

7. (Ils/Elles) ont marché sur (le/ce) pont.
8. (Il/Elle) mange (sa/la/ma/ta) soupe.
9. La jeune fille se brosse les dents.
10. (Ils/Elles) ont cassé tous les oeufs.
11. Le vent fait bouger (les/des) feuilles.
12. (Elle/Il) saute sur (la/ma/ta/sa) trampoline.
13. (Ce/Le) bonbon est très sucré.
14. (Elle/Il) joue avec (ma/ta/sa/la) poupée.
15. (Ils/Elles) vont jouer au parc.
16. L'oiseau s'envole du nid.
17. (Il/Elle) joue aux billes avec (moi/toi).
18. Cette histoire est triste.
19. (Elle/Il) (a fait/fait) fondre de la glace.
20. J'ai un livre à colorier.

List 5

1. (Il/Elle) n'aime pas (le/les/ce) brocoli.
2. (Ils/Elle) regardent (le/les/ce) spectacle.
3. (Les/Mes/Tes/Ces/Ses) roses blanches sont belles.
4. La souris est un rongeur.
5. (Les/Mes/Tes/Ses) vacances sont finies.
6. Maman achète du pain.
7. (Le/Ce/Les) veau grossit vite.
8. L'ours trouve du miel.
9. (Le/Ce) souper était chaud.
10. J'ai peur (des/du) crocodiles.
11. (Notre/Votre) fille se marie demain.
12. (Le/Ce/Les) chat regarde l'oiseau.
13. (Les/Ces) flocons de neige sont blancs.
14. (Elle/Il) a perdu (sa/ma/ta/la) valise.
15. (Elle/Il) (a fait/fait) (son/mon/ton) lit.
16. Il ne faut pas manger vite.
17. (Elle/Il) porte (des/mes/tes/ses/ces) boucles d'oreille.
18. (Le/ce/Les) groupe marchait vers (le/ce) parc.
19. (J'ai/Je) sali (ma/ta/sa/la) blouse.
20. (Ma/Ta/Sa) tante fait de la couture.

List 6

1. (Ils/Elles) ont compté un but.
2. (Son/Ton/Mon) oncle raconte une histoire.
3. (Elle/Il) met (ses/mes/tes/des) souliers.
4. (Ce/Le) livre est rempli d'images.
5. (Le/Ce) pot est brisé.
6. (Elle/Il) pointe du doigt.
7. (Les/Ses/Ces/Tes/Mes) choux poussent dans (le/ce) jardin.
8. Le ciel est nuageux.
9. (Ma/Sa/Ta/La) mère range (la/sa/ta/ma) vaisselle.
10. (La/Sa/Ta/Ma) petite fille cherche (sa/la/ma/ta) bague.
11. (Cette/ces) dame aime se faire bronzer.
12. (Le/Ce) voleur est dans la banque.
13. (Le/Ce/Les) lapin ronge une carotte.
14. (La/Ma/Ta/Sa/Les) vache mange du foin.
15. J'ai gagné (le/ce/les) concours.
16. (Il/Elle) aime (les/des) tranches de fromage.
17. La souris aime être propre.
18. (Cette/Ces) fournaise fonctionne au gaz.
19. Je suis tombé sur la glace.
20. (Il/Elle) est parti à la pêche.

List 7

1. (La/Ma/Ta/Sa) machine fait du bruit.
2. (Il/elle) est né à l'hôpital.
3. (Son/Ton/Mon) cousin est grand.
4. L'arbre a perdu (ses/des) feuilles.
5. L'(enseignante/enseignant) ramasse (les/des) tests.
6. (Tes/Les/Mes/Ces/Ses) lunettes sont rondes.
7. (La/Ma/Ta/Sa) coiffeuse coupe (mes/les/tes/ses) cheveux.
8. (Le/Ce) chemin est droit.
9. (Le/Ce/Les) chien joue dans (la/ma/ta/sa) cour.
10. (Les/Ces/Des/Tes/Mes/Le) ballons flottent sur l'eau.
11. (La/Ma/Ta/Sa) chèvre mangeait de l'herbe.
12. Tous les poissons vivent dans l'eau.
13. Elle est très gentille.
14. L'oiseau a perdu (ses/des) plumes.
15. (Ils/Il/Elles) (bâtissent/bâtit) une école.
16. Nous allons à la banque.
17. (Il/Elle) mange une salade (de/aux) fruits.
18. La dame lave (son/ton/mon) visage.
19. (Ce/Le) film est intéressant.
20. (Elle/Il) (s'est/est) fâchée contre (son/ton/mon) père.

