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REVUE CANADIENNE D'ORTHOPHONIE ET D'AUDIOLOGIE | RCOA

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Speech-Language and Audiology Canada (SAC) is a member-driven organization that supports, promotes and elevates the professions of our members. We are the only national organization passionately supporting and representing speech-language pathologists, audiologists and communication health assistants inclusively.

The association was founded in 1964 and incorporated under federal charter in 1975. SAC's periodical publications program began in 1973.

The purpose of the Canadian Journal of Speech-Language Pathology and Audiology (CJSLPA) is to disseminate contemporary knowledge pertaining to human communication and communication disorders that influence speech, language and hearing processes. The scope of the Journal is broadly defined so as to provide the most inclusive venue for work in human communication and its disorders. CJSLPA publishes both applied and basic research, reports of clinical and laboratory inquiry, as well as educational articles related to normal and disordered speech, language, and hearing in all age groups. Classes of manuscripts suitable for publication consideration in CJSLPA include tutorials; traditional research or review articles; clinical, field and brief reports; research notes; and letters to the editor (see Information to Contributors). CJSLPA seeks to publish articles that reflect the broad range of interests in speech-language pathology and audiology, speech sciences, hearing science and that of related professions. The Journal also publishes book reviews, as well as independent reviews of commercially available clinical materials and resources.

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Speech-Language and Audiology Canada is the national voice and recognized resource for speech-language pathology and audiology in Canada.

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Speech-Language and Audiology Canada supports and empowers our members to maximize the communication and hearing potential of the people of Canada.

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OBJET ET PORTÉE

Nous sommes Orthophonie et Audiologie Canada (OAC), une organisation axée sur la membriété qui appuie, promeut et élève les professions de nos membres. Nous sommes le seul regroupement national qui s'emploie passionnément à appuyer et à représenter les orthophonistes, les audiologistes et les aides en santé de la communication du Canada, inclusivement.

L'association a été fondée en 1964 et incorporée en vertu de la charte fédérale en 1975. L'association a mis sur pied son programme de publications en 1973.

L'objet de la Revue canadienne d'orthophonie et d'audiologie (RCOA) est de diffuser des connaissances relatives à la communication humaine et aux troubles de la communication qui influencent la parole, le langage et l'audition. La portée de la Revue est plutôt générale de manière à offrir un véhicule des plus compréhensifs pour la recherche effectuée sur la communication humaine et les troubles qui s'y rapportent. La RCOA publie à la fois les ouvrages de recherche appliquée et fondamentale, les comptes rendus de recherche clinique et en laboratoire, ainsi que des articles éducatifs portant sur la parole, le langage et l'audition normaux ou désordonnés pour tous les groupes d'âge. Les catégories de manuscrits susceptibles d'être publiés dans la RCOA comprennent les tutoriels, les articles de recherche conventionnelle ou de synthèse, les comptes rendus cliniques, pratiques et sommaires, les notes de recherche, et les courriers des lecteurs (voir Renseignements à l'intention des collaborateurs). La RCOA cherche à publier des articles qui reflètent une vaste gamme d'intérêts en orthophonie et en audiologie, en sciences de la parole, en science de l'audition et en diverses professions connexes. La Revue publie également des critiques de livres ainsi que des critiques indépendantes de matériel et de ressources cliniques offerts commercialement.

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Orthophonie et Audiologie Canada appuie et habilite ses membres en vue de maximiser le potentiel en communication et en audition de la population canadienne.

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SUMMER ISSUE

Our second CJSLPA issue for 2015 presents readers with four articles, three related to speech-language topics and one to audiology. The first two articles both contribute to our understanding about adults who stutter. In a Canadian study, Bauerly and De Nil used a finger-tapping task to compare practice effects and learning in 23 adults, 11 who stutter and 12 who do not stutter. They compared performance in the two groups on performance measures such as accuracy and reaction time under both single and dual task conditions. Interesting differences were found between groups depending on the performance measure observed. In the second paper on stuttering, Hudock and colleagues reported on research that aimed to examine the effect of stuttering on eye-gaze behaviors in fluent speakers. The participants were 16 college-age students who observed brief video speech samples of persons who stutter and persons who do not stutter. They reported noteworthy differences in eye gaze patterns across speaker-group.

In previous issues of the journal, one emerging theme has been the efforts of Canadian researchers to develop new and validated tools in French, particularly for the pediatric population. In this issue, Croteau et al. add to this growing body of Canadian research. They contribute an article that describes the development and validation of a measurement tool for school-age children. The new tool, *Évaluation des facteurs environnementaux influençant la participation sociale des élèves du primaire présentant un trouble de la communication*, consists of two questionnaires that aim to evaluate the environmental factors that influence social participation in 5 to 13-year old children.

Our final article in this issue is related to the current topic of neonatal hearing screening. Qi et al., a team of Canadian colleagues, collected tympanometric data from 31 babies in the Neonatal Intensive Care Unit (NICU) using different approaches to provide preliminary normative data for babies from the NICU. The differences between the traditional baseline approach and the approach investigated resulted in a conclusion that different normative data should be considered.

As always, I remind you to keep CJSLPA on your consideration list when preparing your papers for publication. As an open-access journal widely available to researchers, clinicians, and consumers, your article will receive fantastic exposure. Thank you to our many reviewers and our team of Associate Editors who so freely give your time to help the authors improve the quality of their articles for CJSLPA.

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Mot de la Rédactrice en Chef

NUMÉRO D'ÉTÉ

Notre deuxième numéro de RCOA de 2015 présente à ses lecteurs quatre articles : trois qui ont trait à l'orthophonie et un à l'audiologie. Les deux premiers articles contribuent à notre compréhension des adultes qui bégaient. Dans une étude canadienne, Bauerly et De Nil ont utilisé une tâche de tapotement du doigt pour comparer les effets de la pratique et l'apprentissage chez 23 adultes, 11 qui bégaient et 12 qui ne bégaient pas. Ils ont comparé la performance dans les deux groupes sur des mesures comme l'exactitude et le temps de réaction dans des conditions de tâches simples et de tâches doubles. On a trouvé des différences intéressantes entre les groupes, selon la mesure de performance observée. Dans le deuxième article sur le bégaiement, Hudock et ses collègues font rapport d'une recherche visant à examiner l'effet du bégaiement sur les comportements de fixation du regard chez les locuteurs ayant une bonne fluidité verbale. Seize collégiens ont observé de courts extraits de vidéos de personnes qui bégaient et de personnes sans bégaiement. Ils rapportent des différences remarquables dans les schémas de fixation du regard à travers les groupes de locuteurs.

Dans des numéros précédents de la *Revue*, un des thèmes émergents est celui des efforts déployés par les chercheurs canadiens pour élaborer des outils nouveaux et validés en français, particulièrement pour la population pédiatrique. Dans ce numéro, l'article de Croteau et al. s'inscrit dans ce courant de la recherche canadienne en plein croissance. Ils proposent un article qui décrit l'élaboration et la validation d'un outil de mesure destiné aux enfants d'âge scolaire. Ce nouvel outil, *Évaluation des facteurs environnementaux influençant la participation sociale des élèves du primaire présentant un trouble de la communication*, compte deux questionnaires visant à évaluer les facteurs environnementaux qui influencent la participation sociale d'enfants de 5 à 13 ans.

Notre dernier article, dans ce numéro, a trait à un sujet d'actualité, celui du dépistage de la surdité chez les nouveau-nés. Qi et al., une équipe de collègues canadiens, ont collecté des données tympanométriques de 31 bébés dans les unités des soins intensifs pour nouveau-nés (USIN) en utilisant différentes approches pour produire des données normatives préliminaires pour cette population de bébés. Les différences entre l'approche de référence traditionnelle et l'approche faisant l'objet de cette recherche a mené à la conclusion qu'il faudrait considérer des données normatives propres à chaque approche.

Comme toujours, je vous rappelle de considérer la RCOA quand vous préparez vos articles pour publication. Comme revue à accès ouvert largement disponible aux chercheurs, aux cliniciens et aux consommateurs, votre article recevra une large exposition. Merci à nos nombreux réviseurs et à notre équipe de rédacteurs et rédactrices associés qui donnez si généreusement de votre temps aux auteurs pour améliorer la qualité des articles qu'ils destinent à la RCOA.

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Nonspeech sequence skill learning under single and dual task conditions in adults who stutter

Apprentissage de séquences non verbales dans des conditions de tâches simples et doubles chez des adultes qui bégaient

KEY WORDS

STUTTERING
MOTOR LEARNING
FINGER TAPPING TASK
CONSOLIDATION
AUTOMATICITY
DUAL TASK

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Luc F. De Nil

Abstract

The present study compared practice effects and learning abilities in 11 persons who stutter (PWS) and 12 persons who do not stutter (PNS) using a finger-tapping task under single and dual task conditions. Learning was measured by comparing performance curves of accuracy, reaction time, and sequence duration. In addition, measures were obtained for retention of skill as well as interference effects during dual task conditions. For reaction time and sequence duration data, results showed that PNS' performance reached a plateau in performance while PWS' continued to show improvements in practice on day two. Tests of retention showed that PWS were able to retain the task following retention for accuracy and sequence duration but not reaction time. Although no significant interactions were found for tests of condition, additional assessment showed larger differences in finger tapping performance in PWS compared to PNS when transitioning from the single to dual task condition.

Abrégé

La présente étude a comparé les effets de la pratique et les aptitudes d'apprentissage chez 11 personnes qui bégaient et 12 personnes qui ne bégaient pas en utilisant une tâche de tapotement des doigts dans des conditions de tâches simples et doubles. L'apprentissage a été mesuré en comparant les courbes de performance d'exactitude, de temps de réaction et de durée de séquence. En plus, on a obtenu des mesures pour la capacité de rétention ainsi que pour les effets d'interférence dans les conditions de tâches doubles. Pour les données de temps de réaction et de durée de séquence, les résultats ont montré que la performance des non bègues atteignait un plateau tandis que les bègues continuaient à s'améliorer dans la pratique, le deuxième jour. De plus, les résultats ont montré que les bègues étaient capables de retenir la tâche à la suite de la période de rétention pour l'exactitude et la durée de séquence, mais pas le temps de réaction. Même si on n'a pas trouvé d'interactions significatives, une évaluation additionnelle a montré des différences plus importantes dans la performance du tapotement de doigts chez les bègues, comparativement aux non bègues quand ils passaient d'une condition de tâche simple à une de tâche double.

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Introduction

Many stuttering treatment programs involve acquiring novel speech motor patterns such as prolonging speech or forming light articulatory contacts. Clinical strategies such as these emphasize the importance of practice with the goal of reducing the attentional demands required to monitor the new fluency technique. Central to such approaches to treatment is the client's ability to transition the newly learned speaking pattern to a sufficiently high level of automaticity so that they can be executed effortlessly in natural speaking situations. A number of studies have suggested however that people who stutter (PWS) may perform poorer on tasks of motor learning compared to people who do not stutter (PNS). In particular, these studies have demonstrated slower performance gains in PWS compared to PNS when practicing speech or nonspeech tasks (Ludlow, Siren & Zikria, 1997; Neilson & Neilson, 1991; Smits-Bandstra, De Nil, & Saint-Cyr, 2006a; Smits-Bandstra, De Nil, Rochon, 2006b). Using a speech task, Bauerly and De Nil (2011) and Namasivayam and van Lieshout (2008) have shown that these group discrepancies appear to be maintained even following extended practice and retention, which may suggest impaired motor learning abilities among PWS (Bauerly & De Nil, 2011). Little is known, however, about the ability of PWS to automatize a nonspeech motor pattern when given time to practice and consolidate the new skill. Exploring such motor learning abilities in PWS may lend important contributions to our understanding of stuttering as a general motor control deficit.

1. Motor practice and motor learning

Practice and repetition of a given movement pattern is an essential component of motor learning. Motor practice effects are thought to represent the momentary changes in performance (Schmidt, 2004) and may be used to predict learning (Schmidt & Lee, 2005). Practice effects are traditionally measured using such variables as accuracy, reaction time, and sequence duration (Magill, 1998; Schmidt & Lee, 2004). Studies have shown that practicing a repetitive, sequence skill results in an initial, steep learning curve followed by a plateau where little improvement in performance takes place (Karni et al., 1998).

Motor learning, on the other hand, involves internal processes associated with acquiring a novel motor skill through practice or experience. Internal processes may include morphological changes in the central nervous system such as an increase in dendritic branching or an increase in synaptic connections between neurons (Rose, 1997). Motor learning involves the interaction between the pre-existing capacities of an individual and the characteristics associated with the to-be-learned movement pattern. For example, variability among individuals in the rate of learning a repetitive finger-tapping task may reflect the number of hours they spend a week typing or playing a musical instrument such as the piano. In this scenario, each person brings their previous experiences into the learning paradigm. When practicing a novel movement pattern, muscle execution is thought to rely less on attention and sensory feedback as the development of an internal memory representation of the acquired skill is formed. The movement is then executed with less variability and greater accuracy (Schmidt & Lee, 2005).

The relationship between motor learning and motor practice is complex because it cannot be assumed automatically that learning has occurred based on observed practice effects alone. Indeed, the latter may be influenced also by variables in the environment such as fluctuations in attention, fatigue, or mood (Magill, 1998; Schmidt, 2004). Although motor learning occurs as a result of motor practice, the learning process itself is internal and cannot be directly observed (Schmidt, 2004). Instead, learning is assumed to have occurred if the following two conditions apply: (1) performance improvements are retained following a retention (consolidation) period and (2) performance is resistant to interference by a secondary (dual) task (Schmidt & Lee, 2005). These two conditions will be discussed in more detail in the following sections.

1.1. The role of consolidation in motor learning

Memory consolidation occurs during motor learning when a memory that is initially encoded into a fragile or unstable state (sensitive to interference) is transformed into a more 'stable' state (less sensitive to interference) with the passage of time (Robertson, 2004). Studies have shown that learning a motor skill initially occurs during practice; however, the time between practice sessions also allows an opportunity for the memory to stabilize (Karni et al., 1998; Press, Casement, Pascual-Leone, & Robertson, 2005; Robertson, 2004). Consolidation of a motor skill is typically investigated by looking at performance after a retention interval. Studies have observed this time period to range from a minimum of five hours of wakefulness (Press et al., 2005) to a 24-hour period including sleep (Walker & Stickgold, 2004). This formation and stabilization of motor memories has been proposed to be linked to the reshaping of neural responses reflecting a more stable and more effective representation of the movement plan that is resistant to degradation (Fisher, Hallschmid, Elsner & Born, 2002; Jog, Kubota, Connolly & Graybiel, 1999; Stickgold & Walker, 2007).

1.2. Attentional resources and automaticity

The initial attempts at performing a motor task involve adjusting movement parameters based on information provided by sensory feedback in order to produce accurate movements (Doyon & Ungerlieder, 2002). At the same time, relevant task-specific components previously learned and stored in memory are selected and used for solving the task (Karni et al., 1998). These early motor learning processes require a high degree of attention as the main goal at this stage is to link sensory representations of the environment to muscle control signals (Baddely, 2003; Fitts & Posner, 1967).

With practice, the learner becomes less dependent on sensory input as the development of a new pattern begins to emerge from what was once an initial repertoire of subroutines (Fitts & Posner, 1967). The learner has begun to integrate the appropriate sensory cues in order to produce planned, goal-directed movement. At this stage of learning, less attention is needed for that task and attentional resources can be directed toward other operations (Fitss & Posner, 1967).

Automaticity is a measure of the amount of attention required for a particular task. It is assumed that a well-practiced task requires less attention and thus allows the freeing up of attentional resources for other tasks. As a result, such tasks are less likely to show interference from other, competing tasks. For this reason, dual task experiments are commonly used to estimate the 'amount' of learning that has taken place (Curran & Keele, 1993; Hazeltine, Teague & Ivry, 2002; Logan & Etherton, 1994). This type of experimental paradigm is especially useful when assessing between-group differences in performance on repetitive tasks where performance has reached a plateau across all participant groups. It is assumed that changes in between-group differences on the learned, primary task, that emerge when a competing secondary task is introduced, are a reflection of differences in the level of automaticity achieved by each group for the primary task (Curran & Keele, 1993; Hazeltine et al., 2002; Schumacher et al., 2001).

2. Motor practice effects in PWS

Results from several previous studies have suggested that PWS are slower and less accurate compared to PNS when practicing a speech (Ludlow et al., 1997; Smits-Bandstra et al., 2006b) and nonspeech (Namasivayam van Lieshout, 2008; Smits-Bandstra et al., 2006a) motor task. Bauerly and De Nil (2011) tracked performance between PWS and PNS as they performed 100 repetitions of a nonsense syllable sequence. Although there were no significant differences between groups on any of the measured variables, descriptive analysis showed that PWS' performance was similar to PNS' during the initial practice trials with group differences in the speed of movement emerging as practice continued. Similarly, Smits-Bandstra et al. (2006b) observed that PNS perform a repetitive syllable reading and finger-tapping task more quickly with practice compared to PWS. Ludlow et al. (1997) also showed that PWS were slower to learn the correct productions of two, 4-syllable nonsense words and were overall less accurate compared to controls.

In a study by Neilson and Neilson (1991), an auditory-motor tracking task elicited a longer delay (phase lag) between trigger stimulus and movement response in PWS for both control (jaw or hand) stimuli. Interestingly, when the experiment was replicated using only subjects who, after practicing for one hour, reached a moderate performance criterion, a clear performance difference emerged between groups. The majority (a percentage was not provided) of subjects who were rejected because they failed to meet the performance criteria were PWS.

2.1. Motor learning abilities in PWS: Tests of retention

One limitation to the studies described so far is that learning related measures were obtained during a single practice session. Although practice effects can be observed in as little as ten repetitions (Schmidt, 1988), it may not provide sufficient time to allow the temporary influences on performance (e.g. fatigue) to dissipate (Schmidt & Lee, 2005). As a result, these studies only demonstrated group differences in practice effects while leaving motor learning abilities largely unexplored.

Some studies have demonstrated that PWS show a reduced ability to retain a novel motor task following a rest period (Namasivayam & van Lieshout, 2008; Smits-Bandstra et al., 2006b). In the study by Smits-Bandstra et al. (2006b) differences in motor learning of a novel finger tapping and syllable reading task were assessed by observing difference in group performance following a 40 minute rest period. Response time data for the finger tapping and syllable reading data showed that PWS were not able to retain what they had learned to the same extent as controls. On the contrary, using a similar sequential syllable reading task, Bauerly and De Nil (2011) found that PWS and PNS were able to retain what they had learned for all measured variables (accuracy, reaction time, and sequence duration) following a 24-hour consolidation period. Results from this study suggest that PWS may benefit from

extended practice as 100 repetitions of the speech task were required, as opposed to the 30 repetitions in Smits-Bandstra et al. (2006b).

Using kinematic measures, Namasivayam and Van Lieshout (2008) reported differences in retaining a set of nonsense words that were practiced at two different rates (normal and fast) across three test sessions; two on the same day and one at least a week later. Results showed less stability and strength in coordination patterns in PWS compared to controls as well as significant decreases in the strength of inter-gestural frequency coupling (between closure and tongue body gestures) in PWS at normal, habitual speaking rates following a one week retention period. According to Namasivayam and Van Lieshout (2008), an increase in the strength of inter-gestural frequency coupling, which was observed in the PNS, is thought to represent a more stable relationship between speech gestures and thus indicative of a learned movement pattern, a characteristic not present to the same extent in PWS.

2.2. Motor learning in PWS: Interference effects

Studies assessing the performance of PWS under concurrent task conditions have reported larger interference effects compared to PNS. When performing a simultaneous finger-tapping and spontaneous speaking task, Greiner, Fitzgerald and Cooke (1986) reported that PWS were slower and made more errors on the primary, finger-tapping task. The PWS also demonstrated an increase in stuttered speech on the competing speaking task. Sussman (1982) also found greater disruption in PWS compared to PNS when performing a finger-tapping task concurrently with a verbal task. Similar interference effects have been reported in school–age children who stutter (Brutten & Trotter, 1986).

Other studies have found that PWS require more processing capacity when performing dual tasks that involve the speech-planning system (Bosshardt, Ballmer & De Nil, 2002; Caruso, Chodzko-Zajko, Bidinger & Sommers, 1994). In a study by Bosshardt (2002), participants were required to generate sentences from two unrelated nouns while simultaneously performing a rhyming and category decision task. PWS significantly reduced the number of prepositions under dual task conditions, whereas PNS did not show a difference between single and dual task conditions. The influence of secondary tasks has also been shown to have an effect on the frequency of stuttering (Arends, Povel & Kolk, 1988; Bosshardt, 1999, 2002; Caruso et al., 1994; Greiner et al., 1986). For instance, Bosshardt (2002) found a significant increase in stuttering frequency during a word repetition task when similar words were read concurrently. Results such as these suggest that PWS exhibit greater sensitivity to interference when performing dual tasks.

As previously discussed, dual task paradigms are commonly used in motor learning research in order to measure the level of automaticity achieved following practice (Magill, 1998; Schmidt, 2004). Smits-Bandstra et al. (2006a) compared 12 PWS and 12 PNS when practicing a repetitive, finger-tapping sequence either alone or simultaneously with a color recognition distracter task. They reported that PWS showed a slower and more variable performance in both the single and dual task conditions compared to PNS. In addition, PWS showed significantly more errors on the color recognition distracter task, which according to the authors, suggested that PWS showed difficulties in transitioning a newly practiced motor skill to the same level of automaticity as PNS.

2.3. Present Investigation

All dual task experiments discussed above were based on observation of task performance during a single practice session, and little is known about PWS' ability to learn and automatize a motor task when given more time to practice and consolidate the skill. A nonspeech task was employed in the present study because previous studies (Smits-Bandstra et al., 2006b) have shown similar practice effects for speech and non-speech task. A non-speech task would allow us to determine if differences in PWS reflect a more generalized deficit in motor learning.

Therefore, the present investigation aimed to assess the abilities of PWS and PNS to practice and learn a sequential finger-tapping task during a practice session and following a 24-hour consolidation period. As discussed earlier, for the purpose of the present study, motor learning was defined as (1) the ability to consolidate (retain) improvements in performance following a 24-hour period and (2) the ability to perform the finger-tapping task more automatically in the presence of a concurrent competing task (interference). The following three research questions were addressed:

1. Do PWS show reduced finger tapping speed and more errors following practice of a sequential finger-tapping task under single and dual task conditions?

2. Do PWS, compared to PNS, demonstrate a reduced ability to retain the sequential, nonspeech task following a 24-hour rest period?

3. Do PWS show a reduced ability to automatize the sequential, nonspeech task compared to

PNS by demonstrating greater interference when performing under dual task conditions?

3. Methodology

3.1. Subjects

Eleven right-handed English speaking males who stutter, ranging in age from 23.1 to 40.1 years (*M* = 33.4, S.D. = 6.4) and 12 English speaking males who do not stutter ranging in age from 22.2 to 41.1 years (*M* = 33.2, S.D. = 5.2) participated in this study. The age between the two groups was not significantly different, $t(21) = .635$, $p = .917$. One PWS failed to perform the experimental task correctly due to hand cramping and his data was excluded from the analysis, leaving 11 PWS. All participants were right handed as measured by a minimum score of 9/10 (*M* = 9.25, S.D. = .25) on the Edinburgh Handedness Inventory (Oldfield, 1971). Only male participants were asked to participate in this study because of the predominance of males who stutter and to avoid confounding variables of sex-related differences in motor performance measures (Fitzgerald, Cooke, & Greiner, 1984). Based on their self-rated typing skills, groups' speed of typing was comparable and ranged from slow (3), average (6), fast (10) to very fast (4). No participants self-reported as playing a musical instrument or as being professional typists. Ten PWS and 11 PNS earned a college education and one PWS and one PNS reported a high-school education. All participants indicated no history of neurologic, psychiatric, motor or speech and language disorders (other than stuttering), and were not taking medications that could impair their motor functioning at the time of testing. All participants passed a pure tone hearing screening at 250, 500, 1000, 2000, and 4000 Hz frequencies. In order to test for possible group differences in working memory, all subjects completed the Letter-Number Sequencing test of working memory from the Wechsler Adult Intelligence Scale (WAIS-III; Weschler, 1997). No significant between-group difference were found (PWS: M = 14.82, S.D.= 2.6; PNS: M=13.42, S.D. = 2.5), $t(21) = .093$,] $p = .156$.

All stuttering participants reported an onset of stuttering in childhood. Based on the SSI-3 (Riley, 1994), stuttering severity of the subjects in this study varied from very mild to severe (Table 1). Interjudge reliability measured for 25% of PWS' conversation and reading samples, calculated using Cohen's kappa coefficient, was .92 and .90, respectively. Intrajudge reliability (Kappa coefficient), calculated for 10% of participants conversation and reading samples, was .97 and .96, respectively. Participants had not received treatment for their stuttering for at least one year prior to participation in this study.

Participants provided written informed consent according to the protocol approved by the University of Toronto Health Services Research Ethics Committee.

Table 1. PWS' stuttering severity and overall scores using the SSI-4 (Riley, 1994).

PWS	Reading (%)	Speaking (%)	Total Overall Scores(Severity)
1	3	2	10 (very mild)
2	11	10	18 (mild)
3	1	9	11 (very mild)
4	1	5	10 (very mild)
5	0	8	11 (very mild)
6	5	14	18 (mild)
7	1	5	9 (very mild)
8	3	4	18 (mild)
9	1	23	19 (moderate)
10	1	14	12 (mild)
11	14	25	32 (severe)

3.2. Tasks and procedures

Participants performed a finger-tapping task either as a single task or simultaneously with a tone-monitoring task. The single (finger-tapping) and dual (finger-tapping and tone monitoring) task conditions were administered in a fixed interleaved design for all participants, similar to Smits-Bandstra et al. (2006a).

3.2.1. Finger tapping sequence task

A ten-number sequence (1 3 2 4 1 4 2 3 1 2), derived from a random number generator in Excel (Microsoft, Inc.), was visually displayed on a computer monitor and repeated across 120 practice trials on day one and on day two. The same ten-number sequence was used for all participants. The numbers in the sequence ranged from one to four and each corresponded with one of four horizontally arranged buttons on a response box (Cedrus 610, Superlab Inc.). The motor sequence typing task was designed similar to the one used in Smits-Bandstra et al. (2006a). No number triplet was used more than once, no number pair was used consecutively (e.g. 1 4 1 4), and every number was used two or three times per sequence.

Subjects were asked to reproduce the visually presented number sequence by pressing the four buttons on the response box in the correct order using the fingers of their dominant right hand. Participants placed their index finger on the left most button (button 1), middle finger on button 2, etc. The response box was shielded from view for the subjects in order to prevent visual feedback. Participants were instructed to "type as fast as you can without making mistakes" and to "begin as soon as the sequence appears on the screen".

During the finger tapping single task, subjects were presented with a visual signal ("ready") followed by an interstimulus interval (ISI) (randomly varying between 1.0, 2.0, or 3.0 seconds) to minimize anticipation effects on reaction time. Next, participants were presented with the number sequence displayed horizontally in the middle of a computer screen and printed in black. The numbers remained on the screen for as long as it took the participants to complete the sequence. Completion of the last number in the sequence triggered a new "ready" signal and a new ISI interval, after which the sequence was displayed again.

3.2.2. Tone monitoring task

For the dual task, participants were presented with the same finger-tapping task described above but with a tone monitoring task presented simultaneously with the onset of the number sequence. Because the focus of the present study was on the interference effects of the tone task when performed simultaneously with the finger-tapping task, the tone task was not presented as a single task. The task involved a sequence of four different tones (250, 500, 1000, 2000 Hz), each being presented for 250 ms through a headset, for a total sequence duration of 1 second. The tone sequences were presented at the same time that the number sequence appeared on the screen. The tone sequences were presented as either a repeating or non-repeating sequence. For the repeating sequence, one of the four tones was repeated (e.g. 250, 1000, 250, 2000 Hz). For the non-repeating sequence, all four tones were presented and in random order. The order was randomized while maintaining an equal number of repeating and non-repeating tone sequences across all dual tasks.

In the dual task condition, subjects listened to the tone sequence while simultaneously performing the finger-tapping sequence task. Following each number sequence, a visual question mark was shown following an ISI of one of three random durations (1.0, 2.0, and 3.0 seconds). Participants were instructed to press a 'yes' or 'no' button, corresponding to button one and two on the response box, as quickly as they could to indicate whether or not the same tone was presented twice. Participants were instructed to be as accurate as possible when completing the tone monitoring distracter task. Following the participant's tone response, the next finger sequence trial started following a random ISI interval.

3.2.3. Procedures

The single and dual task conditions were repeated in a fixed interleaved design. Each participant was tested over two days. On the first day, when performance effects from practice were assessed, they performed 30 single, 30 dual, 30 single, 30 dual, and 15 single trials, totaling 135 trials. A trial under single conditions consisted of one finger tapping sequence and a trial under dual conditions consisted of one finger-tapping sequence simultaneous with one tone sequence. The final 15 single finger-tapping trials were not included in the analysis but were added following the last dual task condition in order to avoid the tone-monitoring competing task from being performed last and thereby interfering with the consolidation process.

Participants returned approximately 24 hours later for a second performance testing session. They were asked not to practice the finger tapping sequence during the time between the two test sessions. Although motor skill consolidation can easily continue over a very long period,

a 24-hour period is consistent with the motor learning literature as it is considered sufficient time for a new memory to be consolidated into a stable state and thus more resistant to further interference (Walker & Stickgold, 2004). On day two, the number and sequence of single and dual task trials were the same as on day one, except for the final 15 single trials, which were no longer presented.

3.2.4. Familiarization

Immediately prior to the experiment on day one, participants were provided with the opportunity to become familiar with the tasks. First, participants practiced five repetitions of a finger-tapping task, similar to the one used in the experiment. They were instructed to concentrate on becoming familiar with the button press box rather than trying to respond as quickly as possible. All participants reached the criterion of four out of five correct responses. Second, participants practiced five repetitions of the tone-monitoring task using the same pure tones as in the experimental task. Again, all participants reached the criterion of four out of five correct responses.