List 8

1. (Il/Elle) écoute de la musique.
2. (Elle/Il) se lève tôt (ce/le) matin.
3. (Les/Mes/Tes/Ces/Ses) chaises et (la/ma/ta/sa) table sont brunes.
4. (Elles/Ils) jouaient à la cachette.
5. (Ces/Les/Mes/Tes/Ces/Ses) champignons sont bruns.
6. (Elle/Il) cherche (le/ce) panier de pommes.
7. (Le/Ce/Les) joueur frappe (la/sa/ma/ta) balle.
8. On (plantera/planta) (les/des/mes/tes/ces/ses) graines.
9. (Le/ce) chien est devant l'auto.
10. (Il/Elle) est professeur d'histoire.
11. La fille dort dans (son/mon/ton) lit.
12. (Le/Ce/Les) pirate cherche un trésor.
13. (Les/Des/Ces) abeilles font du miel.
14. (Sa/Ma/Ta) mère fait une tarte.
15. (Le/Ce/Les) facteur apporte une lettre.
16. (Ils/Elles) font des bonhommes de neige.
17. (Il/Elle) a écrit au tableau.
18. (Le/Ce/Les) chat joue avec (la/sa/ma/ta) balle.
19. L'avion est dans les nuages.
20. (Il/Elle) a perdu (son/mon/ton) bas.

List 9

1. (Elle/Il) porte plusieurs bagues.
2. (Les/Ces/Ses/Mes/Tes) chevaux sont dans (le/ce) champ.
3. (Ce/Ces/Le) chemin mène au village.
4. L'herbe est trop longue.
5. (J'ai/Je) fait cuire du poisson.
6. (Ils/Elles) aimaient (les/des/mes/tes/ces/ses) raisins secs.
7. (Ces/Ses/Mes/Tes/Les) bijoux sont en or.

8. (Il/Elle) est parti en voyage.
9. (Le/Ce) voisin tond (la/sa/ma/ta) pelouse.
10. (Le/Les/Ce) savon nettoie bien.
11. (Le/Ce) garçon mange (la/sa/ma/ta) poire.
12. La planète est grosse.
13. L'enfant dessine un cochon.
14. (Le/Ce) corbeau a des plumes noires.
15. (Il/Elle) joue aux quilles avec (nous/vous).
16. (Les/Des/Mes/Ces/Tes) enfants vont à l'école.
17. (Notre/Votre) maison est grise et bleue.
18. (Son/Mon/Ton) bateau est très rapide.
19. (Les/Des) outardes arrivent du sud.
20. (Elle/Il) (s'est/se) sali les mains.

List 10

1. (Son/Mon/Ton) ballon a éclaté.
2. J'ai fabriqué (cette/ces) cabane.
3. L'horloge sonne à toutes les heures.
4. (Son/Mon/Ton) sac est rempli de cadeaux.
5. Il faisait beau hier.
6. (Il/Elle) (a fait/fait) le tour du monde.
7. (Le/Ce/Les) bébé mange souvent.
8. (Son/Mon/Ton) livre est neuf.
9. (Elle/Il) regarde par (la/ma/sa/ta) fenêtre.
10. (Les/Mes/Tes/Ces/Ses/Le) chiens jappent très fort.
11. (La/Sa/Ma/Ta) cabane est dans l'arbre.
12. (La/Sa/Ma/Ta) musique était (trop/très) forte.
13. (Son/Mon/Ton) frère ramasse (les/la/des/mes/tes/ces/ses) poubelles.
14. (Le/Les/Ce) bûcheron coupe du bois.
15. (Il/Elle) ronge encore ses ongles.
16. (Sa/Ma/Ta/La) soeur aime chanter.
17. (Il/Elle) voyage dans l'espace.
18. (Elle/Il) s'est trouvée un emploi.
19. L'ours est pris dans (le/ce) piège.
20. (Le/Ce) chocolat a fondu.