4. Dependent variables and statistical analysis

Each participant's performance was recorded automatically using Superlab pro 4.0 software. The variables used to measure performance gains included accuracy, reaction time, and sequence duration, which are considered strong indicators of motor learning (Schmidt & Lee, 2005). For the dual task condition, performance on the tone-monitoring task was assessed using the variables accuracy and reaction time.

4.1 Finger tapping sequence task

Accuracy was measured based on errors for both the finger-tapping task and tone-monitoring task. Finger-tapping errors were measured as the number of sequences containing one or more incorrect taps. Tone-monitoring errors were measured as the number of incorrect 'yes' or 'no' button presses.

Reaction time was measured as the time (in milliseconds, ms) from the onset of the visual stimulus (number sequence for the finger–tapping task and "?" for the tone-monitoring task) to the first button press in both the finger-tapping and tone-monitoring task. Finger-tapping and tone-monitoring button press reaction times that fell outside three standard deviations from an individual's mean were considered extreme outliers and excluded from analysis (Portney & Watkins, 2000). As a result, on day one, 19 out of the combined 1320 trials for PWS (1.4%) and 18 out of the 1440 trials for PNS (1.2%) were excluded. On day two, 15 out of 1320 trials for PWS (1.1%) and 21 out of 1440 trials for PNS (1.4%) were excluded. No tone-monitoring button presses fell outside three standard deviations from an individual's mean.

Sequence duration was measured as the time interval (ms) between the first and the final button press for the finger-tapping sequence. Sequence durations that fell outside three standard deviations of an individual'saverage were considered outliers and were excluded from analysis. Consequently, on day one, 12 out of the combined 1320 trials for PWS (.9%) and 7 out of 1440 trials for PNS (.4%) were excluded. On day two, 5 out of the 1320 trials for PWS (.3%) and 5 out of 1440 trials for PNS (.3%) were excluded. In addition, trials that were invalid due to behaviors such as sneezing, yawning, or distraction were also excluded. This resulted in the exclusion of one additional trial for both PWS and PNS on day one, and the exclusion of two additional trials for PWS and one additional trial for PNS on day two.

In order to minimize the effect of transient fluctuations in performance from trial to trial, the 60 trials for the single task condition on each of the two days were averaged into 12 equal blocks of five (trial 1-5, 6-10, 11-15, etc.). A similar procedure was used for the 60 dual task trials. This resulted in 12 single blocks (2x6) and 12 dual blocks (2x6) on day one and day two.

The variables accuracy, reaction time, and sequence duration were assessed using separate 2 x 2 x 2 x 4 multifactor repeated ANOVAs (Portney & Watkins, 2000) with two levels of Group (PWS versus PNS), two levels of Day (day 1 and day 2), two levels of Condition (single task versus dual task) and four levels of Trial (first block of 5 finger tapping trials versus last block of 5 finger tapping trials for each single and dual task condition).

4.2 Tone-monitoring task

Accuracy and reaction time for the tone-monitoring task were assessed using two additional 2 x 2 x 4 multifactor repeated ANOVAs (Portney & Watkins, 2000) with two levels of Group (PWS versus PNS), two levels of Day (day 1 versus day 2) and four levels of Trial (first block of 5 tone-monitoring trials versus last block of 5 tone monitoring trials for each dual practice session).

4.3 Tests of retention

The ability to retain improvements in performance following a 24-hour retention period was assessed for PWS and PNS by calculating paired sample t-tests between

the means of the final block of five finger-tapping trials on day one and the first block of five finger-tapping trials on day two. Separate analyses, corrected for multiple comparisons, were carried out for accuracy, reaction time, and sequence duration.

5. Results

Levene's Test of Equality of Error Variance was not significant for measures of accuracy, reaction time or sequence duration data at alpha .05, indicating equal error variance between groups. Mauchly's Tests of Sphericity was performed to determine if the adjustment to the value of p was needed. The sphericity tests were not significant for accuracy, reaction time, or sequence duration comparisons at alpha .05 and therefore no correction was used (Portney & Walkins, 2000).

interaction for Condition x Trial, F (3, 63) = 6.99, $p < .05$, $\acute{\eta}_p^2 = .250$ was found. This interaction indicated that practice of the task reduced the interference effect in the dual task condition, and that this was true equally for both groups. A significant Day x Trial interaction, F (3, 63) = 5.87, $p < .05$, $\acute{\eta}_p^2 = .219$ occurred because of a difference in the effect of practice on the performance curves. For both subject groups, the effect was greatest on day one, while on day two, their changes in performances began to level off (Figure 1). However, this Day x Trial interaction is qualified by the significant Group x Trial interaction F (3, 63) = 2.97, $p < .05$, $\acute{\eta}_p^2 = .240$, pointing to the fact that the two subject groups differed in the overall amount of practice effect across both conditions, with the PWS showing a more pronounced improvement. No other significant interactions were found, nor was there a main effect for Group.

Table 2. The finger tapping errors for PWS and PNS in block 1 (average of trials 1-5), block 6 (average of trials 26-30), and block 12 (average of trials 56-60) in the single and dual task conditions for day one and day two.

Group	Day	Single			Dual		
	1	Block 1	Block 6	Block 12	Block 1	Block 6	Block 12
PWS		.36 (35)	.90 (.32)	.455 (.25)	1.1 (.25)	.81 (.25)	.81 (.28)
PNS		1.25 (.33)	.50 (.35)	.91 (.37)	1.0 (.4)	.58 (.34)	.41 (.13)
	2						
PWS		.09 (.15)	.63 (.36)	.62 (.39)	.63 (.41)	.81 (.36)	.18 (.14)
PNS		.41 (.15)	.91 (.35)	.91 (.37)	1.0 (.4)	.58 (.34)	.41 (.13)

5.1 Finger tapping sequence task

5.1.1 Accuracy

The results for accuracy are shown in Table 2. Finger tapping errors under single and dual task conditions for PWS did not significantly differ from PNS on day one or day two. No significant main effects for Day, Condition, or Trial were found, nor was there a significant interaction.

5.1.2 Reaction time

The results for reaction time are shown in Table 3. Both groups showed significant improvements in performance across trials, Trial F (3,63) = 80.71, $p < .001$, $\acute{\eta}_p^2 = .794$ and days, Day F (1, 21) = 89.86, $p < .001$, $\acute{\eta}_p^2 = .811$. A 2-way

5.1.3 Sequence Duration

The duration data are shown in Table 4. PWS showed significantly slower sequence durations compared to PNS across trials, Group F(1,21) = 9.63, $p < .05$, $\acute{\eta}_p^2 = .314$. A significant Group x Trial interaction F (3,63) = 5.64, $p < .05$, $\acute{\eta}_p^2 = .212$ was found because, with practice, sequence durations of PNS reached a relative plateau while PWS continued to show improvement (Figure 2). These group differences were not as pronounced on day two and this may explain why a Group x Day interaction (1, 21) = 5.53, $p < .05$, $\acute{\eta}_p^2 = .209$ occurred. No significant main effect for Condition or significant 4-way interaction was found.

Table 3. The finger tapping reaction time (ms) of PWS and PNS in block 1 (average of trials 1-5), block 6 (average of trials 26-30), and block 12 (average of trials 56-60) in the single and dual task conditions for day one and day two.

Group	Day	Single			Dual		
	1	Block 1	Block 6	Block 12	Block 1	Block 6	Block 12
PWS		966(46)	744(48)	638(53)	779(72)	598(45)	572(43)
PNS		827(44)	627(46)	525(50)	690(69)	577(43)	480(41)
	2						
PWS		790(45)	555(53)	505(45)	613(48)	477(31)	479(37)
PNS		604(43)	496(51)	472(43)	466(46)	431(30)	410(36)

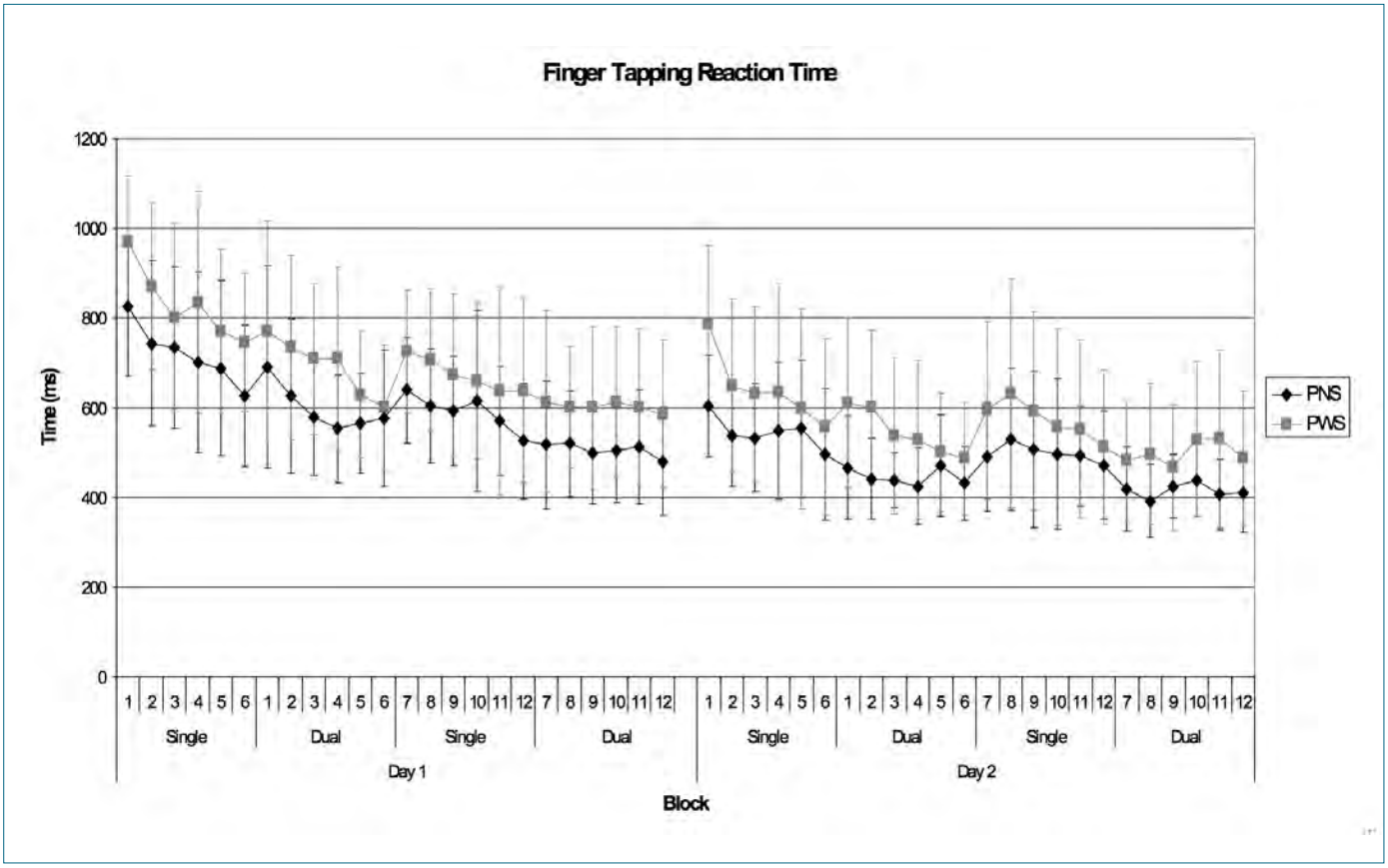

Figure 1. Mean finger tapping reaction times (ms) for single and dual task conditions on day 1 and day 2 for PWS and PNS.

Table 4. The finger tapping sequence durations (ms) of PWS and PNS in block 1 (average of trials 1-5), block 6 (average of trials 26-30), and block 12 (average of trials 56-60) in the single and dual task conditions for day one and day two.

Group	Day	Single			Dual		
	1	Block 1	Block 6	Block 12	Block 1	Block 6	Block 12
PWS		5166(381)	3528(256)	2800(189)	4623(331)	3606(239)	3213(184)
PNS		3968(365)	2620(245)	2370(181)	3140(317)	2585(229)	2418(176)
	2						
PWS		3018(201)	2526(161)	2403(170)	2941(173)	2710(162)	2602(176)
PNS		2275(193)	2040(154)	2104(163)	2080(165)	2060(155)	2115(169)

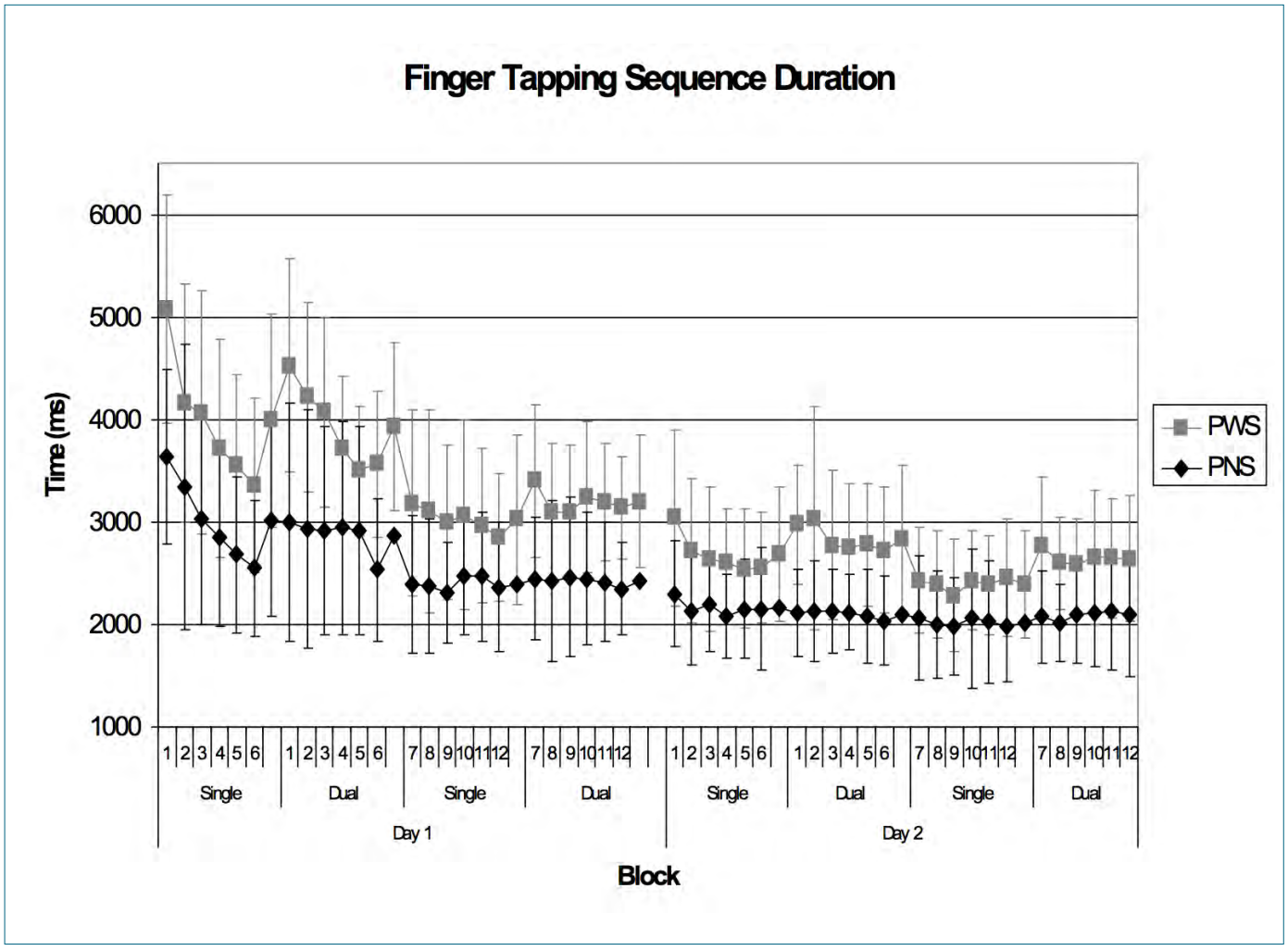

Figure 2. Mean finger tapping sequence duration (ms) for single and dual task conditions on day 1 and day 2 for PWS and PNS

5.2 Tone monitoring task

The Levene's Test of Equality of Error Variance was not significant for accuracy or reaction time data at alpha .05, indicating equal error variance between groups. Mauchly's Tests of Sphericity was performed to determine if the adjustment to the value of p was needed. The sphericity tests were not significant for accuracy or reaction time comparisons at alpha .05 and therefore no correction was used (Portney & Walkins, 2000).

A Group main effect showed significantly more tone-monitoring errors for the PWS compared to the PNS, Group F (1, 21) = 6.59, $p < .05$, $\acute{\eta}_p^2 = .239$ (Figure 3). A Day x Group interaction was also found due to PNS' tone monitoring errors improving from the first trial block on day one (M = .91, S.D. = .9) to the last trial block on day two (M = .41, S.D. = .66), whereas PWS' slightly worsened from the first trial block on day one (M = 1.18, S.D. = 1.2) to the last trial block on day two (M = 1.27, S.D. = 1.10). No main effect for Trial or a 3-way interaction for Group x Day x Trial was found.

Both groups showed significant improvements in tone-monitoring reaction times across Trials, F (3, 63) = 8.04, $p < .001$, $\acute{\eta}_p^2 = .277$. A Day x Trial interaction occurred because most of the performance gains were made on day one; whereas performance started to plateau on day two, F (3,63) = 4.38, $p < .05$, $\acute{\eta}_p^2 = .173$. No main effect for Group was found, nor was there a 3-way Group x Day x Trial interaction.

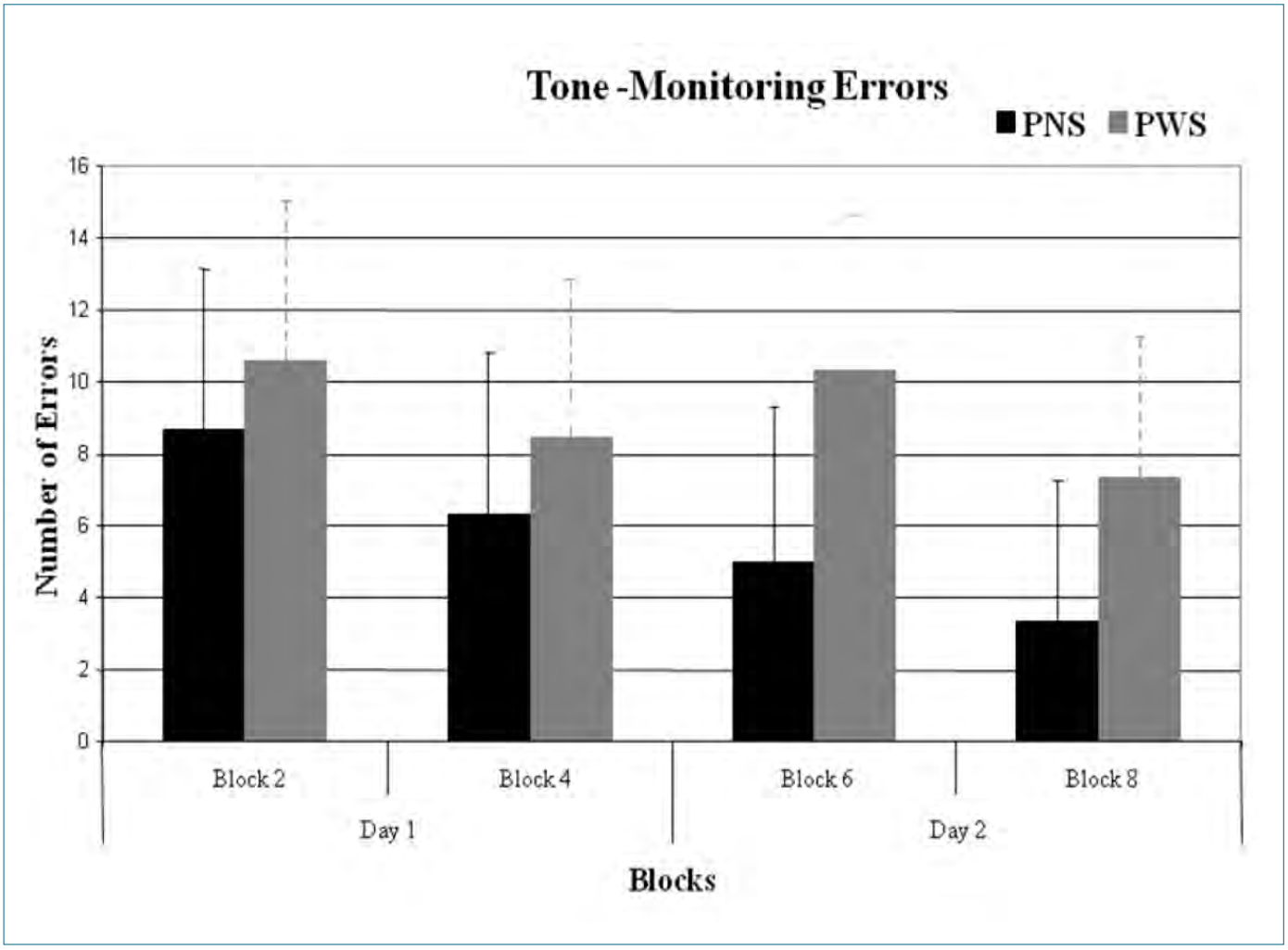

Figure 3. Mean number of tone monitoring errors for PWS and PNS across blocks of 30 trials each on day 1 and day 2.

5.3 Tests of retention

Retention is the ability to maintain improvements in performance from a practice session following a rest period. The results for retention are shown in Table 3 for reaction time and Table 4 for sequence duration. Both the PNS and the PWS showed an ability to retain what they had learned on day one following an approximate 24-hour retention period for accuracy and sequence duration but not reaction time. While PNS' errors showed some decline from day one (M= 1.08, S.D. = 1.3) to day two (M= .416, S.D. = .668), this difference was not significant. Similarly, PWS showed some decline in errors from day one (M= 1.09, S.D. = 1.13) to day two (M= .091, S.D. = .301), which also was not significant. While PNS' mean response times were maintained across the 24-hour retention period; the PWS' mean response times from the last five trials on day one to the first five trials on day two in contrast showed a significant decline, $t(10) = -6.03$, $p < .01$, two-tailed. No significant differences were found for either group between the mean sequence duration for the last five trials on day one and the first five trials on day two.

5.4 Analysis of single to dual task transition

Post hoc analysis was conducted to test the interference effects between the single and dual task conditions. Tests of interference were included in order to assess the ability of participants to practice and learn the finger-tapping task under competing conditions. It was assumed that a decrease in interference from the tone-monitoring task would be a reflection of the participants' ability to automatize the primary, finger-tapping task with practice. Interference effects were measured by taking the difference score between the mean of the last five single task trials in a block and the corresponding mean of the first five dual task trials in the subsequent block for each of the following measures: accuracy, reaction time, and sequence duration.

The between-group Levene's Test of Equality of Error Variance was not significant for accuracy, reaction time, or sequence duration data (alpha .05). Because the Mauchly's Tests of Sphericity were significant for reaction time and sequence duration, a Greenhouse-Geisser correction was used. The Mauchly's Test of Sphericity was not significant for the accuracy data (Portney & Watkins, 2000).

No significant difference was found between the single to dual task difference scores for finger-tapping accuracy between PWS and PNS. Likewise, no significant Group main effect or Group x Transition interaction was found. For finger tapping reaction time, no main effect for Group or Transition was found, nor was there an interaction (see Figure 4). With regard to finger tapping duration, both groups improved on their finger-tapping sequence duration as they transitioned from the single to the dual task conditions, Transition: $F(3,63) = 7.86$, $p < .001$, $\acute{\eta}_p^2 = .272$. In addition, PWS showed significantly larger dual task interference effects on both days compared to controls, Group: $F(1, 21) = 14.25$, $p < .001$, $\acute{\eta}_p^2 = .404$ (see Figure 5). No Group x Transition interaction was found.

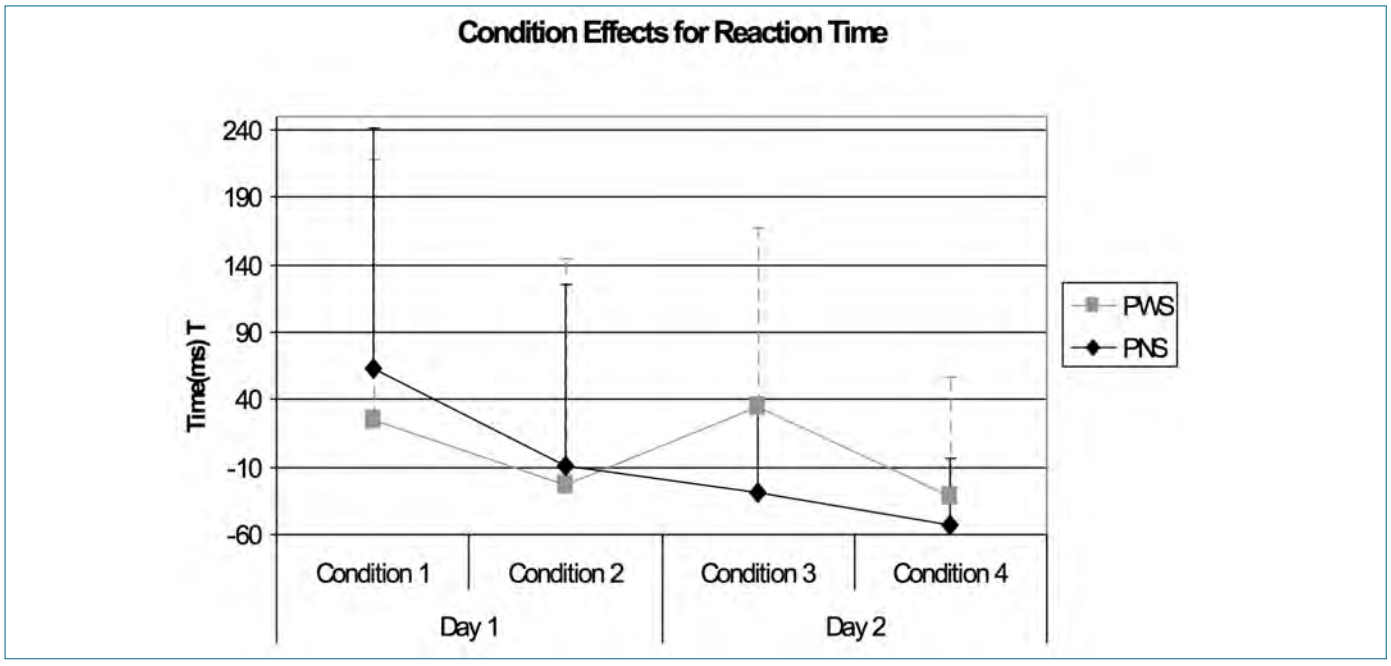

Figure 4. Mean difference in reaction time and variability (S.D.) between the last 5 trials in each single, finger tapping session and the first 5 trials in each subsequent dual session (condition effects) for day one and day two.

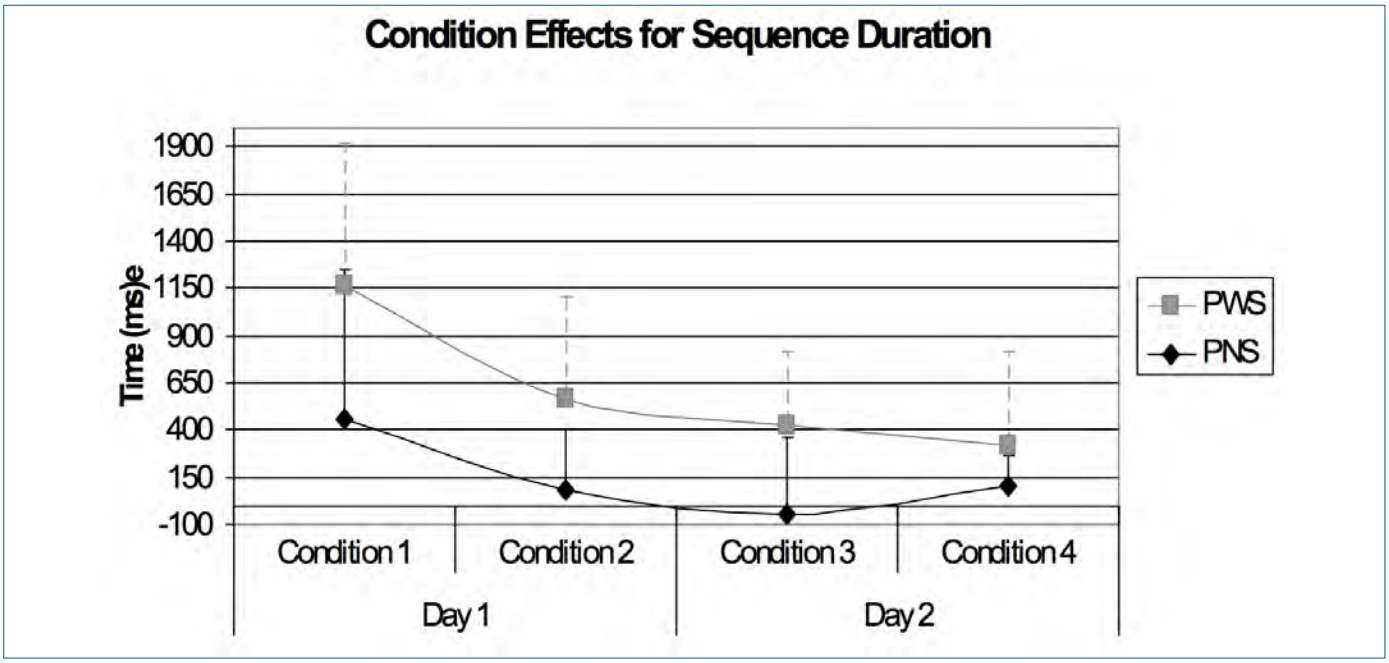

Figure 5. Mean difference in sequence duration and variability (S.D.) between the last 5 trials in each single, finger tapping session and the first 5 trials in each subsequent dual session (condition effects) for day one and day two.

In studies with a small sample size (power = .42) effect size may be more valid than the p-value as an indication of important differences (Portney & Watkins, 2000). The effect sizes in the current study are considered to be moderate to large ($\acute{\eta}_p^2$= .201 to .404) indicating differences between groups that support further investigation using larger sample sizes.

6. Discussion

The specific aim of this study was to assess the ability of PWS to practice and learn a sequential finger-tapping task following practice and a 24-hour consolidation period.

6.1 Finger tapping sequence task

Our first research question was *"Do PWS compared to PNS show reduced finger tapping speed and more errors following practice of a sequential finger-tapping task under single and dual task conditions?"* . As discussed in the introduction section, practice effects are considered to represent momentary improvements in performance (Schmidt, 2004) that are traditionally observed as an increase in speed and accuracy, resulting from a decreased reliance on sensory mechanisms to guide performance (Fitts, 1967).

Both groups showed significant improvements in reaction time and sequence duration across conditions for day one and day two. Visual inspection of the graphed data for reaction time (Figure 1) and sequence duration (Figure 2) showed similar log-linear performance slopes (Newell & Rosenbloom, 1981). That is, PWS benefited from practice and consolidation, although their sequence durations were significantly slower than the PNS.

These group differences, however, were not homogeneous across practice trials as shown by a significant group x trial interaction for reaction time and sequence duration. Visual inspection of the data showed an initial, rapid decrease in reaction time and sequence duration with practice for both groups, although slower in the PWS compared to controls. With practice, however, PNS' performance reached a relative plateau whereas PWS' performance remained relatively variable with improvements in performance still occurring well into practice on day two.

The finger-tapping task was used in the current study in order to assess whether differences between PWS and PNS observed in previous studies are limited to the movements involved in speech production (Bauerly & De Nil, 2011; Smits-Bandstra et al., 2006b; Namasivayam & van Lieshout, 2008) or represent a general motor deficit affecting the control and organization of nonspeech movement. Several studies have found PWS to differ from PNS when performing tasks involving unrelated effector systems (Forster & Webster, 2001; Max, Caruso & Gracco, 2003). In addition, studies specifically designed to assess practice

related differences have found slower performance in PWS when practicing non-speech tasks (Smits-Bandstra et al., 2006a, 2006b). For instance, Smits-Bandstra et al. (2006a) reported significantly slower and more variable performance when practicing a finger-tapping task singly and concurrently with a color recognition task. Results from the current study support this theoretical viewpoint of a motor control deficit in PWS that extends beyond the organizational principles specific to speech production.

6.2. Tests of retention

The second research question addressed was *"Do PWS, compared to PNS, demonstrate a reduced ability to retain the sequential, non-speech task following a 24-hour rest period?"*. One condition that needs to be met in order to assume learning has occurred is that improvements in performance following practice must be maintained following a retention period. This is based on the theoretical assumption that practicing a motor skill triggers a process of consolidation whereby an initial, unstable memory representation is transitioned into a more stable state with the passage of time. The 'amount' of skill lost over the 24-hour consolidation interval was significant for reaction time measures among the PWS but not among PNS. Such differences were not found for accuracy or sequence duration. Descriptive data showed that PWS made improvements in reaction time across trials on day one, although significantly slower than the PNS. Results conform with several motor control studies that have found poor reaction time skills in PWS using non-speech tasks (Cross & Luper, 1979; Weinstein, Caruso, Severing & Verhoeve, 1989. This significant loss in retention of the skill on day two suggests a reduced ability to acquire permanent gains in performance. These results, however, are contrary to what was found in a previous study by Bauerly and De Nil (2011) where both PWS and PNS showed the ability to retain their improvements in reaction time following the practicing and consolidating of a sequential speech task. The reason for this discrepancy is most likely due to an increase in task complexity as the previous study by Bauerly and De Nil (2011) used a single, repetitive speech task without a secondary, interfering task. Smits-Bandstra et al. (2006a) also found retention differences in PWS for reaction time but not for sequence duration and suggest this is due to less effective manual skill learning.

6.3 Tests of Interference

The third research question addressed in this study was *"Do PWS show a reduced ability to automatize the sequential, non-speech task compared to PNS by demonstrating greater interference when performing under dual task conditions?"*. As discussed earlier, another condition that needs to be met in order to assume learning has occurred is that after considerable practice, two tasks can be performed simultaneously with little cost to either (Hazeltine et al., 2002; Schumacher et al., 2001). Any discrepancy in performance can be assumed to reflect the level of automaticity (or lack thereof) achieved on the first, primary task (Hazeltine et al., 2002; Schmidt, 1988; Smits-Bandstra et al., 2006a).

Groups did not show any 2, 3, or 4-way interactions for condition indicating that PWS did not differ from PNS in their ability to perform the finger-tapping task under dual task conditions. However, post hoc analysis of PWS' and PNS' abilities to transition from the last five single finger-tapping trials to the subsequent first five dual finger-tapping trials showed significantly larger interference effects in the PWS compared to PNS for the variable sequence duration. That is, the PWS showed significantly slower finger tapping speeds during the first five dual task trials. In addition, they made significantly more tone monitoring errors. Visual inspection of the graphed data suggested with practice that PNS' finger tapping sequence duration remained relatively the same across the single and dual task conditions and as a result showed very little interference by the time they reached the last dual block on day one (Figure 2). In contrast, PWS' finger tapping sequence duration under the dual task condition remained slower compared to their performance under the single task condition across practice on day one and day two. Smits-Bandstra et al. (2006a) found similar results using a finger-tapping task concurrently with a color-monitoring task. In her study, PNS showed quick, accurate and an increasingly automatic performance with practice while PWS remained slow and variable under both conditions. Greater interference effects in PWS have been found in other studies using finger-tapping tasks concurrently with verbal tasks (Brutten & Trotter, 1986 Greiner et al., 1986; Sussman, 1982). Although interference effects for sequence duration in PWS remained following a relatively large number of practice trials, descriptive analysis showed that these group differences lessened with practice, suggesting that PWS may have the potential to automatize the task to the same degree observed in PNS, but at a slower rate (Figure 5).

6.4 Implications for motor skill limitations in PWS

As discussed above, compared to controls, PWS showed: (1) slower sequence durations across practice trials on day one and day two, (2) a reduced ability to retain the finger tapping sequence following a retention

period (reaction time only), (3) an increase in tone monitoring errors, and (4) greater interference from the dual task (sequence duration only). One explanation for these differences in performance may be that they show limited motor abilities (De Nil, 1999 Van Lieshout, 2004; Van Lieshout, Hulstijn, & Peters, 1996). Schmidt (1988) describes motor abilities as an underlying trait, not modified by practice, which plays a key role to the success on a particular motor task. Motor abilities can be considered to fall along a continuum where individuals possess various levels of ability. Therefore, abilities can define a person's potential for success and may also represent limitations on performance (Schmidt, 1988). Although a motor skill consists of a learned movement that requires practice in order to master; its level of success will ultimately depend on an individual's underlying abilities required for carrying out the task at hand (Magill, 1998; Schmidt, 1988).

In regards to individual differences in motor skill, PWS' reduced performance compared to controls demonstrated in the current study reflects limitations in motor skill and may be an explanation for their difficulty in reaching the reaction time and sequence durations observed in the PNS following practice and consolidation. Supporting evidence comes from a study by Namasivayam and van Lieshout (2008) where PWS showed significantly larger movement amplitudes of upper lip movement following practice and learning of a non-word speech task. They posited that this difference may reflect a motor control strategy used to maintain stability. This is likely the case in the current study as it appeared that maintaining a relatively slower speed of movement may have been a mechanism used to optimize processing of sensory information, particularly under the dual task condition (De Nil & Abbs, 1991; De Nil, 1999; Loucks & De Nil, 2001; Van Lieshout, 2004). In this case, PWS' slower movements for both reaction time and sequence duration may have been a strategy used to keep speed and accuracy in balance. This strategy would have been consistent with the instructions they received to "type as fast as you can without making mistakes". This could explain why PWS failed to reach the speed of performance observed in PNS, even when given a relatively large number of practice trials. Instead, their limited motor abilities led them to continuously require a relative high degree of attention across extended practice and consolidation, as they continued to use a "controlled" movement strategy that required the monitoring of feedback (van Lieshout et al., 1996). As a result, processes required to perform the secondary, tone-monitoring task interfered with performance on the finger-tapping task. This was shown by significantly larger interference effects for sequence duration as well as greater tone-monitoring errors in PWS compared to PNS. However, as stated earlier, differences in interference effects between groups for sequence duration decreased with practice, suggesting the ability to automatize the skill, albeit at a slower rate.

Earlier research has demonstrated that the skills required to perform a particular motor task will change with practice (see Fleishman & Bartlett, 1969 for a review). More specifically, Fleishman and Rich (1963) found that early in practice, performance is more reliant on cognitive functioning such as working memory and reasoning, while later in practice as the task becomes more routine, motor abilities such as movement speed, reaction time, and strength become more important. In line with this, results from the current study lend support for PWS' limitations in motor ability, as opposed to differences in cognition, as poor performance in PWS remained as practice continued into the later stages of practice where motor abilities are thought to dominate. Also, scores on the WAIS-III, Letter-Numbering Subtest for working memory showed no significant difference between groups.

As an alternative explanation, it could be hypothesized that the slower sequence durations under dual task conditions observed in PWS may have been a result of difficulty detecting and monitoring the pure tones. PWS showed significantly greater tone-monitoring errors compared to PNS on day two. This may have caused slower sequence durations and stronger interference effects as they would require greater attentional resources when performing the dual task compared to controls. However, during the familiarization task, PWS reached the criteria of four out of five correct. An increase in tone-monitoring errors became apparent in PWS only when performing the tone-monitoring task under dual task conditions. Therefore, results do not lend support for difficulties in PWS in monitoring the pure-tones in isolation. Also, an increase in tone monitoring errors did not emerge until day two, suggesting practice related differences. Supporting evidence stems from a study by Sasisekaran, De Nil, Smyth and Johnson (2006) where no differences in speed or accuracy were found between PWS and PNS when performing a pure tone monitoring task similar to the one used in the current study. Corbera, Corral, Escera and Idiazabal (2005) also did not find differences in cognitive evoked potential (ERP) activity in PWS compared to controls in response to pure tone stimuli. Although PWS have shown to take longer detecting changes in a tracking signal (Nudelman, Herbrich Hess, Hoyt, Rosenfield, 1987) or when responding to pure tones (Hampton & Weber-Fox, 2008), these studies required immediate responses as

opposed to the present study which required a response following completion of the finger-tapping task and a 1-3 second ISI. As a result, participants were given ample time to process the tones and thus prepare for a response.

7. Conclusion

Our main findings do not lend strong support for differences in motor learning; however based on additional measurements of retention and single to dual task transition, PWS did differ from PNS on a number of important variables that relate to practice effects and learning. One question that remains is whether task complexity would influence results. While the dual task used in the present study was relatively demanding, it may not have sufficiently taxed the participants' resources to yield very strong effects in a relatively short period of time. Also, the interleaved design used in the current study, whereby the single and dual tasks order was kept constant across participants, may have resulted in an order effect. This however would only affect our interpretation significantly if one assumes that the order effect would be different between the PWS and PNS, which remains a question for follow-up studies. In conclusion, while the current study provides some partial support for a motor learning deficit in PWS, it fails to provide unequivocal support. Instead, results from the current study support the theoretical viewpoint that PWS possess limitations in motor skill. Future research in the area of motor abilities and motor learning is clearly needed, especially given the potential implications for clinical intervention.

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KEY WORDS

STUTTER
STAMMER
FLUENCY
FLUENCY DISORDERS
COMMUNICATION
PERCEPTION
EYE GAZE
EYE TRACKING

Segmented Analysis of Eye Gaze Behaviors of Fluent and Stuttered Speech

Analyse segmentée des comportements de fixation du regard sur une élocution fluide et une élocution bégayée

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Abstract

Purpose: To measure the effect of stuttering on eye-gaze in fluent speakers while viewing video presentations of typical speakers and people who stutter (PWS) speaking because eye-gaze behaviors provide indicators of emotion and communicative integrity.

Method: Sixteen fluent college-age adults, naïve to stuttering, observed six 30-second audiovisual speech samples of three PWS, and three age and gender matched controls who do not stutter (PWNS). A desk-mounted eye-tracker recorded the amount of time participants spent watching four regions of interest (ROIs) in the stimulus videos of PWS and PWNS: eyes, nose, mouth, and "outside" (i.e., any gaze-point not occurring within the eyes, nose, or mouth area). Proportions of gaze-time in each ROI were the dependent variables of interest in the study. Comparisons were made between proportions of time spent in each ROI for the PWS and PWNS speaker groups, and also between fluent versus disfluent speech segments produced by the PWS.

Results: Participants spent significantly more time watching the eyes (e.g., maintaining eye-contact) when viewing PWNS than PWS. They also spent significantly more time observing mouth regions of PWS. When watching the videos of PWS, participants spent significantly more time observing nose and mouth regions when speech was stuttered (PWS-S) than when the speech was fluent (PWS-F).

Conclusions: Overall, the difference in eye gaze patterns across speaker-group is interpreted to indicate negative emotional responses to stuttering. Current findings align with previous research showing that stuttered speech elicits negative reactions from listeners. Specifically, stuttering behaviors avert gaze from the eyes. Gaze aversion is a clear sign of disrupted communication that is visible to PWS and may contribute to their negative reactions to their own stuttering.

Abrégé

Objectif : Mesurer l'effet du bégaiement sur la fixation du regard chez les locuteurs fluides qui visionnent des présentations vidéo de locuteurs typiques et de personnes qui bégaient, parce que les comportements de fixation du regard sont des indicateurs de l'émotion et de l'intégrité dans la communication.

Méthode : Seize adultes d'âge collégial ayant une parole fluide, sans histoire de bégaiement, ont observé six échantillons audiovisuels de parole de trois bègues et de trois personnes ne bégayant pas, jumelées selon l'âge et le sexe. La durée des échantillons était de 30 secondes. Un dispositif de suivi oculaire de type bureau a enregistré le temps passé par les participants à regarder quatre régions d'intérêt dans les vidéos : les yeux, le nez, la bouche et « l'extérieur » (c.-à-d. tout point de fixation du regard situé ailleurs que sur les yeux, le nez et la bouche). Les portions de temps de fixation du regard dans chaque région d'intérêt étaient les variables dépendantes de l'étude. Les comparaisons furent faites entre les portions de temps passées dans chaque région d'intérêt pour les groupes de locuteurs bègues et non bègues et également entre des segments de parole fluide et de bégaiement des bègues.

Résultats : Les participants ont passé un temps significativement plus important à regarder les yeux (par ex., maintenir le contact visuel) en visionnant les non bègues que les bègues. Ils ont également passé significativement plus de temps à observer la région de la bouche des bègues. En visionnant les vidéos des bègues, les participants ont passé significativement plus de temps à examiner les régions du nez et de la bouche quand le locuteur était dans des périodes de bégaiement comparativement à des moments où sa parole était fluide.

Conclusions : Dans l'ensemble, les différences des comportements de fixation du regard à travers les groupes de locuteurs sont interprétées comme indiquant des réponses émotionnelles négatives vis-à-vis le bégaiement. Les constatations présentes vont dans le même sens que des recherches précédentes qui montraient que les périodes de bégaiement suscitent des réactions négatives chez les auditeurs. Spécifiquement, les comportements de bégaiement détournent le regard des yeux. Ce détournement du regard est un signe clair d'un bris de communication, perceptible par les bègues et qui peut contribuer à leurs réactions négatives envers leur propre bégaiement.

Introduction

Stuttering is a disorder characterized by auditory disruptions and visually evident struggle behaviors. Acoustic productions of sound and word repetitions, phoneme prolongations, and postural fixations often co-occur with visually distracting secondary behaviors of excessive lip tension, forceful blinking, involuntary head jerking, and other extremity movements (Bloodstein & Bernstein-Ratner, 2007). These disruptive speech behaviors categorically distinguish stuttering from fluent speech. These disruptions adversely impact the dynamics of a verbal communicative exchange between two individuals, which hypothetically may be signaled by changes in visual attention such as averted eye gaze.

Evidence that people react differently to PWS is supported by self-reported responses and physiological reactions from listeners observing recordings of stuttered and fluent speech. Participants usually self-reported similar negative emotional reactions of increased anxiety, tension, and uneasiness during video observations of PWS speaking, via a bipolar semantic differential state emotional scale (Guntupalli, Kalinowski, Nanjundeswaran, Saltuklaroglu, & Everhart, 2006). Finally, studies have also shown increased average skin conductance and decreased average heart rates in both PWNS (Guntupalli, et al., 2006; Guntupalli, Everhart, Kalinowski, Nanjundeswaran, & Saltuklaroglu, 2007) and PWS (Zhang, Kalinowski, Saltuklaroglu, & Hudock, 2010) when observing video presentations of PWS speaking. This change in skin conductance is likely a manifestation of anxiety/tension since it co-occurs with self-reports of such emotions. Evidence for alterations in attention, changes in physiological responses, and sender receiver dynamics are also indicated by several "stereotyping studies" of stuttering (e.g., Cooper & Cooper, 1996, for a review). In these studies participants are typically requested to complete personality attribute questionnaires regarding hypothetical people who stutter (PWS) and people who do not stutter (PWNS). PWNS typically judge PWS as being more tense, anxious, and uneasy. Similar personality judgments are reported during video observations of PWS as compared to PWNS (Tatchell, van den Berg, & Lerman, 1983). However it should be noted that the previously mentioned physiological reaction and stereotyping studies examine features that are not observerable to the PWS. It is important to look at a reaction that is visible to the PWS as it is these reactions that most likely alter the communicative dynamics.

Eye Gaze and Tracking

Interpersonal communication is a dynamic process of sending and receiving information between individuals. Verbal messages are transmitted synchronously with non-verbal nuances, including hand gestures, posture, facial expressions, proximity, and eye contact, which together signal the emotional tone of the exchange. In fact, it is often easy to understand the emotional tone of a communicative exchange simply by watching two individuals interact. Eye contact in particular provides telling clues regarding integrity and emotional valence of verbal interaction. According to a large body of research, negative avoidance-oriented emotions (e.g., embarrassment, grief, and revulsion) are typically conveyed via gaze aversion (Argyle & Cook, 1976; Blakemore & Frith, 2004; Kleinke, 1986; Rutter, 1984). Humans have the capacity (e.g., Theory of Mind) (Baron-Cohen, 1997) for understanding and reciprocating the subtle cues that encode emotions (Gallese, 2003). This occurs to the extent that when a sender portrays an emotion, receivers understand intentional cues, and display similar emotions back to the sender, therefore dynamically influencing sender-receiver interactions.

It is a common understanding that PWS exhibit decreased eye contact during interpersonal communicative exchanges (Bloodstein & Bernstein-Ratner, 2007). To examine one aspect of this, Atkins (1988) asked 133 college students to judge hypothetical speakers' personality characteristics as a result of their perceived criteria of "good" eye contact (i.e., 90 – 100%) versus minimal or no eye contact. Students judged speakers who used good eye contact much more favorably than speakers with minimal eye contact. The researcher inferred that therapy for PWS should target increasing eye contact. Other researchers more directly examined influences of eye contact and verbal fluency on listeners' personality judgments. For example, Tatchell et al. (1983) examined undergraduate students' personality judgments/ratings from video recordings of an actor who maintained or averted eye contact during fluent and stuttered speech. Participants' perceptions were differentially affected during the four test conditions. Maintained eye contact with fluent speech was judged the most positive. The next highest ranking was maintained eye contact with stuttering. The lowest ranked condition was averted eye gaze and stuttering. Clinicians have argued for the importance of maintaining "good" eye contact for PWS and have integrated it as a crucial component to therapeutic success (Breitenfeldt & Lorenz, 1989; Sheehan, 1970; Tatchell et al., 1983). In fact, amount of eye contact has also been used in clinical transcription during stuttering therapy (Tetnowski & Franklin, 2002). Based on this evidence, one might expect listeners to also avert their eye gaze when witnessing stuttering. However,

listeners' eye gaze behaviors when watching a PWS who is maintaining eye contact has yet to be fully explored.

Eye tracking using video presentations are commonly used procedures for exploring interpersonal human social communication. It is pertinent to mention that all of the studies listed in the introduction that examined participants' reactions to stuttering, and many of the experiments that use eye-tracking technology, use prerecorded videos for stimuli. This procedure is typically implemented to insure consistency and standardization of speech characteristics (Mendel & Owen, 2011). Additionally, there are very limited studies comparing participants' reactions to live communication to reactions towards recorded speech. There are certain drawbacks to presenting recordings to participants; first, it limits the interpretations that one can make from the data. Secondly, it is not a true naturalistic situation, so participants' reactions might not be truly representative of what occurs during interpersonal communication exchanges.

The eyes transmit information regarding attention, turn taking, respect, emotion, and intention (Adams & Kleck, 2005; Baron-Cohen & Cross, 1992, Frischen, Bayliss, & Tipper, 2007). From infancy to adulthood, humans and higher order mammals demonstrate a propensity to fixate on eye regions and eye-like objects (Tomalski, Csibra, & Johnson, 2009). This proclivity for directed gaze behavior may be developmentally influenced by anatomical characteristics (i.e., elevated cheek bone, pronounced brows, and contrast of the sclera to the iris) or social-emotional factors involved in nonverbal communication (Kobayashi & Kohshima, 2001; Tomalski et al., 2009). As eye-gaze appears to be largely innate and important for communicative exchanges, gaze aversion leads to a variety of interpretations, including social cueing responses, reducing empathetic connections, increasing cognitive loads, presentation of peripheral stimuli, and decreased interest (see Blakemore & Frith, 2004, for a review). Simply put, although there are many possible interpretations of eye gaze aversion during communicative exchanges, some of the most common relate to turn taking, emotional factors, and altered attention. For example, conspicuous breakdowns in this process are observed in children with autism spectrum disorders, as compared to their fluent peers, who exhibit reduced time spent observing eye regions when viewing social communication situations (Klin, Jones, Schultz & Volkmar, 2003).

Eye-tracking procedures with PWS have examined a variety of factors; initially however, researchers primarily attempted to examine anticipation of stuttering during silent reading (Bakker, Brutten, Janssen, & van der Meulen, 1991; Brutten & Janssen, 1979; Roland, 1972). PWS exhibited more retraces and fixations, although anticipations were not related to stuttering. Participants who stuttered tended to gaze ahead at words that they listed as "difficult to say", and would gaze more often at sections that they had just read. Neither anticipation nor retracing behaviors were significantly related to overt stuttering. More recently, researchers have examined social factors related to the sender or receiver dynamics of speech. Lowe et al. (2012) examined PWS eye gaze towards prerecorded audiences during oral presentations. Participants were initially told that the presentations were being televised to audience members in an adjacent room, however full discloser occurred after the study, as is common practice in deception style studies. Participants who stutter as compared to fluent controls, spent less time viewing audience members with positive reactions as compared to negative and neutral reactions. Furthermore, the extent of gaze aversion from more positive audience members was significantly correlated to self-reported anxiety about the speaking situation.

To examine the receiver aspect of the communication process, researchers presented participants with fluent and stuttered audiovisual segments while they recorded eye gaze (Bowers, Crawcour, Saltuklaroglu & Kalinowski, 2010; Zhang & Kalinowski, 2012). Bowers et al. (2010) employed a single PWS during 20 second (s) audiovisual segments of fluent and disfluent speech. Results revealed that participants decreased observations of eye regions and increased observations of nasal regions during stuttered stimuli. This study provided pilot objective evidence of gaze aversion to stuttering speech. Being the first of its kind, it had a number of constraints, including the use of only one speaker to provide fluent and stuttered speech samples, requiring participants heads to be constrained within a chin mount, and ensuring that the videos of the speaker did not contain head movements. Zhang and Kalinowski (2012) also employed three speakers under both fluent and stuttered conditions, but presented 60 s audiovisual recordings, and examined responses by Caucasian Americans, African American, and Chinese participants. Results revealed both American groups decreased observation of eye regions and increased observation of mouth regions when presented stuttered stimuli. The Chinese group exhibited less eye gaze for both fluent and stuttered stimuli. Different from the American groups, the Chinese also increased observation time of outside regions of interest (ROI) during stuttered speech.

By objectively quantifying eye gazing behaviors during the presentation of audiovisual recordings from both fluent and disfluent speakers, clinicians and researchers can gain insight into factors influencing communication dynamics. As with recent research (Bowers et al., 2010; Zhang & Kalinowski, 2012), the current study sought to explore fluent listeners eye gaze behaviors during observation of stuttered and fluent speech. This study differed systematically from Bowers et al. (2010) in several ways. First, it increased ecological validity by including greater talker variability (i.e., six speakers in two mutually exclusive speaker categories) for the stimulus (e.g., Gilbert, Tamati, & Pisoni, 2013) instead of one and three speakers under two speaker conditions in Bowers et al. (2010) and Zhang and Kalinowski, (2012) respectively. Also, every participant watched each speaker only once, unlike the previous studies that presented the same speaker during fluent and disfluent conditions. The current study is the first to examine duration of direct gaze from the speaker, allowing for more complete quantification of gaze pattern behavior. Most importantly, stuttering is an intermittent pathology. That is, PWS do not stutter in every production. Hence, to better understand the impact of stuttering on eye gaze, it is necessary to examine how listener eye gaze varies as a function of speech fluency (i.e., stuttered vs fluent speech) when watching PWS. This is the first study using eye-tracking that analyzed gaze patterns in response fluent (PWS-F) and disfluent (PWS-S) segments of PWS speech. Previous study designs have not made this distinction. As such, an examination of the extent to which gaze aversion is tied to actual episodes of stuttering versus being a more global phenomenon related to communicative integrity is possible.

We first hypothesized that participants would decrease the proportion of time spent observing eye regions as well as increase proportion of time spent viewing mouth regions when viewing PWS as compared to PWNS. We also hypothesized that participants would decrease observation time of eye regions and gaze more toward the nose/mouth region when observing PWS-S as compared to PWS-F.

Methods

Participants

Twenty-one undergraduate students with no training in speech-language pathology, or self-reported history of cognitive, emotional, hearing, visual, speech, or language abnormalities participated. Participants reported being naïve to stuttering and had not participated in any previous studies of this kind. Two participants were unable to take part in the experiment due to inability in obtaining appropriate calibration (i.e., one had nystagmus, and one had a chip in their bifocals which inhibited accurate calibration). Additionally, three participants data were not used in the analysis because they maintained gaze with only one region throughout all stimulus presentations therefore resulting in sixteen participants (6 male and 10 female; M = 21.1 years, SD = 3.2). Prior to experimental procedures, informed consent (approved by the University and Medical Center Institutional Review Board at East Carolina University) was obtained from all participants.

Stimuli

Stimuli for the current study were designed similar to those used in Zhang and Kalinowski (2012). However, the current study used six speakers with 30 s durations instead of three speakers under both fluent and disfluent conditions for 60 s durations, as in Zhang and Kalinowski (2012). Video production for the current study required speakers to maintain direct gaze with the camera, were standard definition quality, and framed on the face, therefore omitting shoulder areas (see Figure 1). Audio-visual recordings of three male PWS with three age and gender matched PWNS maintaining directed eye gaze with a teleprompter were used as stimulus videos. Texts consisted of six non-standardized passages from fifth to seventh grade reading levels, as determined by the Flesch-Kincaid reading scale (Kincaid, Fishburne, Rogers, & Chissom, 1975; as reported in Saltuklaroglu, 2004). Reading was chosen to control for content and complexity. Multimedia staff at East Carolina University professionally recorded stimulus videos. Speakers were recorded in a sound-treated studio while wearing a unidirectional collar microphone attached below the viewpoint of the camera. Table 1 presents the behavioral characteristics of speakers. All three PWS samples were considered to be severe via informal assessment from three credentialed speech-language pathologists.

Videos were presented on a 51 cm Dell 2001FP computer monitor. Center point of the monitor was located approximately 60 cm at 0^0 azimuth and 0^0 altitude from the participants' line of sight. Stimulus presentation was controlled by a Dell Optiplex GX280 personal computer via GazeTracker software (Version 8.0; Eye Responses Technologies, 2009). Audio sound recordings were presented simultaneously on two speakers (Harman Kardon DP-N 02320V) located adjacent to the monitor. Presentation levels were set at a comfortable listening level (e.g., 65-75 dB SPL). A D6 desk-mounted optical/camera array eye-tracking system

Table 1. Speech and behavioral characteristics of stimulus speakers.

Speaker characteristics

Stimuli Video	Total Syllables Spoken	% Stuttered Syllables	% Total Time Stuttered	Longest Stuttering Episode (s)	Speech Rate (syllables/s)	Duration of eye contact (s)	Number of Eye blinks	Concomitant Stuttering Behaviors
PWS 1	23	26	96	14.7	NA*	29.48	4	Lip protrusions and muscle tension in the forehead
PWS 2	52	19	57	4.1	NA*	27.11	13	Lip protrusions, eyebrow raising, and head movements
PWS 3	69	16	61	9.7	NA*	28.68	20	Lip protrusions and head jerks
Fluent Speaker 1	124	0	0	NA	4.7	28.58	5	NA
Fluent Speaker 2	132	0	0	NA	4.8	28.80	4	NA
Fluent Speaker 3	100	0	0	NA	4.2	29.36	4	NA

Note. Behavioral characteristics of fluent and stuttered speech samples (per 30 s segments) as a function of speaker. Stuttering was operationally defined as part-word or whole word repetitions, phoneme prolongations, and postural fixations. *Indicates that speech rate could not be calculated for the PWS since 50 perceptually fluent contiguous syllables were not produced (Kalinowski, Armson, Roland-Mieszkowski, Stuart, & Gracco, 1993).