List 11

1. (Mon/Ton/Son) argent est à la banque.
2. (Le/Ce) chien joue avec son os.
3. (Ils/Elles) ont trouvé un sapin.
4. (Ces/Les) palmiers sont magnifiques.
5. (Il/Elle) (jouera/joua) de la flûte.
6. (Il/Elle) (a fait/fait) plusieurs erreurs.
7. (Elle/Il) a eu mal au dos.
8. (Elle/Il) devinait les réponses.
9. (Il/Elle) (m'a/a) dit une menterie.
10. (Elle/Il) raconte une belle histoire.
11. Je (vais/veux) m'asseoir sur (ce/le) banc.
12. (Il/Elle) fait tomber toutes (les/ses) quilles.
13. (Le/Ce) loup n'avait rien mangé.
14. (La/Ma/Ta/Sa) vache est noire et blanche.
15. (Elle/Il) prend (son/ton/mon) sac à dos.
16. (Il/Elle) est sorti de prison.
17. (Tes/Ces/Ses/Mes/Les) souliers sont en cuir.
18. Maman (a fait/fait) cuire une dinde.
19. (Elle/Il) porte une tuque en laine.
20. (Mon/Ton/Son) parapluie est jaune.

List 12

1. Nous aimons voyager.
2. (Il/Elle) (gardera/garda) (sa/ma/ta) soeur.
3. (Il/Elle) marche sur la pointe des pieds.
4. (Les/Ces/Ses/Mes/Tes) bonbons coûtent un dollar.
5. Il faut lire (la/sa/ma/ta) page.
6. (La/Sa/Ma/Ta) porte est orange.
7. (Ce/Le) jeu (nous/vous) amuse.
8. (Mes/Ses/Tes) dessins sont les plus beaux.
9. (Les/La/Mes/Tes/Ces/Ses) filles jouent dans le sable.
10. (Le/Ce) lac est très calme.
11. (Les/Des/Mes/Tes/Ces/Ses) enfants sautent dans la neige.
12. Le soleil se couche tôt.
13. (Il/Elle) porte un nouveau gilet.
14. Je voyage par autobus.
15. (Le/Ce) fromage sent mauvais.
16. Cette boîte contient (des/les/mes/tes/ses/ces) livres.
17. (Elle/Il) dessine une fleur bleue.
18. (Les/Mes/Tes/Ces/Ses) vaches sont dans l'étable.
19. (C'est/T'es) une perle rare.
20. (Il/Elle) porte un chandail.

Appendix B Practice sentence sets

List 1

1. Les feuilles tombent à l'automne.
2. (Le/Ce/Les) cochon joue dans la boue.
3. Je bois du chocolat chaud.
4. La cloche sonne à midi.
5. (Le/Ce) lion est dans sa cage.
6. (Elle/Il) écrit avec un stylo.
7. (Elle/Il) porte (des/ses) lunettes.
8. (Ces/Les) biscuits sont bons.
9. Cette auto roule très vite.
10. (Il/Elle) mange un morceau de tarte.
11. (Ses/Les) souliers sont pleins de boue.
12. (Les/Des/Ces) oiseaux chantent dans l'arbre.
13. (Les/Ces) citrouilles sont oranges.
14. (Elle/Il) vend de la limonade.
15. La cuisine est grande.
16. (Ils/Elles) vont à la campagne.
17. (Les/Ces/Mes/Tes) tulipes sont jolies.
18. La lune brille dans le ciel.
19. L'oiseau sort de (sa/la) cage.
20. La dame a gagné un prix.

List 2

1. (Elles/Ils) glissaient sur la côte.
2. La jeune fille est très mignonne.
3. (Le/Ce) cochon buvait de l'eau.
4. (Il/Elle) joue aux dominos.
5. (La/Sa/Ma/Ta) valise est pleine de linge.

6. (Elle/Il) parle au téléphone.
7. (Elles/Ils) vont au cinéma.
8. L'homme portait un chapeau.
9. (Le/Ce) garçon prend l'autobus.
10. (Le/Ce) clochard dort dans le parc.
11. (Sa/La/Ma/Ta) montre est brisée.
12. (Les/Ses/Mes/Tes) livres sont tous bien rangés.
13. (Le/Ce) monsieur lit son (mon/ton) journal.
14. (Elle/Il) nageait dans la (sa/ta/ma) piscine.
15. (Elle/Il) ouvre son (ton/mon) parapluie.
16. (Sa/Ta/Ma) mère lui donne une caresse.
17. (Les/Ses/Tes/Mes) enfants traversent la rue.
18. (Le/Ce) chef prépare un repas.
19. (Ma/La/Ta/Sa) grand-mère tricote des bas.
20. (Ses/Tes/Mes) yeux sont remplis de larmes.