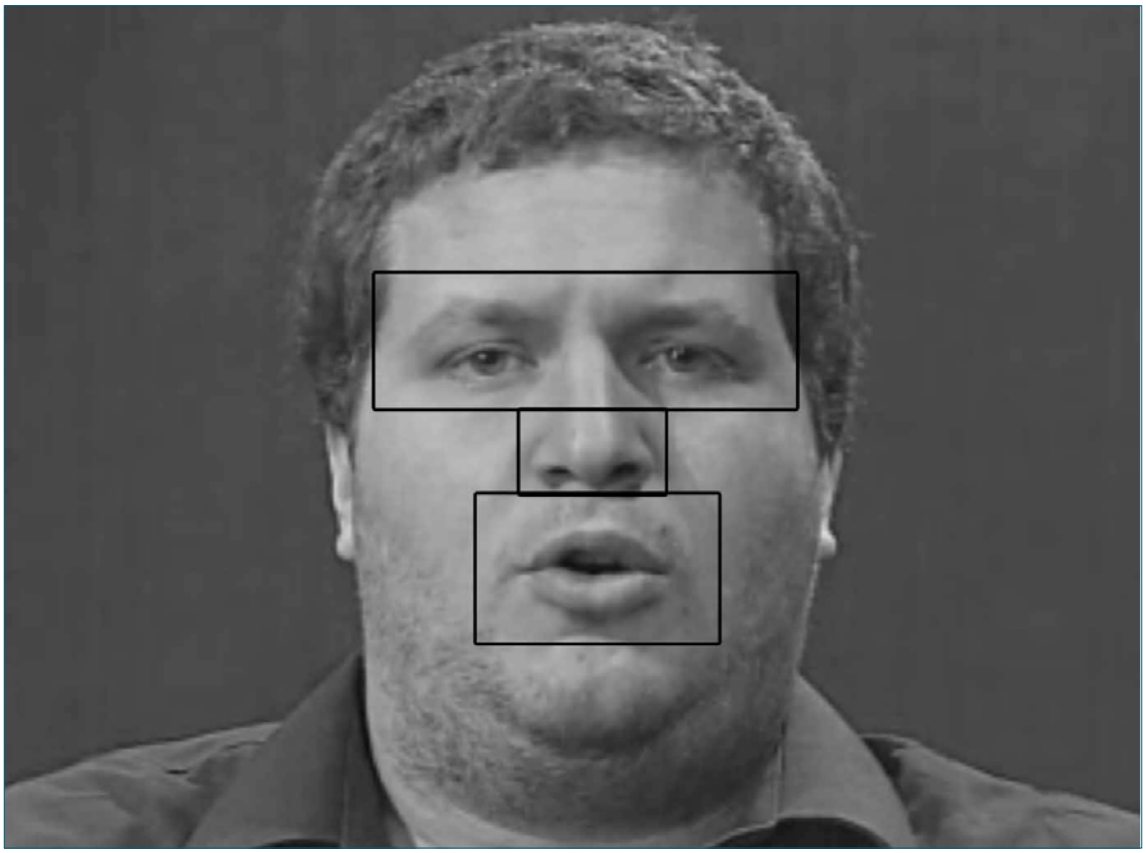


Figure 1. Example of Regions of Interest (ROI) framing used in the current study. Anatomical markers for region creations were retrieved via Bowers, *et al.*, (2010).

(Applied Sciences Laboratories - ASL) was used to collect gaze behaviors. It sat directly below the monitor and housed an infrared camera designed to capture the pupil diameter and corneal reflection of the left eye at 60 Hz. It is common for eye-tracking devices to only record one eye due to synchronous movements of both eyes. The D6 unit also employed a second camera for online video head tracking to adjust for subtle X, Y, and Z spatial head movement. However, participants were instructed to move as minimally as possible during the experiment, especially during the calibration phase. A second Dell Optiplex GX280 personal computer controlled the D6 unit via EYE-TRAC®6 software (ASL) capturing gaze data and allowing for real-time monitoring of gaze behaviors on an 18 cm VGA closed circuit monitor. Prior to data collection, each participant performed a nine-point calibration sequence per manufacturer's specifications. Offline analysis was performed with GazeTracker software that overlaid recorded data onto stimulus videos enabling the creation of dynamic ROI.

Procedure

A fluent research assistant initially briefed participants about general experimental procedures, and requested that they remain as motionless as possible throughout the study, especially during the calibration. Participants then read and signed informed consent documents. They were seated in a stationary chair positioned 61 cm in front of the stimulus screen/eye tracking system. A second researcher was seated behind a partition, out of view of the participants, to calibrate the equipment and start the experiment. Researchers adjusted camera positions through the software controls, acquired adequate pupil contrasts and corneal reflections, and turned on the video-head-tracker for auto calibration. Researchers then calibrated participants according to standardized nine-point ASL calibration procedures. The calibration sequence presented a 1.5 cm grey cross at nine distinct points (three equidistant rows and columns) across the screen. Crosses were displayed only one at a time. Participants fixated on the cross until the software acquired calibration data for each point. Once data for one point was calibrated, the cross would disappear and the next cross would appear sequentially from top left to top right before moving down a row and proceeding from left to right. The final point for calibration was the bottom right. Upon calibration of all nine points, participants fixated on a central cross, if tracking was off more than 1.5 cm from the central cross, the calibration sequence was re-administered. Researchers then started the experiment via GazeTracker that presented random sequences of the six stimulus videos. Each participant observed all six videos in a randomized order. Between each video presentation the central cross was presented to subjectively determine tracking consistency. No participants' tracking data drifted more than 1.5 cm from the outside edges of the central cross, so no recalibrations were performed.

Regions of Interest

Using Gaze-Tracker software, four ROIs, similar to those employed by previous researchers (Bowers et al., 2010; Zhang & Kalinowski, 2012), were generated for offline analysis. They included: both eyes (i.e., approximately superior to the eyebrows, lateral edges of the eye sockets, and zygomatic process protrusion "cheek bone protrusions"); nose (i.e., inferior portion of the nasium, extending in close proximity past the lateral edges of the nostrils, and inferior portion of the nasal bone); mouth (i.e., extending past the inferior portion of the lips, lateral edges of the lips, and inferior portion of the nasium); and "outside" (i.e., any gaze-point not occurring within the eyes, nose, or mouth area) regions (see Figure 1). A visual overlay was used to create unique dynamic ROI using a 0.25 s video playback speed during placement of the ROIs to increase accurate placements without overlap.

Gaze Analysis

Gaze data were exported from GazeTracker for offline analysis. Only the tracked time in the ROI was examined as the dependent variable in the current study. For fixation counts and fixation durations during the observation of stuttered compared to fluent speech, please see Bowers et al. (2010). Proportion of total time tracked data was analyzed to account for any time lost during recordings (i.e., loss of corneal reflection, loss of pupil diameter, and blink artifact). Percent time recorded was typically over 92%.

For further examination, using previously described methods to create ROIs, researchers created ROIs for the PWS videos including sub-segments of fluent (PWS-F) and disfluent (PWS-S) periods. Disfluencies were defined using Stuart, Frazier, Kalinowski, and Vos's (2008) adapted categorization of Conture (2001). Two researchers trained on analyzing stuttering independently categorized fluent and disfluent segments while observing audiovisual presentations on Peak Pro Version 6.0. This enabled researchers to make note of time of onset/offset for disfluencies. Disagreements on stuttering episodes were under 1.8% of total spoken syllables. Disfluencies ranged from approximately 200 ms to 14.3 s. If one syllable in a word was classified as disfluent by both researchers,

the entire word was categorized as disfluent for segment analysis. Between word disfluencies that carried into initial syllable disfluencies and phrase repetitions were classified as disfluent segments. For example, if the speaker exhibited a postural fixation that proceeded to a tense production (e.g.,_____C-C-C-Carried) the auditory or visual moment when the observers marked the disfluency beginning was included in the PWS-S segment. Only agreed upon stuttering episodes were used for the disfluent segments. When stuttering occurred at the onset of a word, an average onset time as marked by the two researchers was used. Our shortest PWS-S segment was just over 400 ms with the average PWS-S segment being 927 ms (excluding the 14.3 s outlier). However, the outlier was included in the ROI analysis. Additionally the fluent, PWS-F, segments ranged from 320 ms to 6.8 s with an average fluent duration of 4.3 s. As with the previous analysis, GazeTracker exported total time tracked data in region for each ROI for total PWS-F and PWS-S segments, which were then analyzed using SPSS.

Results

In the initial set of analyses, we examined whether eye gaze patterns systematically differed during the viewing of PWS compared to PWNS. Prior to inferential statistical analysis, participants' proportional gaze-times were transformed into arcsine units to reduce endpoint weighting (see Zar, 1996). The means and standard errors for proportion of gaze time averages, as a function of speaker group and ROI, are displayed in Figure 2. First, a two-factor repeated measures analysis of variance (ANOVA) was used to examine proportions of gaze as a function of fluency and ROI. A significant main effect of ROI was observed [$F(1.70, 25.48) = 15.25$, Greenhouse-Geisser $p < 0.0001$, $\eta_p^2 = 0.50$], but not for fluency overall [$F(1, 15) = 2.75$, $p = .12$, $\eta_p^2 = 0.16$]. A significant ROI by fluency (PWS vs. PWNS) interaction, however, was observed [$F(2.59, 38.84) = 5.47$, Greenhouse-Geisser $p = 0.005$, $\eta_p^2 = 0.27$], indicating that effects for fluency may have arisen in certain ROIs.

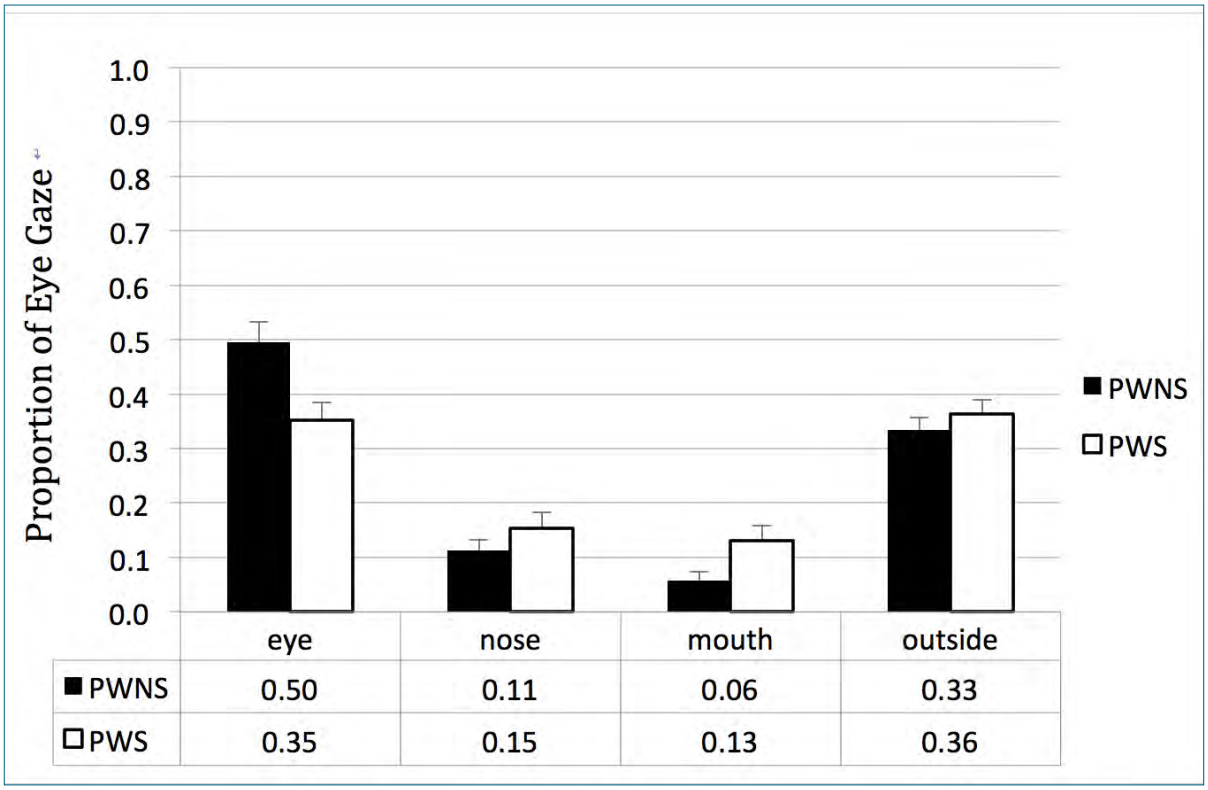
To examine the source of the interaction, four separate paired samples t-tests were utilized to examine the proportions of gaze time as a function of speaker at each ROI. We used a Bonferroni corrected alpha level of .0125 (.05/4) to correct for multiple comparisons. First, significant differences were not observed in the proportions of gaze time for the nose ($t(15) = -0.83$, $p = 0.42$, $\eta_p^2 = .044$) and outside regions of interest ($t(15) = -0.78$, $p = 0.45$, $\eta_p^2 = .039$). There were significant differences in the proportions of gaze time for the eye ($t(15) = 4.01$, $p = 0.001$, $\eta_p^2 = .52$) and mouth regions ($t(15) = -2.89$, $p = 0.012$, $\eta_p^2 = .36$) for PWS versus PWNS. These results revealed that participants' gazed more at PWNS eyes, and PWS mouths when examining the entire videos. To obtain a relative index ratio of these differences, an eye gaze to mouth gaze proportion was computed for each participant, then averaged for both of the speaker conditions (i.e., PWNS and PWS). We found that participants viewed eye regions during PWNS stimuli 7.7 times more often than the mouth in comparison to PWS (cf. ratios of 309 vs. 40).

Analysis of stuttered (PWS-S) and fluent (PWS-F) segments from the PWS

A major aim of this study was to investigate the extent to which stuttering episodes versus fluent speaking in PWS influences eye-gaze behavior. This will help determine whether stuttering episodes contribute to shifting of eye gaze to an ROI or alternatively, whether participants treat stuttered and fluent episodes similarly when viewing PWS.

Mean proportion of gaze times in each ROI are displayed for PWS-F and PWS-S episodes in Figure 3, and compared to PWNS. We utilized two-factor repeated measures ANOVAs to examine participants' gaze proportions of PWS video speech as a function of production fluency (i.e., PWS-F or PWS-S) and ROI. (Once again, participants' proportional eye gaze times were transformed into arcsine units prior to inferential analysis). Significant main effects of ROI [$F(1.69, 25.37) = 7.76$, Greenhouse-Geisser $p = 0.004$, $\eta_p^2 = 0.34$] and ROI by speaker category were observed [$F(2.18, 32.75) = 3.40$, Greenhouse-Geisser $p = 0.042$, $\eta_p^2 = 0.18$]. The main effect of speaker category was not statistically significant [$F(1, 15) = 0.25$, $p = .63$, $\eta_p^2 = 0.016$]. Next, four paired samples t-tests were carried to examine the proportion of gaze-time as a function of fluency (PWS-S vs. PWS-F) at each ROI. A Bonferroni corrected alpha level of .0125 (.05/4) was again implemented to correct for multiple comparisons.

First, we failed to observe significant differences in the proportions of gaze time for eye, although interestingly, there was a trend for greater gaze time when stuttering occurred ($t(15) = 2.33$, $p = 0.034$, $\eta_p^2 = .015$). Second, the nose region was significant, with greater gaze time directed toward the nose when stuttering occurred ($t(15) = 3.62$, $p = 0.003$, $\eta_p^2 = .022$). Third, the mouth region was significant; again, with greater gaze time occurring during episodes of stuttering ($t(15) = 2.95$, $p = 0.01$, $\eta_p^2 = .013$). Finally, there was a non-significant trend for the outside ROI in PWS-S versus PWS-F ($t(15) = 2.43$, $p = 0.028$,



	eye	nose	mouth	outside
PWNS	0.50	0.11	0.06	0.33
PWS	0.35	0.15	0.13	0.36

Figure 2. Mean proportion of gaze time for speaker and region (x-axis). The gaze appears to shift from the eyes to mouth in PWS compared to PWNS. Error bars represent plus one standard error of the mean.

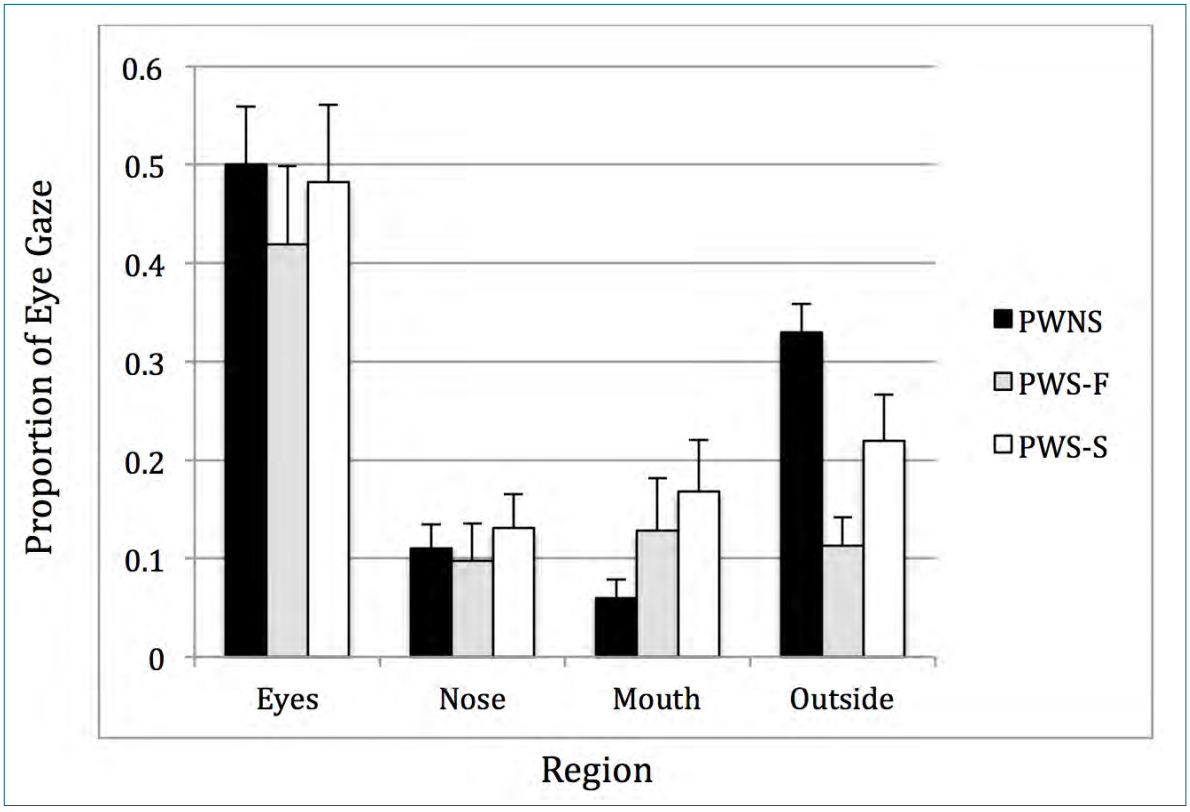


Figure 3. Mean proportion of gaze time in ROI for segment analysis. Error bars represent plus one standard error of the mean.

η_p^2 = .08). Taken together, these results suggest that stuttering contributed to gaze aversion toward the nose-mouth region, as predicted.

Discussion

This study aimed to collect objective data to better understand eye contact and gaze aversion in response to stuttered speech. In doing so the current study produced findings that are consistent with, yet expand upon the findings of Bowers et al., (2010) and Zhang and Kalinowski, (2012). That is, fluent speakers averted their eye gaze when they observed audiovisual recordings of PWS speaking. Most importantly however, this study further decomposed the speech of PWS into fluent versus disfluent segments and demonstrated a more specific pattern of gaze aversion to stuttered events.

First, significant differences were observed between the proportion of time participants spent observing both eye and mouth regions throughout the entire videos. When viewing PWS as compared to PWNS, participants decreased observation of the eyes region by 30% and increased observation of the mouth region by 115%. Our findings supported our initial hypothesis that participants would decrease proportion of time spent observing eye regions and increase proportion of time spent observing mouth regions when viewing PWS compared to PWNS. Findings that fluent speakers spend less time observing the eyes region of PWS during whole video analysis adds converging support to prior results (Bowers et al., 2010; Zhang & Kalinowski, 2012). However, this is the first study to examine fluent and stuttered segments of PWS speech (i.e., PWS-F and PWS-S), in regard to listeners' eye gaze behaviors. This novel examination indicates that eye-gaze behavior does not result from aversion to PWS *per se*, but instead result from aversion to stuttered events themselves.

A commonly accepted theory of gaze aversion is the presence of avoidance-oriented emotions (e.g., increased anxiety, tension, and uneasiness). It could therefore be interpreted that the reduction in proportion of time spent observing the eyes region of PWS supports evidence of negative self-reported emotional states and physiological arousal in listeners when observing PWS speaking (see e.g., Bowers et al., 2010; Guntupalli et al., 2006, 2007; Zhang et al., 2010). These interpretations are also supported by our findings that participants increased observations of nose and mouth regions during PWS-S. The display of anxiety, uneasiness, tension, shame, and guilt on the faces and in the eyes of PWS may lead receivers to avoid observing these manifestations (Bowers et al., 2010; Zhang & Kalinowski, 2012).

Another interpretation for eye gaze shift relates to the "meaningfulness" of eye gaze aversion. Here, participants seem to have been engaging in eye gaze avoidance rather than searching for additional visual cues to understand speech. On the other hand, during presentation of static facial images of prerecorded audiovisual or visual-only speech samples and face-to-face communication, participants typically spend 50-60% of the time observing eye regions (Bowers et al., 2010; Vatikiotis-Bateson, Eigsti, Yano, & Munhall, 1998). The current study revealed values within these ranges during perception of PWNS, PWS-S, and PWS-F. However, during perception of PWS videos, these proportions significantly decreased overall compared to PWNS. Proportion of eye gaze decreased during PWS, although this was not the case for PWS-F or PWS-S. This finding demonstrated how variable eye-gaze can be depending extraneous factors including: peripheral distractions, S/N ratio, direction of the senders gaze, duration of presentation, social interpretation, emotional context, situation of presentation (life or video), and the speaker's verbal fluency (Klin et al., 2003).

Differences in observed gaze-time of mouth regions supported Zhang and Kalinowski's (2012) findings, but differed from Bowers et al. (2010) who previously reported differences in observations of eye versus nose regions rather than eyes to mouth. Although there appears to be disparity between these findings, there may be considerable similarity. The one PWS used as the stimulus speaker for Bowers et al. (2010) manifested his visually aberrant stuttering behavior at the level of the nose (i.e., nostril flaring during stuttering). The multiple PWS used for stimuli in both Zhang and Kalinowski (2012) and the current study primarily exhibited their associated visual stuttering behaviors at the level of the mouth (i.e., lip tension, flexion, and fixation). There is another important implication of the participants' tendency to spend more time looking at the mouth of PWS; given that participants can only observe one spot at a time, any increase in time spent in one location implies a move from another location. In other words, our current findings suggest the participants made gaze shifts from eyes to mouth regions when observing PWS. Postural fixations and excessive lip activity may have acted as peripheral stimuli enhancing the avoidance behaviors. Presentation of visual distractions in participants' periphery has been shown to shift directed eye gaze to search for and fixate on the peripheral stimuli (Greene, Mooshagian, Kaplan, Zaidel, & Iacoboni, 2009). In the case of observing PWS, an automatic visual orienting response may be triggered by the anticipation of stuttering, therefore requiring participants to proactively recruit additional gestural information for increased

comprehension. This process is similar to that described in speech reading studies and speech threshold studies (Lansing & McConkie, 2003; Vatikiotis-Bateson et al., 1998). As participants are presented with increased amplitudes of white noise during speech perception, their gaze tends to shift from eyes to central (i.e., nose) or mouth regions. Similarly, when participants are presented with audiovisual recordings of different speakers with auditory masking noise, they fixate on mouth regions more frequently and for longer durations (Buchan, Pare & Munhall, 2008). If presented with the same speaker across various intensities of the same auditory masking noise they tend to have central fixations on nose regions. The findings from Bowers et al. (2010) are relevant here; recall that the study had one speaker for all speaker conditions and that participants shifted eye gaze to the nose region where nostril flaring was occurring. These findings suggested that the shift in gaze may be motivated by an altered state of attention or the presence of peripheral visual distractions instead of searching for additional gestural information.

Conclusion

The current results support related findings that people react differently when viewing PWS speaking as compared to their fluent counter parts. Conclusions can be summarized into three categories. First, participants viewed the eyes region more and the mouth region less when watching the fluent speakers – the inverse, gaze shifting from eyes to mouth region, occurred when watching PWS speaking. Second, participants observed nose and mouth regions more during PWS-S compared to PWS-F. Thirdly, results from the segmented analysis appear to indicate that once a speaker is perceived as disfluent the listeners' gaze is altered during both fluent and disfluent segments. These findings are consistent with avoidance-oriented behaviors and support previous eye tracking and biobehavioral experiments showing negative self-reported and physiological arousal when viewing stuttered stimuli.

It is of interest to later examine what influence the use of a disclosure statement (e.g., "Hi my name is... and I stutter), altered levels of eye contact, or communicative skills training have on sender-receiver dynamics during video presentations and during naturalistic communicative exchanges. Future studies should examine both communication partners in more naturalistic environments to determine the initiator of gaze alteration behaviors with segmented methods of analysis. It is also likely that different results may be obtained during face-to-face interactions as compared to viewing prerecorded videos on a monitor. The use of high definition avatars might later allow for a more precise representation of naturalistic interactions that have limited output responses to defined input parameters (Le, Ma, & Deng, 2012). Additionally, future studies should further investigate dynamic sender-receiver interactions during the perception of typical and various types of disordered speech in order to better understand how to effectively and efficiently increase communication naturalness during interpersonal exchanges when total fluency might not be possible.

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Développement et validation d'un outil de mesure – Évaluation des facteurs environnementaux influençant la participation sociale des élèves du primaire présentant un trouble de la communication

Development and Validation of a Measurement Tool: Evaluation of Environmental Factors Influencing the Social Participation of Primary School Students with Communication Disorder

MOTS CLÉS

TROUBLES DE LA COMMUNICATION

TROUBLE PRIMAIRE DE LANGAGE

TROUBLE DE TRAITEMENT AUDITIF

FACTEURS ENVIRONNEMENTAUX

QUESTIONNAIRE

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Les troubles de la communication, notamment le trouble primaire de langage et le trouble de traitement auditif, peuvent restreindre la participation des enfants d'âge scolaire dans leurs différents milieux de vie. Les facteurs environnementaux jouent un rôle prépondérant dans les difficultés observées chez les élèves. Il est donc nécessaire de les considérer dans l'offre de service proposée aux enfants ayant un trouble de la communication. Il semble toutefois qu'aucun instrument francophone valide ne permet d'évaluer ces facteurs en différents milieux de vie pour cette clientèle. La présente étude de type méthodologique vise donc à développer un outil de mesure francophone évaluant les facteurs environnementaux qui influencent la participation sociale d'enfants âgés entre 5 et 13 ans présentant un trouble de la communication et ce, dans divers milieux de vie. Ce texte a pour objectif de présenter le développement de l'outil, basé sur le Modèle de Développement Humain-Processus de production du handicap (Fougeyrollas, Cloutier, Bergeron, Côté, Côté, & St-Michel, 1998; Fougeyrollas, 2010), ainsi que l'appréciation de certaines de ses qualités psychométriques. L'outil *Évaluation des facteurs environnementaux influençant la participation sociale des élèves du primaire présentant un trouble de la communication* comporte deux questionnaires, un de 99 items à l'intention d'un parent et un de 76 items à l'intention d'un intervenant scolaire. Les questionnaires sont divisés en grandes sections représentant les milieux ou contextes de vie de l'enfant. L'outil est suffisamment valide pour être utilisé en clinique et en recherche. La complétion des questionnaires par les personnes visées peut permettre d'identifier les principaux éléments de l'environnement qui sont favorables ou non à l'enfant et d'intervenir de façon ciblée.

Abstract

Communication disorders, including the primary language impairment and auditory processing disorder, may restrict the participation of school-age children in their various life environments. Environmental factors play a predominant role in the difficulties observed in the students. It is therefore necessary to take them into consideration in the service proposal to children with communication disorder. However, it seems that no valid Francophone tool makes it possible for those factors to be assessed in different life environments for this population. This methodological-type study therefore aims at developing a French measuring tool evaluating the environmental factors that influence the social participation of children with communication disorder aged 5 to 13, and this in diverse life environments. This paper aims at introducing the development of the tool based on the *Modèle de Développement Humain-Processus de production du handicap* (Fougeyrollas, 2010), as well as the appreciation of some of its psychometric qualities. The tool *Evaluation des facteurs environnementaux influençant la participation sociale des élèves du primaire présentant un trouble de la communication* (Evaluation of the environmental factors influencing the social participation of primary-school students with a communication disorder) includes two questionnaires, one with 99 items for parents, and one of 76 items for school personnel. The questionnaires comprised large sections representing the environments or contexts of the child's life. The tool is valid enough to be used in clinics and in research. Completion of surveys by targeted persons may make it possible to identify the main factors of the environment that are conducive, or not, to the child, and to provide proper intervention.

Les troubles de la communication observés chez les enfants peuvent affecter leur participation sociale en milieu scolaire tant au niveau de leurs relations sociales que dans les tâches scolaires proprement dites. Deux de ces troubles, le trouble primaire de langage (TPL) et le trouble de traitement auditif (TTA), touchent un grand nombre d'élèves. Le TPL, appelé en anglais *primary language impairment* (Thordadottir et al., 2011) ou, plus fréquemment, *specific language impairment*, est l'un des troubles les plus couramment observés chez les enfants. Selon une étude épidémiologique américaine (Tomblin et al., 1997), il affecterait 7,4 % des enfants entrant à l'école. Le TPL est défini par Kohnert, Windsor et Ebert (2009) comme étant une limitation significative du langage qui n'est pas causée par un trouble sensoriel ou cognitif, comme une perte auditive ou un syndrome de Down. Reed (2011) mentionne que ce trouble de langage se manifeste sous différentes formes pouvant atteindre l'expression et la compréhension ou l'expression seulement. En outre, la mémoire de travail et la vitesse de traitement du langage peuvent être affectées chez les enfants ayant un TPL, ce qui peut aggraver leurs difficultés langagières (Leonard et al., 2007). Quant au TTA, le Groupe directeur canadien interorganisationnel en orthophonie et audiologie (GDCI) mentionne que sa prévalence est difficile à confirmer (GDCI, 2012), mais on estimerait qu'il touche environ 2 à 5 % des enfants (Bellis et Anzalone, 2008). Ce trouble résulte d'une déficience dans les mécanismes et le fonctionnement du système auditif en l'absence d'une perte auditive (Chermak et Musiek, 1997). Le TTA se traduit par un déficit dans une ou plusieurs des fonctions du système auditif central, telles la localisation et la latéralisation du son, la discrimination auditive, la reconnaissance des formes sonore et des aspects temporels de l'audition ainsi que la performance auditive face à une dégradation des signaux acoustiques (ASHA, 2005 ; Bellis, 2003).

La majorité des travaux sur le TPL est centrée sur les capacités langagières de l'enfant. Quelques études ont tout de même établi des relations entre la présence de ce trouble et des difficultés scolaires, des troubles socio-émotionnels et comportementaux (Beitchman, Wilson, Brownlie, Walters, et Lancee, 1996a ; Beitchman et al., 1996b; Franc et Gérard, 1996), de même que des difficultés à établir des relations interpersonnelles (Brinton, Fujiki, Campbell, et Robinson, 1997; Brinton, Fujiki, et Higbee, 1998; Brinton, Fujiki, et McKee, 1998; Fujiki, Brinton, et Clarke, 2002; Fujiki, Brinton, Isaacson, et Summers, 2001; Fujiki, Brinton, Morgan, et Hart, 1999; Fujiki, Brinton, et Todd, 1996). Par contre, peu d'entre elles réfèrent aux diverses composantes de l'environnement de l'enfant. Or, considérer ces composantes permettrait d'offrir une vision plus complète de son vécu. Il en est de même pour le TTA. En effet, bien que le GCDI (2012) mentionne que ce trouble affecte l'exécution de tâches en classe et par conséquent la participation de l'élève en milieu scolaire, et bien que quelques auteurs mentionnent une relation entre ce trouble et des troubles d'apprentissage (Chermak et Musiek, 1997; Jerger et Musiek, 2000; Welsh, Welsh et Healy, 1996), aucune recherche ne s'est attardée aux aspects environnementaux impliqués dans ce trouble de la communication. Des stratégies d'intervention concernant les dimensions physiques de l'environnement, tel que l'aménagement de la classe, sont proposées dans la littérature, mais il y a peu d'informations sur les autres composantes de l'environnement sur lesquelles il serait possible d'agir afin de soutenir les enfants. Les facteurs environnementaux associés à une meilleure participation sociale de ces enfants sont peu connus.

Pourtant, la Classification internationale du fonctionnement, du handicap et de la santé (CIF) (Organisation Mondiale de la Santé (OMS), 2000) et le Modèle de Développement Humain-Processus de production du handicap (MDH-PPH) (Fougeyrollas, 2010) défendent la conception interactive selon laquelle la situation de handicap est un phénomène issu de la rencontre entre l'environnement (son accessibilité, ses exigences, ses facilitateurs et ses obstacles) et les caractéristiques de la personne (ses ressources et ses limites de capacités). Les facteurs environnementaux, sociaux et physiques jouent, fort probablement, un rôle à considérer dans les difficultés observées chez les élèves. Ils peuvent soit restreindre le fonctionnement de l'élève, soit le faciliter (Guerdan, Belet, Corthesy, Jaccottet, et Gigon, 2013). Il est donc nécessaire de mettre au point des outils pour évaluer les facteurs de l'environnement qui semblent favorables ou défavorables à la participation sociale dans divers milieux de vie des enfants ayant un trouble de la communication. Par l'identification des facteurs environnementaux ayant un effet sur la participation sociale et la réussite scolaire, il sera possible de déterminer les aménagements nécessaires et permettre, par la suite, de guider et orienter l'intervention sans cibler uniquement les capacités langagières ou auditives. De même, il sera alors possible d'identifier les facteurs environnementaux sur lesquels agir, tant pour les adapter que pour en retirer les obstacles. Ainsi, une intervention langagière ou auditive sera bonifiée par la considération de l'environnement social et physique de l'enfant.

Différents instruments de mesure de la qualité de l'environnement ont été développés, mais ceux-ci comportent des limites quant à l'environnement évalué, la clientèle ciblée ou la variété de répondants. Plus précisément, le contenu de certains outils existants est spécifique à un environnement particulier tel la classe (Fisher et Fraser, 1981; Fraser, Andersen et, Walberg, 1982; Fraser et O'Brien, 1985; Guerdan et al., 2013; Moos, 1979; Moos et Trickett, 1974), l'école (Janosz, Georges, et Parent, 1998) ou l'environnement familial (Moos et Moos, 1983). De plus, les outils existants s'intéressant aux enfants sont généralement complétés par une seule personne significative, soit le parent ou l'enseignant. Aucune étude n'a comparé et jumelé à la fois le point de vue du parent et de l'enseignant pour avoir une vision plus large et plus juste de la qualité de l'environnement. Il existe néanmoins un questionnaire valide sur la qualité de l'environnement basé sur le modèle conceptuel MDH-PPH (Fougeyrollas, Noreau, et St-Michel, 1997) nommé *La Mesure de la Qualité de l'Environnement (MQE)*. Il vise à évaluer l'influence des facteurs environnementaux sur la réalisation des activités courantes et des rôles sociaux des individus et ce tout en tenant compte de leurs capacités et de leurs limites personnelles. Toutefois, cet outil ne s'adresse qu'à la clientèle adulte. Cet instrument ne s'applique pas aux enfants ayant des troubles de la communication et par conséquent, il n'y a pas de garantie qu'il a la capacité de traduire fidèlement les facilitateurs et obstacles de l'environnement pour la clientèle ciblée. Michallet et Boudreault (2014) ont récemment élaboré un outil de mesure des habiletés et des besoins de jeunes dysphasiques de 4 à 15 ans. Bien que le concept de besoin englobe certains facteurs environnementaux et certaines habitudes de vie, l'outil créé n'a pas pour objectif d'évaluer les facteurs environnementaux. Il semble donc qu'aucun instrument francophone valide ne permet d'évaluer la qualité de l'environnement de différents milieux de vie des enfants d'âge scolaire. De plus, les outils cités ne ciblent généralement pas une population spécifique d'enfants, comme ceux ayant un trouble de la communication. Dans ces conditions, l'environnement des enfants d'âge scolaire ayant un trouble de la communication est peu mesuré ou documenté, ni par le milieu scolaire ni par le milieu de la réadaptation.

La présente étude de type méthodologique vise donc à développer un outil de mesure francophone évaluant les facteurs environnementaux qui influencent la participation sociale d'enfants âgés entre 5 et 13 ans présentant un trouble de la communication (TPL ou TTA). Éventuellement, l'outil pourrait être utilisé par les milieux scolaire et de la santé (réadaptation) afin d'adapter l'environnement et suggérer des pistes d'intervention. Pour inspirer le développement de cet outil, la Classification internationale du fonctionnement (CIF, OMS, 2000) ainsi que le Modèle de développement humain - Processus de production du handicap (MDH-PPH) (Fougeyrollas, 2010), seuls modèles de classification opérationnels et complets porteurs du paradigme systémique (Petitpierre, 2013), ont été consultés. Le modèle ayant principalement guidé le développement de cet outil provient du MDH-PPH. L'utilisation du MDH-PPH est répandue au Québec, tant dans les politiques de soins et de services que dans les plans d'intervention individuels. Il permet de s'attarder à l'environnement dans son ensemble en tenant compte des facteurs environnementaux touchant l'enfant de près, comme sa famille ou son enseignant, ou de loin comme les services dans la communauté. Au sein de ce modèle théorique, les facteurs environnementaux interagissent de façon dynamique avec toutes les composantes du processus de production du handicap (facteurs personnels et habitudes de vie). Les facteurs environnementaux sont décrits comme des facteurs externes de l'individu (à l'opposé des facteurs personnels qui eux, sont les facteurs internes de l'individu) et peuvent être considérés comme étant des éléments facilitateurs (aspect positif) ou des obstacles (aspect négatif). Les modèles et outils de Moos (Moos, 1979; Moos et Moos, 1983) et de Janosz et al. (1998) ont aussi été consultés. Certaines composantes de ces modèles et outils ont également été intégrées pour permettre d'approfondir davantage les deux environnements affectant le plus la participation sociale des enfants, c'est-à-dire les milieux scolaire et familial.

Deux questionnaires ont été développés à partir du modèle conceptuel décrit. Un pour les parents et l'autre pour les intervenants scolaires (l'enseignant principalement). Cet article rapporte brièvement les assises du projet, la conception et la validation de l'instrument. Considérant que l'élaboration et la validation d'un instrument sont des processus longs et complexes, l'appréciation des propriétés métriques de cet instrument visait dans un premier temps la validité de contenu et la consistance interne des différentes sous-sections composant les questionnaires.

Méthodologie

La méthodologie propre à cette étude réfère, dans un premier temps, au développement des questionnaires et, par la suite, à l'appréciation de leur validité de contenu et de la consistance interne de chacune des sous-sections.

Développement des questionnaires

Le développement des questionnaires s'est réalisé en plusieurs étapes : 1) la création et la sélection des items; 2) la formulation des énoncés; 3) le classement des énoncés; 4) la formulation de la consigne de base et 5) le choix de l'échelle de mesure.

Création et sélection, formulation et classement des items. La création des items a d'abord été effectuée à partir de données préliminaires issues d'entrevues réalisées auprès de parents et d'enseignants d'enfants ayant un TPL de degré sévère. Ces entrevues semi-dirigées, réalisées dans le cadre d'un projet antérieur auprès de cinq parents et quatre enseignants, ont permis d'identifier les obstacles et les facilitateurs environnementaux en lien avec des habitudes de vie d'enfants aux prises avec un trouble de la communication. Ces facteurs environnementaux ont été consignés en conservant les termes utilisés par les participants dans le but d'assurer une bonne validité de contenu. De plus, une analyse des facteurs environnementaux fréquemment rapportés dans la littérature comme ayant une influence sur les enfants ayant un trouble de la communication a bonifié la création des items. Comme il existe un nombre limité d'outils de mesure des facteurs environnementaux, la revue de littérature s'est étendue à d'autres clientèles telles les enfants ayant un trouble de comportement ou d'apprentissage. De plus, ces instruments de mesure ont été conçus en s'inspirant de l'outil MQE pour la clientèle adulte (Fougeyrollas et al., 1997) qui est basé sur le modèle conceptuel MDH-PPH (Fougeyrollas, 2010). La sélection des items a tenu compte, entre autres, de leur fréquence d'apparition dans les entrevues et les écrits consultés. De plus, le jugement de cliniciens œuvrant auprès de la clientèle visée (orthophonistes et audiologistes) a contribué à la sélection des items.

Formulation des items. Lors de la formulation des items, une attention particulière était accordée à la clarté, à la pertinence et à la neutralité (Mayer et Ouellet, 1991). Pour garantir cette clarté, des énoncés concis et unidimensionnels utilisant une terminologie générique et comportant un vocabulaire simple et familier pour les répondants visés ont été formulés. Les termes utilisés par les répondants dans l'étude précédente ont d'ailleurs été privilégiés et le contexte franco-québécois a été considéré. Pour favoriser la pertinence des items, une analyse de la possibilité pour un bon nombre de répondants de juger les facteurs ou situations impliqués a été effectuée. Les items étant de nature plutôt anecdotique et ne pouvant vraisemblablement être répondu par un nombre intéressant de parents ou d'intervenants scolaires ont été éliminés. Enfin, pour ne pas engendrer de biais dans les réponses, il était essentiel de formuler les énoncés de façon neutre. Il importait donc de ne pas induire un aspect négatif ou positif. Par exemple, le mot « bruit » a été remplacé par « environnement sonore ».

Classement et ordre des items. Une fois les items sélectionnés et formulés, ils ont été classés en regroupant tous les énoncés se rapportant à un même aspect pour que le répondant puisse mieux s'y retrouver (Mayer et Ouellet, 1991). Le regroupement des items en dimension de la qualité de l'environnement a été réalisé par deux juges de l'équipe de recherche en s'inspirant de différents outils portant sur la qualité de l'environnement (Fougeyrollas et al., 1997 ; Janosz et al., 1998; OMS, 2001). L'ordre des sections a été établi de façon à favoriser la collaboration des répondants. Les questionnaires débutent ainsi par les sections les plus générales ou objectives (par exemple, la composition de la classe). Les sections plus délicates, portant par exemple sur les attitudes, sont placées vers la fin de chacune des sections. Pour le reste, l'ordre des sections respecte la logique des liens les unissant. Les mêmes préoccupations prévalent pour l'ordre des items à l'intérieur de chaque sous-section (Mayer et Ouellet, 1991).

Une fois ces étapes effectuées, chaque version de l'outil de mesure – « à l'intention d'un parent » et « à l'intention d'un intervenant scolaire » - était composée de 130 items différents. Ainsi, le questionnaire à l'intention d'un parent était divisé en quatre grandes sections correspondant aux milieux de vie de l'enfant : *(A) Milieu scolaire – Activités d'apprentissage, (B) Milieu scolaire – L'école proprement dite et ses services, (C) Milieu familial et (D) Milieu communautaire*. Le questionnaire à l'intention d'un intervenant scolaire comportait les mêmes grandes sections à l'exception de celle portant sur le milieu communautaire puisque celui-ci n'y était pas abordé.

Formulation de la consigne de base et sélection de l'échelle de mesure. Le principe qui a servi à la formulation de la consigne de base était d'avoir une seule consigne, aisément compréhensible, pour faciliter la complétion du questionnaire. La consigne était la suivante : *« Pour chaque énoncé, indiquez à quel point la situation ou le facteur influence défavorablement ou favorablement la vie quotidienne de (nom de l'enfant) »*.

Pour ce qui est de l'échelle de mesure, sa sélection est basée sur les critères d'homogénéité et d'aisance de complétion (un seul type de réponse pour tous les

énoncés). L'appréciation de la qualité de l'environnement s'établit donc à partir d'une échelle de type Likert en cinq points équilibrés de chaque côté et qualifiant le degré de « favorabilité » (de « très défavorable » à « très favorable ») des facteurs ou situations. Les répondants ont aussi la possibilité de répondre *Ne sais pas* ou *Ne s'applique pas*.

Appréciation de la validité de contenu de l'outil

La validité d'un outil traduit sa capacité « à mesurer le phénomène étudié, c'est-à-dire l'adéquation qui existe entre les variables retenues et le concept théorique à mesurer » (Contandriopoulos, Champagne, Potvin, Denis, et Boyle, 1990). Plus précisément, l'évaluation de la validité de contenu consiste à vérifier si le contenu des items est approprié pour mesurer la réalité souhaitée (Laveault et Grégoire, 2002).

La première version de chaque questionnaire mesure fut envoyée à des juges-experts choisis sur la base de leurs expériences et connaissances dans le champ des troubles de la communication. Trois d'entre eux, soit un professeur-chercheur en audiologie non-membre de l'équipe de recherche, un orthophoniste et l'enseignant d'un enfant ayant un TPL, ont participé à la validation du questionnaire à l'intention d'un intervenant scolaire. Quatre autres juges-experts ont validé le questionnaire à l'intention d'un parent, soit un professeur-chercheur en orthophonie externe à l'équipe de recherche, un audiologiste et deux parents (un pour chaque trouble de la communication étudié). Les juges-experts devaient donner leur appréciation, à l'aide d'une échelle de 1 à 4 allant de faible à excellent, sur tous les items qui composaient l'outil. Leur évaluation portait sur les critères suivants : la clarté des énoncés (i.e. la formulation de l'énoncé) et la pertinence de l'énoncé en fonction de l'objet d'étude (i.e. l'importance de l'énoncé). Pour chacun des items à apprécier, des espaces étaient prévus pour recueillir les commentaires et suggestions. Ensuite, les juges-experts devaient se prononcer, à l'aide de la même échelle, sur l'ensemble du questionnaire. Ils devaient évaluer la clarté de la phrase explicative au début de chacune des sections, l'aisance de complétion du questionnaire et d'utilisation de l'échelle, la couverture des aspects environnementaux abordés (le nombre et la diversité des énoncés), l'ordre de présentation des items et des sections, l'utilité des données recueillies à l'aide de l'outil et l'appréciation générale de l'outil.

Ces différentes données ont ensuite été compilées et des modifications furent apportées aux questionnaires. Comme le nombre de juges-experts était différent pour chacun des questionnaires, des critères distincts ont été établis pour décider d'éliminer ou modifier un item. Pour le questionnaire à l'intention d'un parent, le critère était que 50% des juges-experts aient donné une cote de 1 ou 2, 1 correspondant à une faible clarté ou pertinence. En ce qui concerne le questionnaire à l'intention d'un intervenant scolaire, le critère pour modifier ou éliminer un item était plutôt que la moyenne des cotes soit de 2,25 ou moins sur 4. Un item atteignant le critère pour les cotes de non pertinence était éliminé tandis qu'un item atteignant ce critère pour les cotes de non clarté était modifié. Les commentaires et suggestions des juges-experts étaient tous analysés individuellement et lorsque cela était approprié, des modifications étaient proposées. Lorsqu'un item était éliminé ou modifié dans un des questionnaires, la pertinence de le faire dans l'autre questionnaire était envisagée. Par contre, avant d'éliminer ou de reformuler un item, un consensus devait avoir lieu dans l'équipe de recherche puisqu'il se peut qu'un item soit pertinent pour un parent et non pour un intervenant scolaire et vice versa. De même, un même item devait souvent être formulé différemment selon qu'il s'adresse à un parent ou à un intervenant scolaire.

Une seconde version de l'outil a ainsi été élaborée à partir des résultats de cette première démarche de validité de contenu. Cette nouvelle version des questionnaires a également fait l'objet d'une consultation auprès de nouveaux juges-experts choisis sur les mêmes bases que lors de la première validation de contenu. Cette fois, cinq juges-experts (un professeur-chercheur en orthophonie non-membre de l'équipe de recherche, un audiologiste et trois enseignants (deux auprès d'un enfant ayant un TPL et un auprès d'un enfant ayant un TTA)) ont donné leur appréciation concernant le questionnaire à l'intention d'un intervenant scolaire. En ce qui concerne le questionnaire à l'intention d'un parent, cinq juges l'ont aussi évalué : un professeur-chercheur en audiologie externe à l'équipe de recherche, un orthophoniste et trois parents (deux d'enfants ayant un TTA et un d'un enfant ayant un TPL).

Les juges-experts réalisaient la même tâche que celle effectuée lors de la première validation de contenu, c'est-à-dire qu'ils cotaient les mêmes points sur une échelle identique de 1 (faible) à 4 (excellent). Une fois ces données compilées, des modifications aux questionnaires ont été effectuées. Tous les items ont été analysés de façon plus descriptive en fonction des cotes données par les juges et de leurs commentaires. Il y a alors eu élimination de quatre items du questionnaire à l'intention d'un parent. En ce qui concerne le questionnaire à l'intention d'un

intervenant scolaire, deux items concernant les méthodes d'évaluation des travaux faits en classe ou à la maison ont été écartés. De même, bien qu'ayant obtenu une bonne cote de pertinence de la part de tous les juges-experts, d'autres items ont été éliminés jumelés ou déplacés et ce, suite à la lecture des commentaires émis concernant l'item en particulier ou les questionnaires de façon globale. Il est à noter que la redondance des items et leur grand nombre étaient des commentaires récurrents. Certains de ces items ont aussi été éliminés en lien avec le fait que les aspects de l'environnement dont ils traitaient ne pouvaient être modifiés, qu'ils soient favorables ou non. En adoptant une procédure identique à celle réalisée pour les cotes de pertinence, des items des deux questionnaires ont été reformulés en fonction des cotes de clarté et des commentaires émis par les juges-experts. Finalement, des modifications au niveau de la syntaxe de certains énoncés ont été effectuées pour en faciliter la lecture. La troisième version de l'outil a ainsi été élaborée à partir des résultats de cette seconde démarche de validité de contenu. Cette troisième version demeurait composée de deux questionnaires comportant les mêmes grandes sections qu'au départ. Le questionnaire à l'intention d'un parent comportait alors 106 items tandis que celui à l'intention d'un intervenant scolaire était composé de 93 items.

La troisième version de l'outil, conçue suite à cette appréciation de la validité de contenu par deux groupes distincts de juges-experts, a été administrée aux parents de 55 enfants ayant un trouble de la communication (26 avec un TPL et 29 avec un TTA) et à 18 intervenants scolaires œuvrant auprès de certains de ces enfants (11 avec un TPL et 7 avec un TTA).

Les données ainsi recueillies ont permis de vérifier la possibilité pour les répondants visés de juger des facteurs ou situations mentionnés. Le nombre de réponses *Ne s'applique pas* et *Ne sais pas* pour chacun des items a été compilé. Une analyse des items pour lesquels 40 % ou plus des répondants avaient coché une de ces réponses a été effectuée. Certains de ces items ont été éliminés ou déplacés suite à une discussion entre deux auteures de cet article. Les premiers éléments considérés pour la prise de décision étaient la cause probable expliquant le grand nombre de réponses *Ne sais pas* ou *Ne s'applique pas* et la richesse de l'information apportée par les répondants qui ont été en mesure de juger le facteur ou la situation en question. Une des explications au grand nombre de ces réponses est qu'ils traitaient de services qui ne sont pas utilisés par tous, par exemple le service d'aide aux devoirs. Il demeure qu'un facteur ne s'appliquant pas à une grande part de la population peut tout de même être très pertinent à considérer pour les enfants concernés. Les items traitant de ces facteurs ont donc été déplacés dans une nouvelle section comportant des « questions filtres ». Ces dernières permettent d'éviter aux répondants non-concernés de s'attarder sur ces items. La redondance de l'item avec un autre et la présence ou non de réponses dans la catégorie « défavorable » (i.e des items que tous les répondants évaluaient de façon positive) étaient aussi pris en compte pour éliminer ou déplacer des items. Les modifications effectuées suite à cette analyse ont ainsi permis de créer la quatrième version de l'instrument. Dans cette version, le questionnaire à l'intention d'un parent comportait 99 items tandis que celui à l'intention d'un intervenant scolaire était alors composé de 76 items.

Évaluation de la consistance interne de chacune des sous-sections

La consistance interne de chacune des sous-sections de cette quatrième version du questionnaire a été vérifiée à partir des mêmes données recueillies auprès d'intervenants scolaires et de parents des 55 enfants ayant un trouble de la communication. Ces sous-sections composent les grandes parties des questionnaires représentant les milieux de vie de l'enfant. Le coefficient alpha de Cronbach – se situant entre 0 et 1 - est la mesure statistique qui a été employée. Elle est d'ailleurs la plus utilisée pour évaluer la consistance interne d'un questionnaire comportant des échelles de Likert (Brown, 2001). Plus sa valeur est proche de un, plus la consistance interne d'un groupe d'items est élevée. Pour le présent article, la valeur d'un alpha de Cronbach est considérée bonne si elle est égale ou supérieure à 0,70.

Lors du calcul des alphas de Cronbach, les réponses *Ne sais pas* et *Ne s'applique pas* ont été traitées comme des valeurs manquantes. Les autres réponses données par les répondants se situaient toutes entre 1 (très défavorable) et 5 (très favorable). Différentes options pour contrôler le biais potentiellement engendré par la présence des réponses *Ne sais pas* et *Ne s'applique pas* ont été envisagées. L'option d'éliminer les répondants ayant coché une de ces réponses à au moins un item de la sous-section analysée n'a pas été retenue puisque le nombre de répondants restants devenait limité pour plusieurs sous-sections. L'option qui a été choisie est une technique d'imputation par la moyenne, c'est-à-dire que les réponses *Ne sais pas* et *Ne s'applique pas* ont été remplacées par la moyenne des cotes données par les autres répondants au même item. Par contre, pour minimiser le biais, les répondants ayant coché *Ne sais pas* ou *Ne s'applique pas* à 50% ou plus des items de la sous-section ont été éliminés pour le calcul de la sous-section en question.

À partir des résultats obtenus, des déplacements d'items ont été réalisés pour certaines sous-sections ayant une faible consistance interne (valeur de l'alpha de Cronbach inférieure à 0,70). L'objectif de ces déplacements était d'améliorer la consistance interne et d'ainsi optimiser le classement des items pour faciliter la complétion et l'analyse des réponses. Un critère important était alors qu'aucun item ne se retrouve seul dans une sous-section. Certains items ayant ensemble une faible consistance interne sont alors demeurés dans la même sous-section. Ils composaient en fait tous des sous-sections comportant 2 ou 3 items qui ont un point commun et qui, malgré qu'ils suscitent des réponses différentes, sont regroupés faute de lien plus approprié avec d'autres sous-sections. Une fois ces quelques modifications effectuées, la version définitive de l'instrument a été obtenue.

Les tableaux 1 et 2 présentent les résultats de l'analyse de la consistance interne pour chacune des sous-sections de la version définitive des deux questionnaires. Globalement, l'alpha de Cronbach des différentes sous-sections est bon. Seulement quatre des dix-neuf sous-sections composant le questionnaire à l'intention d'un parent et deux des quatorze formant le questionnaire à l'intention d'un intervenant scolaire présentent un alpha de Cronbach inférieur à 0,70. Ces sous-sections comportent au maximum trois items. La moyenne des taux de réponses *Ne sais pas* et *Ne s'applique pas* par sous-section pour les deux questionnaires est de 3,97 %.

Structure définitive de l'instrument et compilation

L'outil de mesure *Évaluation des facteurs environnementaux influençant la participation sociale des élèves du primaire présentant un trouble de la communication* comporte deux questionnaires, un à l'intention d'un parent et l'autre à l'intention d'un intervenant scolaire. Les répondants doivent évaluer chaque énoncé selon son influence défavorable ou favorable sur la vie quotidienne de l'enfant. L'appréciation s'effectue en cochant un choix parmi l'échelle suivante : *très défavorable, défavorable, pas d'influence, favorable, très favorable.* Le répondant peut aussi cocher *Ne sais pas* ou *Ne s'applique pas* le cas échéant.

Le questionnaire à l'intention d'un parent comporte 99 items groupés en quatre grandes sections. Les deux premières traitent du milieu scolaire selon deux aspects : *(A) Milieu scolaire – Activités d'apprentissages* (42 items divisés en 11 sous-sections) et *(B) Milieu scolaire – L'école proprement dite et ses services* (24 items séparés en quatre sous-sections). La dernière sous-section de la partie *Milieu scolaire – Activités d'apprentissages* est subdivisée selon le service abordé pour permettre la présence de « questions filtres » permettant aux répondants non concernés par le service traité de passer à la sous-section suivante. La section (C) *Milieu familial* comporte 26 items se répartissant en quatre sous-sections. Finalement, le dernière section traite du (D) *Milieu communautaire* et comporte deux sous-sections totalisant sept items.

En ce qui concerne le questionnaire à l'intention d'un intervenant scolaire, il est composé de 76 items classés en trois grandes sections qui correspondent aux trois premières sections du questionnaire à l'intention d'un parent. La section *(A) Milieu scolaire – Activités d'apprentissage* est nettement la plus longue avec 58 items divisés en 12 sous-sections. La deuxième section *((B) Milieu scolaire – L'école proprement dite et ses services)* comporte 11 items séparés en trois sous-sections. Enfin, la section *(C) Milieu familial* ne comporte qu'une sous-section de sept items. Ces sept items contiennent le mot « parents » qui, par un astérisque, est lié à une question demandant au répondant de préciser à qui ce terme se rapporte principalement dans le cas présent et pourquoi. Le temps de passation moyen pour chacun des questionnaires est de 15 minutes.

Quarante items sont identiques ou semblables dans les deux questionnaires, ce qui correspond à 40 % des items du questionnaire à l'intention d'un parent et à 52 % des items de la version destinée à un intervenant scolaire. Ces items sont ombragés dans les questionnaires et une référence au numéro d'item correspondant dans l'autre version du questionnaire est donnée pour faciliter la compilation des résultats et l'analyse des différents points de vue. Au départ, les deux versions du questionnaire existaient étant donné que la banque d'items avait été créée à partir des entrevues réalisées auprès des personnes cibles respectives à chacune des versions. Les deux questionnaires étaient toutefois très semblables. La pertinence de l'existence des deux versions du questionnaire s'est confirmée lors du processus de validation. Des spécificités à chacune des versions se sont graduellement ajoutées pour en arriver à deux versions distinctes. Ces distinctions résultent du fait que la famille et les intervenants scolaires ne peuvent juger des mêmes aspects de l'environnement de l'enfant, d'où l'importance de considérer les deux visions. Pour faciliter la mise en commun des informations recueillies par un professionnel en milieu clinique, une grille de compilation est proposée avec l'outil. Celle-ci permet de mettre en perspective les

Tableau 1. Alpha de Cronbach (α) pour les sous-sections du questionnaire à l'intention d'un parent

Milieu scolaire-Activités d'apprentissage	α de Cronbach
Composition de la classe	0,71
Environnement physique et sonore de la classe	0,53
Matériel et produits utilisés lors des activités d'apprentissage	0,81
Organisation et temps accordé aux activités d'apprentissage	0,84
Règles et encadrement en classe	0,79
Évaluation des apprentissages	0,89
Travaux scolaires à réaliser à la maison	0,82
Attitudes et soutien du professeur	0,84
Attitudes et soutien des autres intervenants scolaires	0,66
Attitudes et soutien des élèves de la classe	0,97
Mesures particulières	–[a]
Milieu scolaire - L'école proprement dite et ses services	**α de Cronbach**
Services spécialisés de l'école	0,85
Règles et encadrement dans l'école	0,82
Récréations et parascolaire	0,64
Autres moments de transition et services de l'école	–[b]
Milieu familial	**α de Cronbach**
Matériel et produits	0,64
Règles et encadrement à la maison	0,79
Travaux scolaires à réaliser à la maison	0,77
Attitudes et soutien dans la famille	0,88
Milieu communautaire	**α de Cronbach**
Organisation des services dans le quartier	0,75
Attitudes et soutien des gens du quartier	0,93

[a] La consistance interne de la sous-section Mesures particulières n'a pas été calculée puisqu'il n'y a pas de lien conceptuel entre les items. Les items doivent donc être considérés un à un.
[b] Étant donné la présence de questions « filtres » dans la sous-section *Autres moments de transition et services de l'école*, l'alpha de Cronbach n'a pas été calculé. Les items de cette section sont regroupés dans le but d'éviter aux répondants non-concernés de s'y attarder et regroupe donc des items également variés.

Tableau 2. Alpha de Cronbach (α) pour les sous-sections du questionnaire de l'intervenant scolaire

Milieu scolaire-Activités d'apprentissage	α de Cronbach
Composition de la classe	0,86
Environnement physique et sonore	0,60
Matériel et produits utilisés lors des activités d'apprentissage	0,68
Organisation et temps accordé aux activités d'apprentissage	0,84
Approches pédagogiques et travaux en classe	0,85
Évaluation des apprentissages	0,82
Travaux scolaires à réaliser à la maison	0,92
Règles et encadrement en classe	0,71
Attitudes et soutien des élèves de la classe	0,90
Attitudes et soutien de l'enseignant(e) titulaire	0,89
Attitudes et soutien des autres intervenants scolaires	0,85
Milieu scolaire - L'école proprement dite et ses services	**α de Cronbach**
Environnement sonore	–[a]
Services spécialisés de l'école	0,82
Attitudes et soutien des autres personnes de l'école	0,88
Milieu familial	**α de Cronbach**
Attitudes et soutien dans la famille	0,86

[a] La consistance interne de la sous-section *Environnement sonore* n'a pu être calculée puisqu'un item avait été peu répondu malgré sa pertinence.

deux questionnaires et de mettre en lumière les facteurs favorables ou non.

Discussion

La présente étude avait comme but de présenter le développement et certaines étapes de validation d'un outil de mesure francophone sur les facteurs environnementaux influençant la participation sociale d'enfants âgés entre 5 et 13 ans présentant un trouble de la communication. L'outil en question pourrait être utilisé dans un contexte d'intervention en milieu scolaire ou de réadaptation. La discussion portera sur une critique méthodologique liée au développement de l'outil, sur les étapes subséquentes touchant la psychométrie de l'outil et sur l'utilité de l'instrument.

Méthodologie et qualités psychométriques

Lors de la création d'un questionnaire, les grandes phases de conception et d'évaluation des qualités psychométriques sont des processus continus qui peuvent se chevaucher. Un retour sera fait sur cette méthodologie de conception du questionnaire, puis sur les étapes subséquentes en termes de psychométrie.

Deux grandes options s'offrent aux cliniciens et chercheurs qui désirent obtenir de l'information en vue

de porter un jugement sur la qualité de l'environnement. Il est possible d'effectuer des enquêtes (entrevues et questionnaires) ou de faire de l'observation directe. Sabourin, Valois, et Lussier (2005) mentionnent que le questionnaire permet d'obtenir aisément des informations riches et variées sur une diversité de thématiques d'intérêt pour les milieux cliniques et la recherche et qu'il est plus facile à administrer que les autres méthodes d'évaluation. Le questionnaire constitue effectivement une des méthodes les moins exigeantes pour les utilisateurs (chercheurs, cliniciens) et son utilisation n'exclut pas qu'une entrevue puisse être effectuée. Également, le questionnaire peut servir de point de départ en entrevue, et ce principalement dans les milieux cliniques. De plus, il donne accès à des informations qui peuvent difficilement être observées (Sabourin et al., 2005) et apporte le point de vue des personnes significatives dans la vie de l'enfant. Finalement, contrairement à l'observation, le questionnaire est une méthode non-intrusive qui permet d'éviter le biais lié à la présence d'un observateur dans l'environnement. Le choix du questionnaire pour évaluer la qualité de l'environnement des enfants de 5 à 13 ans ayant un trouble de la communication s'avère donc un choix judicieux.

Il est important de se questionner sur le choix des répondants, à savoir qui seraient les personnes les mieux placées pour juger de la qualité de l'environnement des enfants de 5 à 13 ans. Un élément important du présent questionnaire était de cibler plusieurs milieux de vie des enfants. Considérant qu'un enfant d'âge scolaire fréquentant une école primaire se trouve principalement dans deux milieux de vie, soit l'école et la maison, il était tout à fait approprié d'opter pour les parents et l'enseignant (ou un autre intervenant scolaire connaissant bien l'élève) pour compléter les questionnaires, l'enfant étant le plus clair de son temps en présence de l'un ou l'autre de ces adultes. Le milieu communautaire est un troisième milieu fréquenté par les enfants de niveau primaire où les parents sont alors habituellement impliqués. Le choix de répondants plus « experts » dans le domaine de la communication, tels les orthophonistes et les audiologistes, pourrait être envisagé, mais ces intervenants ne sont généralement pas témoins de tous les aspects de la vie quotidienne des enfants et ne peuvent donc être les répondants à privilégier. Le choix des parents et intervenants scolaires renforce la sélection du questionnaire comme méthode de mesure puisqu'il peut s'avérer complexe, principalement en milieu clinique, de réaliser des entrevues auprès d'un parent et ensuite d'un intervenant scolaire. Il serait aussi bénéfique que les enfants ciblés apportent leur point de vue. Un juge-expert mentionnait d'ailleurs, lors de l'analyse de la validation de contenu, qu'il serait intéressant de comparer le point de vue des parents et des intervenants scolaires à celui des enfants. La vérification du point de vue de l'enfant lui-même s'inscrirait d'ailleurs dans le cadre de référence pour l'établissement des plans d'intervention du Ministère de l'Éducation du Loisir et du Sport du Québec qui précise que non seulement l'élève doit comprendre pourquoi cette démarche est entreprise, mais aussi qu'il doit y être au cœur en étant impliqué du début à la fin (Ministère de l'Éducation du Québec, 2004).

La conception du questionnaire a respecté les grandes étapes recommandées par Sabourin et al. (2005). Comme proposent ces auteurs, la banque initiale d'items a été constituée à l'aide d'une recension de la littérature sur le sujet et d'entrevues avec des personnes de la population cible. Les entrevues ont été réalisées auprès de parents et d'enseignants d'enfants ayant un TPL car, comme mentionné plus tôt, ce sont les personnes les mieux placées pour juger de la qualité de l'environnement de ces enfants. Par contre, il aurait aussi été utile de réaliser des entrevues auprès de parents et d'enseignants d'enfants ayant un TTA. La recension de la littérature effectuée, où les deux troubles de la communication visés (TPL et TTA) ont été pris en compte, a été très efficace pour compléter la banque initiale d'items. Cette banque a également été complétée à partir du point de vue d'experts, tels des audiologistes, orthophonistes et chercheurs, qui ont aussi été consultés lors de l'analyse de la validité de contenu de l'outil. De plus, des membres de l'équipe de recherche avaient procédé à un tri initial des énoncés. Ce tri a été effectué en comparant les items issus des entrevues à ceux présents dans la littérature. Le résultat fût le fruit de plusieurs discussions entre les membres de l'équipe (chercheurs, étudiants et cliniciens). Ce tri correspond d'ailleurs à une étape de conception d'un questionnaire, appelée « Évaluation du bassin initial d'items » selon Sabourin et al. (2005). L'analyse des données recueillies lors de la passation des questionnaires a permis de compléter ce tri des items en fonction du taux de réponses *Ne sais pas* et *Ne s'applique pas*. L'élimination des items entraînant un haut taux de ces réponses a aussi permis d'alléger les questionnaires qui étaient souvent jugés trop longs. Cette dernière étape de sélection des items est une autre manifestation du chevauchement entre la conception et l'évaluation des qualités psychométriques du questionnaire.

La construction de l'échelle de réponse est aussi une étape importante de la conception d'un questionnaire.

Les critères relatifs à la sélection de cette échelle étaient qu'elle soit homogène et facile à compléter. L'utilisation d'une échelle de Likert répond à ces critères, mais possède aussi d'autres avantages. Elle a en effet permis d'obtenir des données quantitatives puisqu'une telle échelle a des propriétés spécifiques aux échelles d'intervalle. L'obtention de telles données fournit donc la possibilité de réaliser différentes analyses statistiques. Par contre, lors de la passation des questionnaires à un échantillon de la population, le nombre de réponses dans la catégorie « défavorable » (défavorable ou très défavorable) était limité, ce qui nuit aux analyses statistiques et à l'identification des éléments de l'environnement sur lesquels il serait bénéfique d'intervenir. Une échelle visuelle ayant à chaque extrémité d'une ligne les termes « Très peu favorable » et « Très favorable », permettrait peut-être de minimiser l'effet de la désirabilité sociale et d'obtenir des données répondant mieux aux exigences de tests statistiques courants. La neutralité (pas d'influence) devrait toutefois demeurer au centre de l'échelle qui pourrait être en sept points pour favoriser la mise en lumière de la nuance entre les jugements.

La présentation générale du questionnaire, incluant la consigne de base et la présence de sections et de sous-sections, a été longuement réfléchie. Le fait qu'il soit mentionné dans la simple explication au début des questionnaires qu'ils « ne visent pas à juger si l'environnement est généralement adéquat ou non, mais à identifier les facteurs qui ont le plus d'influence sur l'enfant » peut favoriser l'objectivité des répondants. Il demeure que certaines sous-sections, particulièrement celles traitant de l'attitude des différents adultes entourant l'enfant, peuvent être interprétées comme un jugement face à la personne visée. Cela amène un questionnement important au niveau d'un possible biais lié à la désirabilité sociale. Les parents étant en droit de consulter le questionnaire rempli par l'intervenant peut amener ce dernier à remplir de façon plutôt positive la section qui concerne les attitudes des parents. Une solution serait d'éliminer cette section pour la remplacer par un endroit en fin de questionnaire où l'intervenant serait invité à noter, s'il le désire, les autres facteurs qui jouent un rôle important. Les intervenants auraient ainsi tout de même l'opportunité de mentionner l'impact du soutien de la famille de façon volontaire et en leurs mots. En milieu clinique, les intervenants pourraient être invités à apporter des précisions lors d'une discussion confidentielle.

La présence des sous-sections favorise l'organisation des questionnaires. L'analyse de la consistance interne a permis de classer les items de façon optimale pour faciliter non seulement la complétion des questionnaires, mais aussi l'analyse des facteurs de l'environnement. Un aspect négatif relevé par les juges-experts lors de l'évaluation de la validité de contenu était le trop grand nombre d'items et leur redondance. Pour y remédier, un travail a été fait pour diminuer le nombre d'items tout en ne diminuant pas la qualité de l'information fournie pas les questionnaires en fonction de l'analyse de la validité de contenu et du taux de réponses *Ne sais pas* et *Ne s'applique pas* pour chacun des items. Le nombre d'items est alors passé de 118 à 99 pour le questionnaire à l'intention du parent et de 97 à 76 en ce qui concerne le questionnaire à l'intention d'un intervenant scolaire. Une rapidité de complétion est aussi favorisée par l'utilisation d'une échelle de type Likert qui permet que le format de réponse soit « à cocher ». Finalement, en milieu clinique, les cliniciens pourraient administrer qu'une partie du questionnaire selon leurs besoins.

L'utilisation des questionnaires ici créés, comme pour tous questionnaires, doit s'appuyer sur des analyses poussées de la cohérence interne, de la stabilité temporelle des résultats observés et des différents types de validité (Sabourin et al., 2005). En d'autres termes, les questionnaires doivent être valides et fidèles. La validité de contenu est la première qualité psychométrique qui a été prise en compte puisqu'elle a fait partie intégrante de la création de l'outil. Comme il se doit, l'évaluation de la validité de contenu s'est basée sur le jugement des chercheurs et experts (Laveault et Grégoire, 2002). Pour atteindre l'objectif d'identifier les facteurs environnementaux qui ont le plus d'influence sur la participation sociale de l'enfant considéré, le contenu des questionnaires doit non-seulement être pertinent, mais les énoncés doivent être clairs et apporter des informations précises. La clarté des énoncés a été évaluée conjointement à leur pertinence puisque ces éléments sont directement liés. Des modifications ont été effectuées selon les cotes obtenues, pour arriver à des items clairement compris par les répondants. Pour faciliter l'utilisation de l'échelle de type Likert et favoriser l'objectivité des répondants, les énoncés se devaient d'être neutres et sans équivoque. Cependant, force est de constater que les énoncés sans équivoque amènent parfois des questionnements non résolus. En effet, des répondants peuvent considérer un élément comme étant défavorable, mais pour des raisons opposées. Par exemple, les règles de conduite en classe sont cotées défavorables à l'enfant, mais sont-elles trop strictes ou au contraire trop permissives ? Pour remédier à cette interprétation difficile des réponses à certains

items, un endroit prévu pour écrire des commentaires pourrait être ajouté aux items ambigus. Par contre, il est primordial de garder en tête que le temps de complétion du questionnaire est déjà important. Pour éviter de l'augmenter davantage, un choix à cocher pourrait être fourni dans cette zone de commentaires. Pour l'exemple cité plus tôt, un choix de ce type pourrait être ajouté :

Les règles de conduite dans sa classe

18 ☐ trop strictes ☐ pas suffisamment strictes

☐ autres commentaires : _____

En milieu clinique, une entrevue avec les répondants pourrait aussi permettre de clarifier les facteurs jugés défavorables et de valider les aspects sur lesquels ils ont un impact (sur la socialisation ou les apprentissages, par exemple).

L'évaluation des autres types de validité devra être effectuée afin de pouvoir affirmer que l'outil créé possède globalement une bonne validité. Deux grands autres types de validité seront à vérifier : la validité en référence à un critère et la validité de construit. En ce qui concerne la validité en référence à un critère, deux aspects seront à prendre en compte, soit la validité concomitante et la validité prédictive. L'outil présenté dans l'étude de Guerdan et al. (2013) serait intéressant comme critère pour évaluer la validité concomitante. L'instrument développé permet de collecter des observations fines sur les élèves placés en situation d'enseignement-apprentissage et sur les conditions environnementales influençant leur fonctionnement et ce, en se basant sur les domaines et catégories de la version pour enfants et adolescents de la CIF (CIF-EA) (OMS, 2012).

La fidélité est la capacité d'un instrument à produire le même résultat si on mesure plusieurs fois le même phénomène. L'instrument peut être utilisé par des personnes différentes (fidelité inter-juges) ou à des occasions différentes (fidélité test-retest). En plus de faire référence à la stabilité des résultats, la fidélité réfère à la cohérence de la mesure. La cohérence interne des questionnaires a été évaluée. L'objectif de l'outil étant d'identifier les facteurs de l'environnement favorables et défavorables à la participation sociale de l'enfant, la visée est que les items d'une même sous-section soient cohérents entre eux. Ainsi, l'aspect de l'environnement qui est évalué par ces items pourra ressortir globalement comme étant favorable ou non et chacun des items apportera une spécificité en lien avec cet aspect. En ce sens, la cohérence interne des questionnaires dans leur globalité et celle de chacune des grandes sections n'a pas été vérifiée. Les résultats des calculs de consistance interne effectués montrent que la grande majorité des sous-sections présentent une bonne cohérence entre les items les composant. Pour les autres sous-sections, la complétion demeure facilitée par le regroupement de ces items, comparativement à la présence de sous-sections ne comportant qu'un seul item. La cohérence interne des sous-sections des questionnaires étant optimisée, l'analyse de la fidélité de l'outil demeure à être complétée par l'évaluation des fidélités inter-juges et test-retest.

Utilisation de l'instrument dans les milieux cliniques et avenues de recherche

Nous souhaitons que ces questionnaires soient utiles autant en recherche que dans un contexte d'intervention. D'abord, lors de la passation des questionnaires à un échantillon de la population, la sévérité de l'atteinte des enfants au plan de la communication pourrait être contrôlée, ce qui permettrait de procéder à différentes analyses. Il serait effectivement pertinent de non seulement connaître les obstacles et facilitateurs de l'environnement d'enfants ayant un trouble de la communication sévère, mais aussi de ceux ayant un trouble considéré « léger » ou « modéré ». Ces derniers n'ont pas systématiquement accès aux services en milieu scolaire ou de la santé et il est probable que certains d'entre eux vivent eux aussi des situations de handicap dans leurs milieux de vie. Ils bénéficieraient donc d'un environnement adapté. Il serait aussi intéressant d'administrer ces questionnaires afin de connaître les facteurs environnementaux favorables ou non aux enfants sans trouble ou incapacités. Il y a fort à parier que plusieurs facteurs identifiés comme étant favorables ou non favorables pour les enfants ayant des troubles de la communication le soient également pour les autres élèves. On pourrait ainsi justifier la pertinence et la nécessité de procéder à des aménagements de l'environnement pour tous comme suggéré par le Universal Design for Learning (Ralabate, 2011). Une analyse de l'effet de la sévérité du trouble de la communication permettrait d'étudier la relation entre les aptitudes (facteurs personnels) et les facteurs de l'environnement dans l'apparition des situations de handicap. L'analyse pourrait aussi s'étendre à d'autres composantes de la production du handicap tels les facteurs personnels (l'âge ou le genre, par exemples).

Une analyse plus poussée d'éléments de l'environnement ayant un impact important sur la participation sociale des élèves avec un trouble de la communication permettrait d'effectuer une élaboration ciblée de moyens pour faciliter leur participation. Il serait

alors important d'impliquer les personnes œuvrant directement auprès de ces enfants pour, entre autres, vérifier les mesures de soutien offrant le plus de bénéfices. Les questionnaires pourraient d'ailleurs éventuellement servir d'outils pour vérifier l'efficacité d'une intervention sur les facteurs environnementaux en effectuant un pré et un post-test.

En milieu clinique, le but premier de l'utilisation des questionnaires sera certainement l'identification d'objectifs précis à inclure au plan d'intervention. Le plan d'intervention ne visera ainsi pas que l'enfant, mais aussi les aspects de son environnement qui ont une influence sur sa participation sociale. D'ailleurs, ayant principalement été basé sur le modèle *MDH-PPH*, l'outil de mesure créé permet de s'attarder à l'environnement dans son ensemble en ciblant tous les milieux de vie de l'enfant. Dans l'esprit de ce modèle, l'intervention auprès des élèves avec un trouble de la communication pourra cibler les facteurs environnementaux tout comme les autres composantes du fonctionnement et du handicap avec lesquelles ils interagissent. L'efficacité de cette intervention pourra ensuite être vérifiée à partir des questionnaires. Ce processus sera d'autant plus efficace s'il est jumelé à une analyse des situations de handicaps vécues par l'enfant. Cerner les obstacles dans l'environnement des enfants ayant un trouble de la communication et réduire leur influence néfaste permettra d'agir directement sur la participation sociale et la réussite scolaire dans son sens large. Il sera ainsi possible de contribuer à la persévérance scolaire des enfants ayant un trouble de la communication.

Les questionnaires permettront aussi aux cliniciens de connaître le point de vue des parents et enseignants face aux difficultés vécues par l'élève. Les questionnaires peuvent d'ailleurs servir de base à une discussion entre le clinicien et ces personnes significatives dans le but, entre autres, d'élaborer un plan d'intervention qui convient à tous et d'ainsi optimiser la participation de chacun au soutien de l'élève. Les points de vue des parents et des intervenants scolaires pourront aussi être comparés grâce aux questionnaires. Une discussion au sujet d'éventuelles divergences d'opinion pourrait optimiser la collaboration école-famille et conséquemment le soutien à l'élève. De plus, la présence d'un grand nombre de réponses Ne sais pas peut inciter le professionnel à vérifier la communication école-famille et intervenir à ce niveau au besoin, un manque de communication entre les milieux familial et scolaire pouvant en soi être un facteur environnemental défavorable. Il serait aussi important de recueillir le point de vue des principaux concernés, soit les enfants ayant une trouble de la communication. Leur perception face à la qualité de leur environnement devrait être prise en compte dans l'élaboration d'un plan d'intervention. L'élaboration d'un outil adapté (syntaxe simplifiée, usage de pictogrammes, etc.) pour les enfants ayant un trouble de la communication permettant d'obtenir ce point de vue est une autre avenue de recherche importante.

Finalement, les juges-experts consultés lors des analyses de la validité de contenu devaient coter de 1 (faible) à 4 (excellent) l' « utilité des données recueillies à l'aide cet outil » et étaient invités à commenter. Les moyennes de cotes pour les deux validations et les deux questionnaires varient de 3,5 à 4 sur 4, ce qui montre que les juges-experts considèrent les données utiles. Il est possible de constater, en examinant leurs commentaires, que les juges-experts se prononcent sur l'utilité en milieu clinique seulement. Les commentaires sont d'ailleurs majoritairement positifs : « l'outil enrichit l'évaluation dans une perspective écologique et systémique », « il permet de cibler des facteurs environnementaux dans la planification de l'intervention », « il permet d'obtenir l'impression des parents, ce qui est essentiel », et « il permet d'orienter l'intervention sur les éléments les plus susceptibles de faire une différence ». Par contre, un aspect à améliorer est mentionné à deux reprises : l'outil permet une prise de conscience sur les facteurs environnementaux à inclure dans un plan d'intervention, mais n'offre aucune piste de solution. Ces commentaires viennent renforcer l'importance de développer des moyens d'interventions ciblées portant sur l'environnement et d'en évaluer l'efficacité.

Conclusion

Bien que quelques modifications soient proposées, il est possible de constater que la création de l'outil a respecté les grandes étapes d'une conception rigoureuse et qu'il est suffisamment valide pour être utilisé en clinique et en recherche. La complétion des questionnaires par les personnes ciblées peut dès lors permettre d'identifier les principaux éléments de l'environnement qui sont favorables à l'enfant et ceux pour lesquels des aménagements seraient bénéfiques. La poursuite des analyses concernant les qualités psychométriques des questionnaires permettra de les peaufiner tout en assurant leur validité et leur fidélité. L'outil de mesure créé ouvre également la porte à de nombreuses avenues de recherche qui permettront de connaître davantage les facteurs environnementaux d'ordre social ou physique associés à une meilleure participation sociale des enfants

ayant un trouble de la communication et ainsi d'intervenir de façon plus éco-systémique auprès d'eux.

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Using 1000 Hz Tympanometry in Hearing Screening of Babies in the Neonatal Intensive Care Unit (NICU)

L'usage de la tympanométrie à 1 000 Hz pour le dépistage de la surdité chez les bébés se trouvant dans les unité des soins intensifs pour nouveau-nés

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KEY WORDS

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AUDITORY BRAINSTEM RESPONSE SCREENING

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Abstract

An issue of great concern in Universal Newborn Hearing Screening (UNHS) is the high false-positive rates, which is especially problematic in the Neonatal Intensive Care Unit (NICU) population. False-positive results may lead to unnecessary follow-up appointments, increased health care costs, and increased stress on parents. High frequency tympanometry has been recommended for healthy babies younger than 6 months of age, which may reduce false-positive results caused by transient middle-ear issues. The objectives of this study were to obtain admittance, susceptance, and conductance data from a sample of NICU babies, to compare tympanometric data obtained from the component compensation approach with the data obtained from the baseline approach, and to provide preliminary normative data for NICU babies when ABR was used as a 'gold standard'. In this study, 31 babies in the NICU were included. Admittance was obtained in 84% (n=52) of 62 ears, and susceptance and conductance were obtained in 77% (n=48) of 62 ears. Using a component compensation approach, at the 5th and 95th percentile the admittances at the tympanic membrane were 0.5 and 1.7 mmho referenced to the positive tail, and 0.6 and 2.0 mmho referenced to the negative tail. Using a baseline approach, at the 5th and 95th percentile the peak-to-tail compensated admittances were 0.2 and 1.2 mmho referenced to the positive tail, and 0.4 and 2.0 mmho referenced to the negative tail. Our results were also compared with several data sets published by other investigators, and the differences among data sets are discussed. A significant difference in admittance existed between the component compensation approach and the traditional baseline approach. Different normative data needs to be considered accordingly.

Abrégé

Le taux élevé de « faux positifs » est un problème très préoccupant dans le dépistage universel de la surdité chez les nouveau-nés. Ils sont particulièrement problématiques dans la population de bébés d'unités des soins intensifs pour nouveau-nés (USIN). Des résultats « faux positifs » peuvent mener à des rendez-vous de suivi inutiles, à une augmentation des coûts de santé et à un stress accru chez les parents. La tympanométrie à haute fréquence a été recommandée pour les bébés en santé âgés de moins de 6 ans, ce qui peut réduire les résultats « faux positifs » causés par des problèmes temporaires de l'oreille moyenne. Les objectifs de la présente étude étaient d'obtenir des données d'admittance, de susceptance et de conductance à partir d'un échantillon de bébés d'USIN, afin de comparer les données tympanométriques obtenues par l'approche de compensation des composantes à celles obtenues par l'approche de référence, et de fournir des données normatives préliminaires pour les bébés d'USIN quand la mesure des PÉATC a été utilisée comme « règle d'or ». Cette étude compte 31 bébés d'USIN. L'admittance a été obtenue dans 84 % (n=52) de 62 oreilles, et la susceptance et la conductance furent obtenues dans 77 % (n=48) de 62 oreilles. En utilisant l'approche de compensation des composantes, aux 5^{e} et 95^{e} percentiles, les admittances à la membrane du tympan furent de 0,5 et 1,7 mmho en référence à l'extrémité positive et 0,6 et 2,0 mmho en référence à l'extrémité négative. En utilisant l'approche de référence, aux 5^{e} et 95^{e} percentiles, les admittances compensées et mesurées du « sommet à la base » furent de 0,2 et 1,2 mmho en référence à l'extrémité positive et 0,4 et 2,0 mmho en référence à l'extrémité négative. Nos résultats furent aussi comparés à plusieurs données publiées par d'autres chercheurs et les différences entre les données sont discutées. Une différence significative dans l'admittance existait entre l'approche de compensation de composantes et l'approche de référence traditionnelle. Différentes données normatives doivent être considérées en conséquence.

ABBREVIATIONS:

Y = Admittance [Equation 1]; B = Susceptance; G = Conductance;
Y_{TM} = compensated admittance at tympanic membrane;
Y_{peak} = uncompensated admittance at peak;
Y_a @+ 200 daPa = uncompensated admittance at positive tail;
Y_a @- 400 daPa = uncompensated admittance at negative tail;
B_{peak} = uncompensated susceptance at peak;
B_{tail} @ +200 daPa = uncompensated susceptance at positive tail;
B_{tail} @ -400 daPa = uncompensated susceptance at positive tail;
G_{peak} = uncompensated conductance at peak;
G_{tail} @ +200 daPa= uncompensated conductance at positive tail;
G_{tail} @ -400 daPa= uncompensated conductance at negative tail;
$+200B_{TM}$: peak-to-positive tail susceptance [Equation 2];
$-400B_{TM}$: peak-to-negative tail susceptance [Equation 3];
$+200G_{TM}$: peak-to-positive tail conductance [Equation 4];
$-400G_{TM}$: peak-to-negative tail conductance [Equation 5];
$+200Y_{TM}$: positive tail component compensated admittance [Equation 6];
$-400Y_{TM}$: negative tail component compensated admittance [Equation 7];
$+200Y_a$: peak-to-positive tail admittance [Equation 8];
$-400Y_a$: peak-to-negative tail admittance [Equation 9];

EQUATIONS:

$$Y = G + jB \quad \text{Equation 1}$$

$$+200B_{TM} = B_{peak}\text{-}B_{tail} \text{ @ } +200 \text{ daPa} \quad \text{Equation 2}$$

$$-400B_{TM} = B_{peak}\text{-}B_{tail} \text{ @ } -400 \text{ daPa} \quad \text{Equation 3}$$

$$+200G_{TM} = G_{peak}\text{-}G_{tail} \text{ @ } +200 \text{ daPa} \quad \text{Equation 4}$$

$$-400G_{TM} = G_{peak}\text{-}G_{tail} \text{ @ } -400 \text{ daPa} \quad \text{Equation 5}$$

$$+200Y_{TM} = \sqrt{(Bpeak - Btail@+200)^2 + (Gpeak - Gtail@+200)^2} \quad \text{Equation 6}$$

$$-400Y_{TM} = \sqrt{(Bpeak - Btail@-400)^2 + (Gpeak - Gtail@-400)^2} \quad \text{Equation 7}$$

$$+200Y_a = Y_{PEAK} - Ya@+200 \quad \text{Equation 8}$$

$$-400Y_a = Y_{PEAK} - Ya@-400 \quad \text{Equation 9}$$

INTRODUCTION

An issue of great concern in Universal Newborn Hearing Screening (UNHS) is the high false-positive rates. A false-positive result means that a neonate who does not have a target hearing loss (typically, this is a permanent hearing loss that is at least moderate in degree) fails the UNHS and is required to undergo a full diagnostic test. It has been reported that in UNHS a substantial proportion (59% to 81%) of false positive results was due to transient conductive hearing loss caused by middle ear dysfunction (e.g., Cristobal & Oghalai, 2008; Holte, Cavanaugh, & Margolis, 1990; Keefe et al., 2000; Stuart, Yang, & Green, 1994).

Reliable and accurate diagnosis of middle ear function in neonates may reduce false positive rates in UNHS. Currently, auditory brainstem response (ABR) and otoacoustic emission (OAE) screening tests are used for newborn hearing screening. Unfortunately, neither test can differentiate between conductive and sensorineural hearing loss, and both tests can be affected by transient outer or middle ear dysfunction (e.g., Zhang & Abbas, 1997; Zhao, Wada, Koike, & Stevens, 2000). Therefore, a baby with normal cochlear and neural function may fail a hearing screening and be referred for a full diagnostic follow up due to a conductive problem. This is especially problematic in the Neonatal Intensive Care Unit (NICU) population as they have a higher prevalence of middle ear dysfunction. Whereas the false positive rate has been shown to be around 2% to 4% in most UNHS programs (Nelson, Bougatsos, & Nygren , 2008), the rate is as high as 15% to 20% in babies in the NICU (Keefe et al., 2000; Thompson et al., 2001).

Tympanometry is a test that is non-invasive, cost effective, and quick. Middle ear function in adults can be assessed by using a 226-Hz probe tone. For infants six months of age or younger, studies have shown that 1000-Hz tympanometry is more effective than the 226-Hz test (Alaerts, Luts, & Wouters, 2007; Baldwin, 2006; Hunter, Feeney, Lapsley Miller, Jeng, & Bohning, 2010; Hunter, Tubaugh, Jackson, & Propes, 2008; Kei et al., 2003; Margolis, Bass-Ringdahl, Hanks, Holte, & Zapala, 2003; Merchant, Horton, &Voss, 2010; Prieve, Vander Werff, Preston, & Georgantas, 2013; Resende, Ferreira, Carvalho, Oliveira & Bassi, 2012; Sanford & Feeney, 2008; Shahnaz, 2008; Shahnaz, Miranda, & Polka, 2008; Son et al. 2012;). The effectiveness of the 1000-Hz probe tone for newborns is likely due to significant anatomical differences between newborns and adults (Anson & Donaldson, 1981; McLellan & Webb, 1957; Northern & Downs, 2002; Saunders, Doan, & Cohen, 1993). Finite-element models of the newborn middle and outer ear were developed by and Qi, Liu, Lutfy, Funnell, and Daniel (2006) and Qi, Funnell, and Daniel (2008) which showed that anatomical changes in the infant's outer ear and middle ear could partially account for the differences in tympanometry between infants and adults (Gulya, 2007).

The use of 1000-Hz tympanometry on full-term healthy babies has been widely studied (Kei et al., 2003; Kei, Mazlan, Hickson, Gavranich, & Linning, 2007; Margolis et al., 2003; Mazlan et al., 2007; Shahnaz, 2008; Shahnaz & Polka, 2002; Swanepoel et al., 2007). Currently, there are few studies on the use of 1000 Hz tympanometry for babies in the NICU who are undergoing a hearing screening. Yoon, Price, Gallagher, Fleisher, and Messner (2003) reported that 37% of NICU graduates (n=82) had abnormal tympanometry in one ear and 29% had abnormal tympanograms bilaterally; however, they did not provide any qualitative data in their paper. The abnormal tympanometry was defined as either flat tympanograms or negative pressures > 200 daPa. Margolis et al. (2003) investigated 1000-Hz tympanometry in 65 babies in the NICU and 30 full term health babies at 2-4 weeks of age. They found the 5th percentile of admittance for both babies in the NICU and full term healthy babies was identical, and they recommended a single pass-fail criterion using the admittance derived from negative tail using a baseline approach, for both NICU and full-term health babies. The negative tail was recommended for clinical practice because it resulted in a larger mean value of admittance, which may make it easier to distinguish between normal tympanograms and abnormal tympanograms. Shahnaz et al. (2008) investigated multi-frequency tympanometry (MFT) and conventional tympanometry in well babies and babies in the NICU at nine frequencies (from 226 to 1000 Hz). Conventional tympanometry and MFT were performed in 33 NICU babies, 16 healthy full term three-week-old babies and 42 babies who met high priority hearing registry criteria. They used the component compensation approach in their study and provided admittance phase and peak compensated susceptance and conductance at different probe tone frequencies. They recommended that the tympanograms obtained at 1000-Hz were more sensitive and specific for presumed abnormal and normal middle-ear conditions for both groups. Alaerts et al. (2007) performed 226 and 1000-Hz tympanometry in six different age groups (131 ears in total), including NICU babies (28 ears), infants/children aged from 0 to 32 months and adults. In their study they measured middle ear admittance at +200daPa, middle ear admittance at peak, tympanometric peak pressure, tympanometric width, and ear canal volume. They found that the visual admittance classification system was more

suitable than the Vanhuyse model. In addition, for infants younger than 3 months, 1000-Hz tympanometry was more reliable and easier to interpret than traditional 226-Hz tympanometry. For older children (9 months of age), traditional 226-Hz tympanometry was more appropriate. For children between 3 and 9 months of age, 226-Hz and 1000-Hz tympanometry were equally reliable.

The admittance is a complex number including both real and imaginary parts, as shown in Equation 1, where *G* is the conductance and *B* is the susceptance. *G* is in phase with the delivered probe tone. *B* is an out-of-phase component which is comprised of two parts. One is the compliance component and the other is the mass component. Admittance obtained from Equation 1 is referred to as the component compensation approach. For adults, conductance is very negligible (e.g., Shahnaz, Cai, & Qi, 2014). Therefore, peak-to-tail difference is almost equal to the true admittance. For infants, conductance is significantly prominent (e.g. Shahnaz et al., 2008), and for this reason, phase information needs to be taken into account. Mathematically, the baseline approach, using a peak-to-tail difference, is not correct; however, from a clinician's point view, the baseline approach is easy to calculate and the value is typically calculated automatically by clinical tympanometers. It is important for clinicians to understand the different tympanometric values may be obtained by using these two different approaches. Therefore, different normative data would be applied accordingly.

To date, there are few studies of conductance and susceptance in NICU babies (Shahnaz et al., 2008). The objectives of the current study were to obtain admittance, susceptance and conductance data from a sample of babies who were in or were graduates of an NICU, to compare tympanometric data obtained from the component compensation approach with the data obtained from traditional baseline approach, and to provide preliminary normative data for NICU babies when the ABR screening was used as the 'gold standard' to indicate middle ear status.

METHODS

Subjects

Thirty one NICU infants (18 males and 13 females) were recruited during hearing screening between 2011-2013 with corrected (or adjusted) ages ranging from 0 weeks to 6 months (mean age 1.30 months; SD 1.43 months), and chronological ages ranging from 1 week to 6 months (mean age 2.22 months; SD 1.53 months). The subjects were recruited according to a protocol approved by research ethics committees at the University of Alberta, the Glenrose Rehabilitation Hospital (GRH) and the Royal Alexandra Hospital (RAH). The consents were obtained from parents or guardians. Subjects were infants admitted to the NICU at the RAH who were screened either during their stay at the RAH or at the GRH soon after discharge from the NICU.

These were babies who would typically have their hearing screening in the NICU based on high-risk criteria including: prematurity (<29 weeks gestational age at birth), low birth weight (<1250 grams at birth), hyperbilirubenemia requiring exchange transfusion, sepsis requiring treatment with antibiotics, etc. These criteria are largely based on the Joint Committee on Infant Hearing (2007) recommendations.

Data collection and analysis

In this study, screening ABR results were used as the 'gold standard' to indicate the infant's middle ear function. This decision was made, in part, because the ABR is the recommended choice for hearing screening in the NICU due to the higher incidence of Auditory Neuropathy Spectrum Disorder in this population (Joint Committee on Infant Hearing, 2007). A "pass" result on the ABR screening required a repeatable Wave V evoked by click stimuli presented at 35 dB nHL for each ear. Each average waveform consisted of at least 1500 individual collections and there were a minimum of 2 average waveforms collected to ensure good replicability. The Wave V latency had to fall within normative limits for the baby's gestational age (local norms were previously collected by GRH audiologists). A Biologic NavPro System was used to collect ABR data. This was not an automated ABR. In order to be enrolled in this study, babies needed to pass the ABR screening. ABR tests and tympanometry were performed by the same tester, who was a registered audiologist. Audiologists collected data for this study were experienced with both ABR screenings and 1000-Hz tympanometry.

The GSI TympStar (version 2; North Carolina) was used for tympanometry measurement. Tympanometry was performed by presenting a 1000 Hz probe tone at 75 ±3 dB SPL into the ear canal (GSI TympStar V2.0 manual). A hand-held probe was used.

Two tympanometry measurements were made for each ear. First, 1000-Hz admittance tympanometry was performed and then the probe tip was removed and reinserted for the second measurement. For the second measurement, 1000-Hz susceptance and conductance were measured. Tympanograms were recorded using a positive to negative sweep pressure method from +200

to -400 daPa with a pump speed varying from 600 daPa/sec at the tails to 200 daPa/sec at the peak. Most tympanometry measurements could be obtained in an ear within a few minutes when the subject was sleeping or awake but inactive. The results of tympanometry were printed out for further analysis. The following tympanometric data were measured for analysis: $+200Y_{TM}$; $-400Y_{TM}$; $+200Y_a$; $-400Y_a$; Y_a @ +200 daPa; Y_a @ -400 daPa; B_{tail} @ +200 daPa; B_{tail} @ -400 daPa; G_{tail} @ +200 da Pa; G_{tail} @ -400 daPa; Y_{peak}; B_{peak}; G_{peak}.

Similar to other reports in this area of research (e.g., Calandruccio, Fitzgerald, & Prieve, 2006; Kei et al, 2003; Margolis et al., 2003; Shahnaz et al., 2008) descriptive statistics were used to analyze the results. The descriptive statistics used in this study were the median and the 5th and 95th percentiles of admittance, susceptance, and conductance.

RESULTS

Typmanometry testing was attempted on 62 ears. Admittance tympanograms were obtained in 52 ears and susceptance and conductance tympanograms were obtained in 48 ears. Tests on 10 ears and 14 ears could not be obtained for admittance measurement and for susceptance and conductance measurements, respectively. The data that could not be obtained were due to infant movement or to a poor seal between the probe and the ear canal. In addition, 8 ears were excluded from this study due to the fact that they failed ABR screening. Therefore, 44 ears were used for admittance analysis and 40 ears were used for susceptance and conductance analysis. Tympanograms were evaluated according to the classification proposed by Kei et al. (2003). They were classified as follows: Type 1 had a single peak; type 2 was flat sloping; type 3 had double peaks. All the other types of tympanograms were considered non-interpretable. Our results showed that tympanograms had a single peak (type 1) for 84% of admittance tests (37/44 ears) and for 70% of susceptance and conductance tests (28/40 ears). A type 2 pattern was found for 7% of admittance tests (3/44 ears) and for 15% of susceptance and conductance (6/40 ears). A type 3 pattern was found for 5% of admittance tests (2/44 ears) and for 8% of susceptance and conductance tests (3/40 ears). The rest were unclassified tympanograms (4% for the admittance test and 7% for the susceptance and conductance test).

In this section, we report our results and compare our data with previously published data. Table 1 shows descriptive statistics of the 1000-Hz susceptance (B) results. This includes the 5th to 95th percentile and the median for: B_{peak}, B_{tail} @+ 200 daPa, B_{tail} @ -400 daPa, $+200B_{TM}$ (Equation 2) and $-400B_{TM}$ (Equation 3). Table 2 shows 1000-Hz conductance results including the 5th to 95th percentile and the median for: G_{peak}, G_{tail} @+ 200 daPa, G_{tail} @ -400 daPa, $+200G_{TM}$ (Equation 4) and $-400G_{TM}$ (Equation 5). Table 3 shows the 5th to 95th percentile and the median results for $+200Y_{TM}$ (Equation 6) and $-400Y_{TM}$ (Equation 7). The 5th to 95th percentile for $+200Y_{TM}$ ranged from 0.5 to 1.7mmho, and the 5th to 95th percentile for $-400Y_{TM}$ ranged from 0.6 to 2.0 mmho. Shahnaz et al. (2008) reported the 5th to 95th percentile for $+250Y_{TM}$ and $-300Y_{TM}$ in 16 healthy full term 3-week old babies were 0.5 to 2.6 mmho and 0.3 to 2.4 mmho, respectively. Alaerts et al. (2007) reported the 5th to 95th percentile for $+200Y_{TM}$ ranged from 0.34 to 2.66 in a combined group of NICU babies and 0-3 month-old healthy babies.

Figure 1 compares the Y_a @ 200 daPa obtained from this study with previously published data. The 5th percentile of Y_a @ 200 daPa obtained in this study is 0.8 mmho, which is in good agreement with the 5th percentile of Y_a @ 200 daPa (0.9 mmho) obtained by Margolis et al. (2003) in 65 babies in the NICU and 0.87 mmho obtained by Shahnaz et al. (2008) in 32 babies in the NICU. The 5th percentile of Y_a @ 200 daPa obtained from healthy babies ranged from 0.37 to 1.44 mmho (Alaerts et al, 2007; Kei et al, 2003; Margolis et al., 2003; Mazlan et al., 2007). The 95th percentile of Y_a @ 200 daPa obtained in this study is 3.0 mmho, which is higher than values obtained by Margolis et al. (2003) and Shahnaz et al. (2008) in NICU babies. Our result is generally consistent with results (3.07 mmho) obtained in healthy babies reported by Alaerts et al. (2007).

Figure 2 compares the Y_a @ -400 daPa obtained from this study with previously published data. The 5th to 95th percentile of Y_a @ -400 daPa obtained in this study ranged from 0.4 to 1.8 mmho. Margolis et al. (2003) reported the 5th to 95th the percentile of Y_a @ -400 daPa to be from 0.4 to 1.0 mmho for babies in the NICU and from 0.3 to 1.4 for healthy full term babies. Shahnaz et al. (2008) reported values (using -300Y) from 0.4 to 1.2 mmho in NICU babies. Kei et al. (2007) reported values in healthy babies from 0.36 to 2.38 mmho.

Figure 3 compares the Y_{peak} obtained from this study with previously published data. The 5th to 95th percentile of Y_{peak} obtained in this study ranged from 1.0 to 3.8 mmho. Margolis et al. (2003) reported the 5th to 95th the percentile of Y_{peak} to be from 1.3 to 2.4 mmho for babies in the NICU and from 1.2.to 4.8 mmho for healthy full term babies. Mazlan et al. (2007) reported 5th to 95th percentile of Y_{peak} to be from 0.7 to 4.2 mmho for healthy babies at

birth and 1.16 to 4.5 mmho for healthy babies of 6 to 7 weeks old.

Figure 4 compares 5th to 95th percentiles of $+200Y_a$ (Equation 8) obtained in this study with previously published data (baseline approach). In this study the 5th to 95th percentile of $+200Y_a$ ranged from 0.2 to 1.2 mmho. The published 5th percentile of $+200Y_a$ ranged from 0.1 to 0.2 mmho in NICU babies (Margolis et al., 2003; Shahnaz et al., 2008) and ranged from 0.1 to 0.35 mmho in healthy babies (Kei et al, 2007; Margolis et al., 2003; Mazlan et al., 2007). The published 95th percentile of +20000 ranged from 1.5 to 1.6 mmho in NICU babies (Margolis et al., 2003; Shahnaz et al., 2008) and ranged from 1.5 to 3.5 mmho in healthy babies (Kei et al., 2007; Margolis et al, 2003; Mazlan et al., 2007)

Figure 5 compares the 5th to 95th percentile of the $-400Y_a$ (Equation 9) obtained from this study and published data (baseline approach). In current study the 5th to 95th percentile of $-400Y_a$ ranged from 0.4 to 2.0 mmho. The 5th percentile of $-400Y_a$ was reported 0.6 mmho by Margolis et al. (2003) for both healthy and NICU babies; and 0.53 mmho in NICU babies by Shahnaz et al. (2008). The 95th percentile of $-400Y_a$ were 2.7 mmho in NICU babies and 4.3 mmho in healthy babies by Margolis et al. (2003) and 2.3 mmho in NICU babies by Shahnaz et al. (2008).

DISCUSSION AND CLINICAL IMPLICATIONS

In this study, we considered the ABR screening results as the 'gold standard' to indicate middle ear status. Normal ABR screening results do not indicate normal auditory or middle ear function. Theoretically myringotomy is the most accurate gold standard to confirm middle ear dysfunction (Marchant et al., 1986); however, it is an expensive and invasive procedure. The use of the ABR as the gold standard for middle ear function is a clear limitation of this study. As indicated in the methods section, the Joint Committee on Infant Hearing (2007) recommends ABR testing for UNHS in the NICU because it is more sensitive to auditory neuropathy spectrum disorder, which has a higher prevalence in the NICU population. It also has a more acceptable "Pass" rate in the NICU. For these reasons, the ABR is the standard screening in the NICU and it was therefore chosen as the gold standard to make this study clinically feasible.

In this study admittance tympanograms were obtained in 52 ears out of 62 ears. This "success" rate was 84%. Similar results were reported by Margolis et al. (2003). They reported that tympanograms could be obtained from 77/88 (87.5%) ears of babies in the NICU. Kei et al. (2003) performed 1000-Hz tympanometry in 170 healthy full term

Table 1. Descriptive statistics of the 1000-Hz susceptance (B) results.

	B_{peak} (mmho)	B_{tail} @ +200 daPa (mmho)	B_{tail} @ -400 daPa (mmho)	$+200B_{TM}$ (mmho)	$-400B_{TM}$ (mmho)
5%	1.1	1.0	0.5	0.3	0.5
Median	1.6	1.4	1.0	0.6	0.9
95%	3.1	2.8	2.7	1.3	1.6

Table 2. Descriptive statistics of the 1000-Hz conductance (G) results.

	G_{peak} (mmho)	G_{tail} @ +200 daPa (mmho)	G_{tail} @ -400 daPa (mmho)	$+200G_{TM}$ (mmho)	$-400G_{TM}$ (mmho)
5%	0.5	0.3	0.1	0.3	0.3
Median	1.6	0.9	0.7	0.6	0.8
95%	2.3	1.7	1.2	1.0	1.2

Table 3. Descriptive statistics of component compensation admittance at tympanic membrane.

	+200Y™ (mmho)	-400Y™ (mmho)
5%	0.5	0.6
Median	1.0	1.2
95%	1.7	2.0

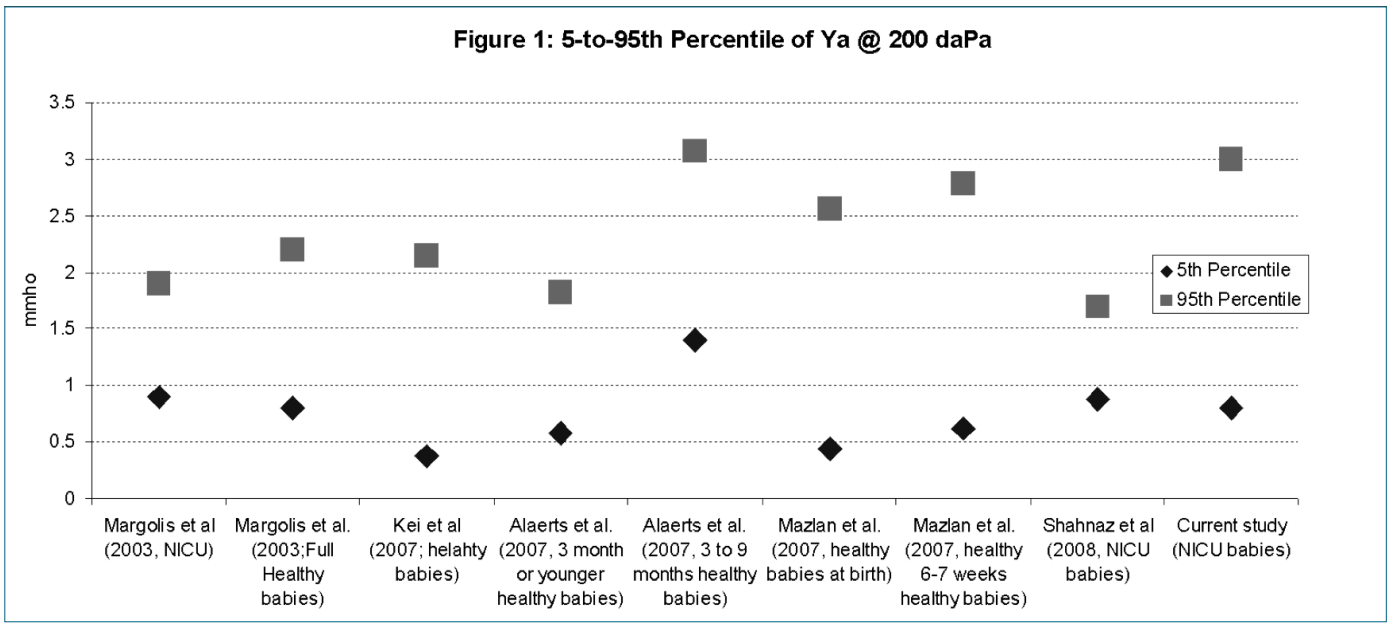

Figure 1. Comparison of Ya @ +200 daPa obtained from this study and published data.

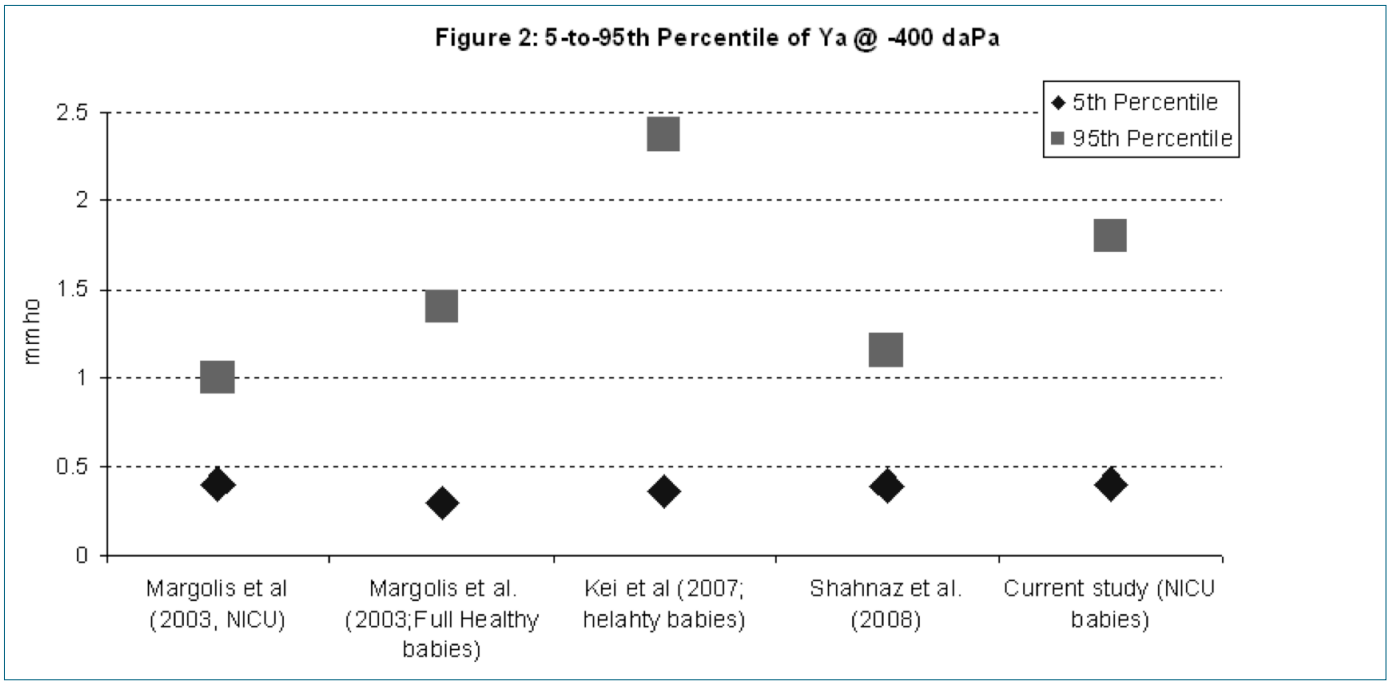

Figure 2. Comparison of Ya @ -400 daPa obtained from this study and published data.

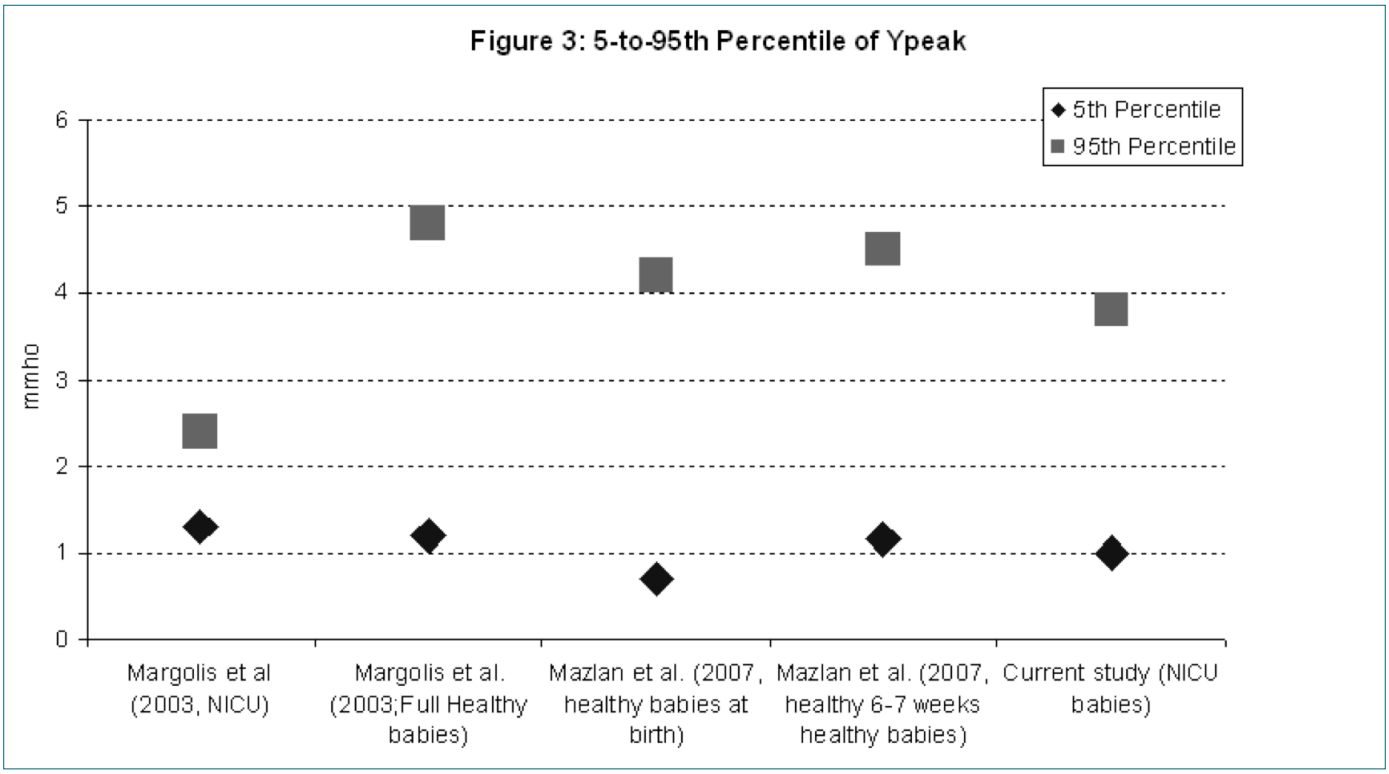

Figure 3. Comparison of the Ypeak obtained from this study and published data.

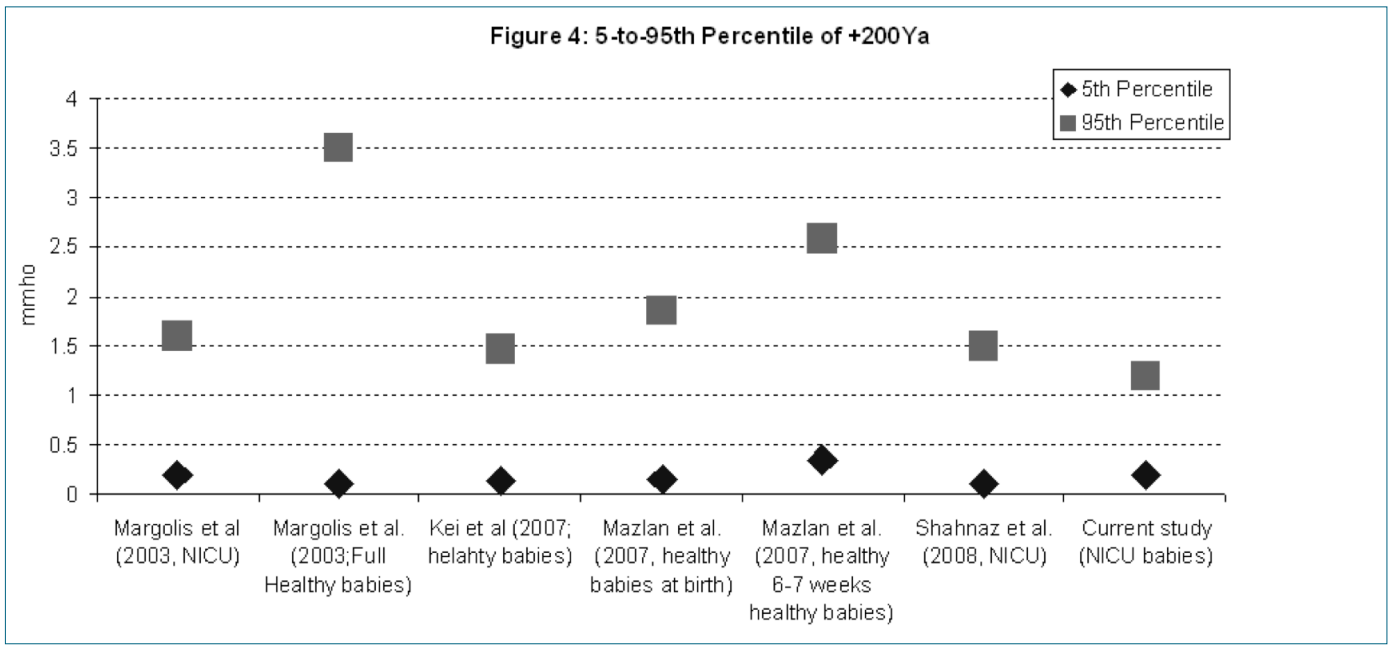

Figure 4. Comparison of the +200Ya obtained in this study and published data (baseline approach).

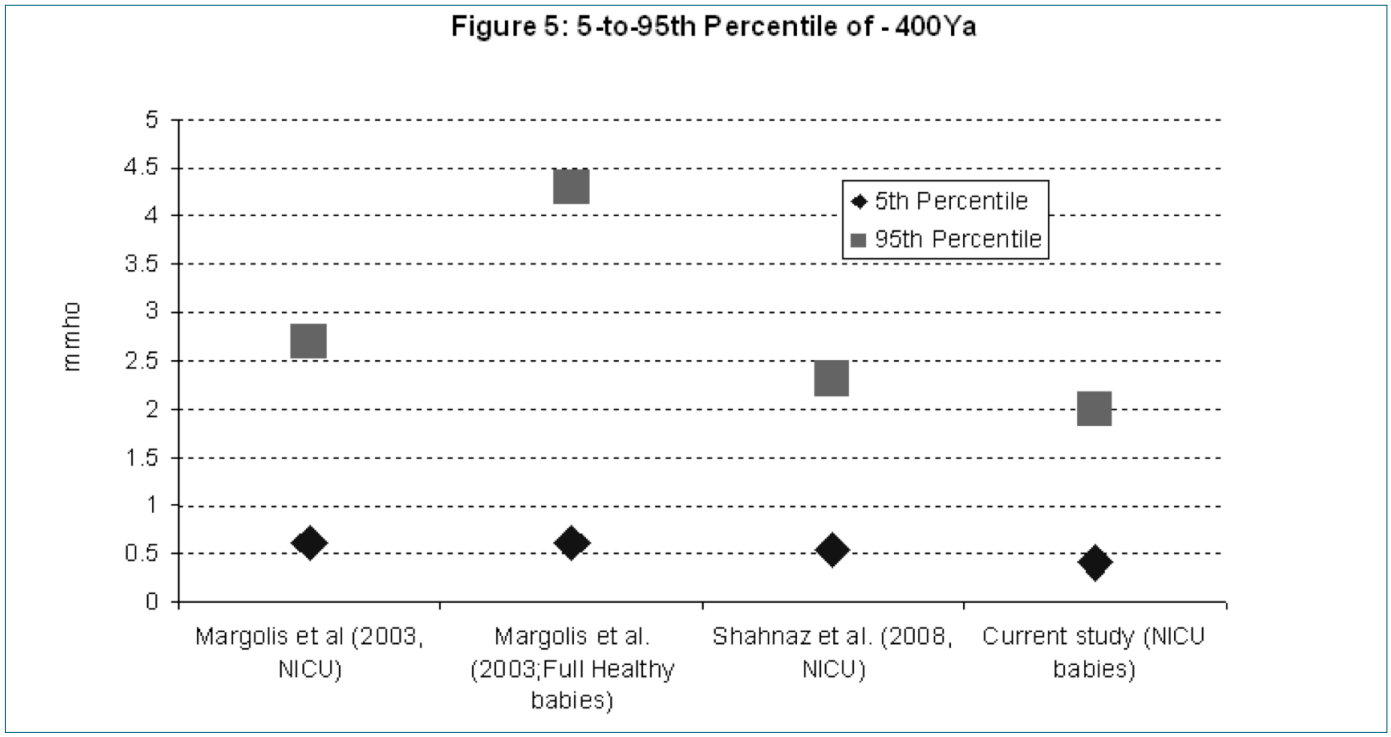

Figure 5. Comparison of -400Ya obtained from this study and published data (baseline approach).

babies (340 ears) and they obtained tympanograms in 299 ears (88%).

In our study, among the different tympanograms, single peaked tympanograms were the most observed type (84% of admittance and 70% of susceptance and conductance). Kei et al. (2003) reported that they obtained 92% single-peaked 1000-Hz admittance in 244 ears of full term healthy babies. Margolis et al. (2003) reported that nearly all infants with single-peaked admittance passed OAE screening. Alaerts et al. (2007) reported a distribution of tympanograms types based on the Liden and Jerger classification systems and the Vanhuyse model. Their results showed that for infants younger than 3 months of age 90% of them had single-peaked admittance and about 50% had 1B1G. Similar results were also reported by other studies (e.g. Shahnaz et al., 2008; Calandruccio et al., 2006). The more complicated type of tympanogram observed in susceptance and conductance measurements were likely due to the fact that the newborn middle ear is a mass-dominated system (e.g., Shahnaz et al. 2014). From a clinician's point of view, a simple and easy-to-interpret classification system is preferred when possible. For this reason, admittance measurement would likely be favored by most clinicians since these measurements result in a higher percentage of single-peaked tympanograms, which are easier to interpret.

Middle ear admittance can be estimated using a baseline approach or a component compensation approach. For 1000-Hz tympanometry in healthy newborns, both methods have been investigated (Kei et al., 2003; Margolis et al., 2003; Prieve et al., 2013). For the baseline approach, admittance at the tympanic membrane can be estimated by subtracting the admittance at the positive tail or at the negative tail (peak-to-tail difference method). Margolis et al (2003) found that the 5th percentile of negative-tail-compensated admittance for babies in the NICU and for full-term healthy babies was identical, suggesting a single pass-fail criterion for both groups. They recommended using the negative tail to compensate middle ear admittance because the admittance obtained from negative tails has a larger value, which may make it easy for distinguishing normal results from abnormal results. Kei et al. (2007) recommended using a positive-tail compensation approach because it has higher test-retest reliability for healthy newborns. This finding may be related to the tendency of the newborn ear canal to collapse (due to the compliant nature of the canal) when using negative pressure (Keefe , Bulen, Arehart, & Burns, 1993).

The baseline and the component compensation approaches have different advantages. Most frontline clinicians are familiar with the baseline approach. In addition, middle ear admittance can be easily estimated by

using the peak-to-tail difference approach. The component compensation approach is a more accurate estimate of the middle ear admittance (Kei et al., 2007); however, it needs to be manually calculated which may significantly limit its use. The purpose of this study is not to justify one approach over another. This will require further study.

The difference in admittance values (mmho) from the various studies may be associated with the difference between the component compensation approach and the baseline approach. For example, in the current study, in which we calculated susceptance and conductance, the 5th percentiles of +200Y_{TM} (component compensated from positive tail) and -400Y_{TM} (component compensation from negative tail) were 0.5 and 0.6 mmho; these values are higher than the peak-to-tail compensated (baseline approach) admittance reported above. Such difference in admittance is consistent with a previous report by Kei et al. (2007) who showed the component compensation middle ear admittance to be greater than the baseline compensated admittance.

The difference in admittance values (mmho) from the various studies could be also due to factors, such as sample size, age, and race. Instrumentation also plays a key role in tympanometry measurement. Previous research has shown that different middle ear analyzers may have different measurement results (e.g., Margolis & Popelka, 1975). In our study, we used a middle ear analyzer (GSI TympStar version 2) as used by Margolis et al. (2003). Kei et al. (2007) used a Madsen Capella (version 2.1) OAE/middle ear analyzer. Shahnaz et al. (2008) used a Madsen Capella (version 2.1) OAE/middle ear analyzer.

Studies have also shown that age specific normative tympanometric criteria for newborns and young infants might be required (Alaerts et al., 2007; Calandruccio et al., 2006; Mazlan et al., 2007; Shahnaz et al. 2014) recently investigated 1000 Hz tympanometry and wideband reflectance energy in infants from newborn up to six months of age using a longitudinal approach. A similar study would also be valuable for NICU babies.

Recent studies have shown that different tympanometric criteria might be needed for different ethnic groups (Beers, Shahnaz, Westerberg, & Kozak, 2010; Shahnaz & Bork, 2006; Shahnaz & Davies, 2006; Shahnaz, Feeney, & Schairer, 2013). This might warrant a comparison of study of 1000-Hz tympanometry in newborns amongst different ethnic groups.

In addition to the use of the screening ABR as a 'gold standard' for middle ear status as discussed above, other limitations of this study include a relatively small sample size and the fact that the admittance, susceptance and conductance were manually estimated, which may have introduced some errors in data analysis. A larger sample size study with computer estimated data is desired. Another source of difference between current study and other published studies in NICU babies is the wider age range used in this study.

CONCLUSIONS

This study showed that 1000-Hz tympanometry can be used with some success as a part of hearing screening in the NICU. The component compensation and the traditional baseline approach have different advantages and limitations. A further study comparing clinical performance of both methods in a large NICU sample is needed. An age-related normative tympanometry study for NICU babies is desired as well.

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SAC Position Paper on

The Role of Speech-Language Pathologists with Respect to Augmentative and Alternative Communication (AAC)

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A position paper represents the direction SAC has taken on a particular topic or provides guidelines for particular areas of practice. These positions are time-bound, representing the thinking at a particular point in time.

Position

It is the position of Speech-Language and Audiology Canada (SAC) that all speech-language pathologists (S-LPs), regardless of their work settings, should have basic knowledge of the augmentative and alternative communication (AAC) tools and strategies that can support the expressive and receptive communication needs of their clients. All S-LPs should be prepared to apply their knowledge of AAC strategies in the course of assessment and intervention. S-LPs also have a responsibility to refer to specialized AAC services where required.

Recognizing that some AAC interventions involve complex technology and require access to specialists, SAC advocates for ready access across Canada to specialized, interprofessional AAC services in order to ensure that all clients, regardless of the complexity of their needs, are well served.

Rationale

Communication is essential to participation in life, including meaningful social, learning and vocational activities across one's lifespan. AAC tools and strategies can play an important role in enabling individuals with limited or no speech to live independent, dignified lives, commensurate with their abilities and desires.

Because individuals who require augmentative and alternative communication represent a highly diverse but low incidence population (Beukelman & Mirenda, 2012a), AAC is a domain of speech-language pathology that may be relatively unfamiliar to many S-LPs. Students in speech-language pathology frequently receive minimal education or training in AAC (Hurtig, 2013). Consequently, many S-LPs report discomfort or a lack of confidence when assessing an individual who requires AAC (Marvin, Montano, Fusco, & Gould, 2003; Dietz, Quach, Lund, & McKelvey, 2012).

Generalist S-LPs may find themselves increasingly involved in AAC interventions due to a number of converging factors. First, national and international efforts to make society more inclusive continue to gain speed. The United Nations Convention on the Rights of Persons with Disabilities recognizes the importance of ensuring accessibility to effective means of communication, including AAC. Accessibility legislation now exists in Canada that specifically addresses communication needs. For example, the 2005 Accessibility for Ontarians with Disabilities Act has mandated accessibility standards, applicable to both public and private organizations, to ensure all residents have equal access to information, regardless of disability. In Manitoba, similar legislation, the Accessibility for Manitobans Act, came into force in 2013.

Attempts to address organizational and other barriers to full participation have come alongside changes in legislation. For example, Communication Disabilities Access Canada (www.cdacanada.com), a national non-profit organization that promotes human rights and accessibility for individuals with communication disabilities, has, in response to documented needs (Collier, Blackstone, & Taylor, 2012), developed a number of initiatives that support businesses and organizations in becoming more accessible to individuals with communication disabilities, including access to essential services such as legal and justice services.

Additionally, in health-care settings, there is growing recognition that effective communication between the provider and recipient of care is critical to patient safety and quality care. One recent study found that hospital inpatients with a communication disorder are three times more likely to experience a preventable adverse medical event than those without, resulting in extended hospital stays, readmissions and other negative sequelae (Bartlett, Blais, & Tamblyn, 2008). The Joint Commission, the largest US hospital accreditation organization, now considers effective patient-provider communication, including access to AAC systems at all points along the continuum of care, as a criterion for accreditation (Joint Commission, 2010).

Concurrently, the adoption of relatively affordable mainstream consumer technology, such as tablets and smartphones, for use as speech generating devices (SGDs) has transformed the field of AAC. Until very recently, the cost of an SGD was prohibitive for many families. Now, individuals who use AAC, along with their families, can often afford to purchase a tablet and communication software independently. This has led to an increase in the number of individuals with access to high-tech AAC systems (Niemeijer, Gosnell Caron, Marden, & Shaham, 2012). It also presents a challenge to S-LPs: they no longer play a gatekeeping role in determining who might access funding for an SGD to the same degree as they did in the past. While this can be seen as empowering for families, it also increases the risk that technology will be selected in the absence of appropriate assessment or intervention planning. Regardless of the technology options available, or their cost, the importance of careful clinical decision-making cannot be overstated.

With growing demand and recognition of the role that AAC can play in supporting greater life participation, there comes a new urgency in providing guidance to all S-LPs regarding their roles in AAC interventions.

Background

AAC interventions are appropriate for individuals who are without functional speech either permanently (Millar, Light, & Schlosser, 2006) or temporarily (Hurtig & Downey, 2009).

AAC tools and strategies can help ensure that an individual can communicate successfully while receiving therapy aimed at restoring natural speech (Weissling & Prentice, 2010).

For individuals whose communication needs cannot be met through speech alone, there are many potential benefits to employing AAC tools and strategies including: an increase in the amount and complexity of language that can be produced relative to unaided speech; access to more effective methods for acquiring and demonstrating knowledge; greater social acceptance and inclusion; heightened self-esteem and motivation; an expansion or maintenance of viable communication partners and environments (Beukelman, Garrett, & Yorkston, 2007); stronger interpersonal relationships; increased productivity; and access to a greater range of vocational and academic opportunities. These outcomes ultimately translate into an enhanced quality of life.

AAC interventions are often most successful when delivered in an interprofessional manner. This is especially true in the case of clients who present with physical, sensory and/or cognitive disabilities in addition to any speech or language impairments. S-LPs should have a basic knowledge of the roles and responsibilities of other professionals as they pertain to clients who require AAC, including but not limited to occupational and physical therapists, psychologists, teachers and rehabilitation engineers.

AAC systems should be developed in consultation with the client, family members, caregivers and other stakeholders in order to ensure that the system will meet the client's communication needs and abilities and be functional in the client's typical environments.

Although no standardized tests can directly identify the type of AAC system an individual requires, AAC interventions can and should be delivered with the same rigour that is applied to other areas of clinical practice. The goal of an assessment is to identify a client's strengths and abilities and to develop a strategy for building on those strengths. Depending on the client, an assessment may include evaluation of a client's current abilities and needs in areas including language, literacy, mobility, physical access, hearing and vision (Beukelman & Mirenda, 2012b). An assessment should also consider a client's current and future language development and communication needs and goals across environments and communication partners. It is clear that the areas examined during a complex AAC assessment transcend the boundaries of any single discipline. For that reason, an interprofessional approach to assessment and intervention is critical to achieving positive client outcomes.

Assessments are typically guided by frameworks such as SETT (Zabala, 2005), the Communication Matrix (Rowland, 2012), the Participation model (Beukelman & Mirenda, 2012c, p. 109) and Social Networks theory (Blackstone & Hunt Berg, 2003a; Blackstone & Hunt Berg, 2003b).

In determining the most appropriate interventions for a client, AAC specialists frequently attempt to situate a client on the continuum of communicative independence (Dowden, 1999). The continuum ranges from emerging communicators (i.e., those who communicate about the 'here and now' using means such as gesture or facial expression) to independent communicators (those who are able to communicate on any topic with any partner). The midpoint on the continuum is the context-dependent communicator who is able to communicate in a symbolic manner, provided the message content and/or communication partner are familiar. AAC strategies are a valid means of supporting clients at every point on the continuum, including those who may always require partner support to enjoy communicative success.

Recommendations

The recommendations below are intended to provide general guidance to S-LPs whose clients may benefit from AAC interventions. Because AAC tools and strategies can be effectively incorporated into a wide range of clinical settings with an array of clients, the list of recommendations below is very general and broadly organized. S-LPs are strongly encouraged to seek further information specific to their own clientele.

The recommendations below are organized by client population or need. Recommendations under the "Universal" heading apply to all clients.

Universal Recommendations

1. Adopt a client-centered approach that recognizes the client and, where appropriate, family/caregiver as critical members of the care team.

2. Recognize that there are no minimum linguistic or other prerequisites to introducing AAC tools or strategies of some kind (Kangas & Lloyd, 1988).

3. Develop basic knowledge related to:

    a. AAC tools and strategies for supporting comprehension, including visual schedules, picture and written supports for spoken language, use of picture albums and modeled use of a client's own AAC system.

    b. AAC tools and strategies for supporting expressive communication, including object- or picture-based choice making, communication displays, alphabet boards, symbol- and text-based speech-generating devices and alternative access methods.

    c. Unaided communication strategies for supporting expression and comprehension, including pointing, looking, vocalizing, gestures, signs, facial expressions and body language.

    d. Partner communication strategies, including yes/no tagging and written choice presentation (Garrett & Lasker, 2013), partner-assisted scanning and the use of communication passports/dictionaries (see, for example, http://www.communicationpassports.org.uk for information).

    e. Modeling as a strategy for improving comprehension and expressive communication abilities (i.e., Aided Language Stimulation) (Goossens, Crain, & Elder, 1992).

4. Give consideration to the full range of a client's communication needs, abilities and functions (Light, 1989), including requesting, sharing information, observing etiquette and maintaining social relations.

5. Consider all four areas of communicative competence: operational, linguistic, social and strategic (Light, 1989; Light 2003).

6. Address a client's real world face-to-face communication needs. Where required by the client for social or vocational reasons, an AAC system should also address distance and electronic communication needs (e.g., telephone, email and social media).

7. Design AAC systems in a way that supports opportunities for meaningful participation in activities across environments (e.g., home, school, rehab setting and the community).

8. Recognize that interventions that target communication partners, thereby creating opportunities and expectations for meaningful communication, are an inherent feature of AAC service provision (Ball & Lasker, 2013).

9. Develop AAC systems that are multimodal, if needed, in order to accommodate a client's communication needs in different environments, with different partners or as physical abilities change throughout the day.

10. Consider low-tech (non-electronic) AAC supports for expressive communication and comprehension. Low-tech supports, including communication displays and alphabet boards, can serve as a backup to a high-tech system, as a primary AAC tool or as one component of a multimodal system for use with certain communication partners or in certain contexts.

11. Include, wherever possible, one or more equipment trials prior to making a purchase decision.

12. Select equipment through a process of feature matching, where a client's needs are aligned with the hardware, software and linguistic features of an AAC system (Shane & Costello, 1994, as cited in Costello, Shane, & Caron, 2012).

13. Obtain information from vendors regarding software, equipment and resources, as required. However, do not rely on vendors for clinical decision making.

Recommendations for AAC and Literacy

S-LPs should:

1. Make every effort to provide a system that includes access to spelling for clients who have some literacy skills.

2. Support literacy development in children and adults who use AAC. Literacy plays a critical role in academic success and in gaining meaningful, satisfying employment (Erickson, 2003; McNaughton & Richardson, 2013). Literacy is also essential for autonomy in daily personal affairs, such as shopping, banking or making health-related decisions. It is also valuable in leisure and for quality of life.

3. Advocate and facilitate literacy development for the purpose of face-to-face communication (Light & McNaughton, 2013; Light et al., 2005). The development of literacy skills, including the use of spelling, empowers adults and children who use AAC to fully express themselves through the generation of novel messages. Spelling is the most powerful generative language method.

4. Consider the use of compensatory supports during early stages of literacy development or on an ongoing basis, depending on the needs of the client.

5. Ensure that goals related to language and literacy development are reflected in the design and implementation of an AAC system (Sturm & Clendon, 2004; Fallon & Katz, 2008).

Recommendations for AAC and Children

Services for children who require AAC are complex because S-LPs are not only introducing a new communication tool with a new symbolic vocabulary, but also supporting the development of language in general. Therefore, S-LPs serving children who require AAC should:

1. Introduce AAC early, especially to promote receptive language development and provide immersion in the AAC system (Kangas & Lloyd, 1988; Romski & Sevcik, 2005).

2. Ensure an AAC system is designed to meet the child's immediate communication needs and also to facilitate further linguistic development (Beukelman & Mirenda, 2012d; Goossens' et al., 1992).

3. Act on the knowledge that AAC does not inhibit natural speech development (Millar et al., 2006; Romski & Sevcik, 2005).

4. Ensure the child has abundant opportunities to observe proficient use of an AAC system (Romski & Sevcik, 1996). This will ensure that the child using AAC, like his or her typically developing peers, benefits from observing fluent communication in his or her own expressive modality.

5. Work in conjunction with a child's family, teacher and other professionals to ensure that AAC recommendations are consistent with language, learning and other goals. In schools, these goals would often be identified in a student's individualized education plan.

6. Analyze the communication and participation skills and patterns of the child's peers to inform vocabulary and implementation planning (Ball et al., 1999; Banajee, Dicarlo, & Stricklin, 2003; Fried-Oken & More, 1992).

7. Consider core vocabulary needs to ensure a combination of developmental, environmental and functional vocabulary is included in the child's system (Banajee et al., 2003).

8. Support a child's communication partners in knowing how to use the AAC system and how best to interact with the child using the system.

Recommendations for AAC and Adults

Adults' communicative function can be impaired due to acquired or congenital impairments, sometimes resulting in changes that require consideration of new communication environments and partners, and education on the social, operational, strategic, and linguistic competencies required for communicating effectively using one or more new methods (Light, 1989). As a result, S-LPs serving adults who require AAC should:

1. Work with clients and their communication partners to explain new communication methods, describe how those methods can be of benefit and demonstrate their use (Thiessen & Beukelman, 2013).

2. Implement AAC systems in a way that is minimally disruptive to a client's established patterns of behaviour and involve the client in decision making to the greatest extent

possible. Doing so is likely to facilitate adoption of the system and reduce the risk of abandonment.

3. Anticipate and plan for changes in physical, cognitive or other functions when serving clients who have progressive diagnoses such as ALS or primary progressive aphasia (Ball, Beukelman, & Bardach, 2007; King, Alarcon, & Rogers, 2007).

4. Consider AAC systems for adults who have short-term needs, e.g., due to tracheostomy (Zubow & Hurtig, 2013), or who are undergoing therapy to recover natural functional speech and require a temporary system (Weissling & Prentice, 2010).

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Exposé de position d'OAC

Le rôle des orthophonistes par rapport à la communication améliorée et alternative (CAA)

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Un exposé de position représente l'orientation qu'OAC a prise sur un sujet ou propose des lignes directrices pour des domaines particuliers de la pratique. Ces positions ont une dimension temporelle et représentent la pensée de l'Association à un moment particulier.

Position

Orthophonie et Audiologie Canada (OAC) soutient la position que tous les orthophonistes, peu importe leur milieu de pratique, devraient avoir une connaissance de base des outils et des stratégies de communication améliorée et alternative (CAA) pouvant répondre aux besoins de communication expressive et réceptive de leurs clients. Tous les orthophonistes devraient être prêts à appliquer leurs connaissances des stratégies de CAA lors de l'évaluation et de l'intervention. Les orthophonistes ont également la responsabilité de soumettre une consultation à des services spécialisés en CAA au besoin.

Même si elle reconnaît que certaines interventions en matière de CAA font recours à une technologie complexe et nécessitent l'accès à des spécialistes, OAC préconise l'accès à des services spécialisés et interprofessionnels en CAA partout au Canada de façon que tous les clients, peu importe leurs besoins, reçoivent des services adéquats.

Justification

La communication est essentielle pour la participation aux activités de la vie, y compris les activités sociales, l'apprentissage et la pratique professionnelle, toute la durée de la vie. Les outils et stratégies de CAA peuvent contribuer de façon importante pour permettre aux personnes avec une parole limitée ou sans parole de vivre une vie indépendante, digne et correspondante à leurs capacités et désirs.

Comme les personnes nécessitant une communication améliorée et alternative constituent une population hautement diversifiée mais à faible incidence (Beukelman et Mirenda, 2012a), la CAA est un domaine de l'orthophonie qui demeure relativement peu connu de nombreux orthophonistes. Les étudiants en orthophonie reçoivent souvent un enseignement ou une formation limités en CAA (Hurtig, 2013). Par conséquent, de nombreux orthophonistes indiquent se sentir mal à l'aise ou manquer de confiance quand ils évaluent une personne nécessitant une CAA (Marvin, Montano, Fusco, et Gould, 2003; Dietz, Quach, Lund, et McKelvey, 2012).

Les orthophonistes généralistes peuvent trouver qu'ils participent de plus en plus souvent à des interventions en CAA en raison de certains facteurs convergents. Premièrement, les initiatives nationales et internationales pour accroître l'inclusivité de la société continuent de s'activer. La Convention des Nations Unies relative aux droits des personnes handicapées reconnaît l'importance d'assurer l'accès à un moyen de communication efficace, y compris la CAA. Il existe maintenant au Canada des lois sur l'accessibilité qui portent particulièrement sur les besoins en matière de communication. Par exemple, la *Loi de 2005 sur l'accessibilité pour les personnes handicapées de l'Ontario* entérine des normes sur l'accessibilité s'appliquant tant aux organismes publics que privés pour faire en sorte que tous les résidents aient un accès égal à l'information, peu importe leur handicap. Au Manitoba, une loi semblable, la *Loi sur l'accessibilité pour les Manitobains*, est entrée en vigueur en 2013.

Des tentatives de cibler les barrières à la participation d'origine organisationnelle et autres ont accompagné ces changements aux lois. Par exemple, Accès Troubles de la Communication Canada (**fr.cdacanada.com**), un organisme national à but non lucratif qui fait valoir les droits de la personne et l'accessibilité pour les personnes avec des troubles de la communication, a créé en réponse aux besoins documentés (Collier, Blackstone, et Taylor, 2012) des initiatives visant à aider les entreprises et organisations à devenir plus accessibles pour les personnes avec un trouble de la communication, y compris l'accès aux services essentiels comme les services juridiques.

De plus, dans les milieux des soins de santé, on reconnaît de plus en plus que la communication efficace entre le prestataire de soins et la personne recevant ces soins est essentielle pour la sécurité des patients et la qualité des soins. Une étude récente a déterminé que les patients

hospitalisés qui présentent un trouble de la communication sont trois fois plus susceptibles que les personnes sans trouble de vivre un événement médical indésirable évitable, menant à des prolongements du séjour à l'hôpital, des réadmissions et autres conséquences négatives (Bartlett, Blais, et Tamblyn, 2008). L'organisme Joint Commission, le plus vaste organisme d'agrément des hôpitaux des États-Unis, tient maintenant compte de la communication efficace entre patients et prestataires de soins, y compris l'accès à des systèmes de CAA à tous les points du continuum de soins, en tant que critère d'agrément (Joint Commission, 2010).

Parallèlement, la nouvelle utilisation d'une technologie de communication connue du grand public et relativement abordable, notamment les tablettes électroniques et les téléphones intelligents, en tant qu'appareils générateurs de parole a transformé le monde de la CAA. Jusqu'à tout récemment, le coût d'un générateur de parole était inabordable pour de nombreuses familles. Aujourd'hui, les personnes utilisant la CAA, ainsi que leurs familles, peuvent souvent se permettre d'acheter une tablette électronique et un logiciel de communication de façon indépendante. Cette nouvelle réalité a mené à une augmentation du nombre de personnes ayant accès à un système de CAA haute technologie (Niemeijer, Gosnell Caron, Marden, et Shaham, 2012). Or, elle pose un nouveau défi pour les orthophonistes: ces derniers ne contribuent dorénavant plus à déterminer qui aurait accès à un financement pour un générateur de parole dans la même mesure qu'ils ne le faisaient dans le passé. Ce changement peut être vu par les familles comme un élargissement de leur pouvoir de décision, mais il augmente aussi le risque que la technologie soit choisie en l'absence d'une évaluation ou d'une planification de l'intervention appropriées. Peu importe les options technologiques disponibles ou leur coût, on ne saurait trop insister sur l'importance d'une prise de décision clinique consciencieuse.

Compte tenu de la demande croissante et de la reconnaissance du rôle que peut jouer la CAA pour accroître la participation aux activités de la vie, il existe maintenant un besoin urgent de fournir à tous les orthophonistes des lignes directrices établissant leur rôle quand aux interventions en matière de CAA.

Contexte

L'intervention en CAA est appropriées pour les personnes qui n'ont pas de parole fonctionnelle soit de façon permanente (Millar, Light, et Schlosser, 2006) ou temporaire (Hurtig et Downey, 2009). Les outils et stratégies de CAA peuvent aider une personne à communiquer avec succès tout en recevant de la thérapie visant à rétablir la parole naturelle (Weissling et Prentice, 2010).

L'utilisation de stratégies et d'outils de CAA peut avoir de nombreux avantages potentiels pour les personnes dont les besoins de communication ne sont pas remplis par la parole à elle-seule, y compris : une augmentation de la quantité et de la complexité du langage pouvant être produit en comparaison à la parole sans aide; l'accès à des méthodes d'acquisition et de démonstration de connaissances plus efficaces; une meilleure acceptation et une plus grande inclusion au niveau social; une plus grande estime de soi et une meilleure motivation; une meilleure capacité à maintenir des partenaires et des milieux de communication viables (Beukelman, Garrett, et Yorkston, 2007); un renforcement des relations interpersonnelles; une accroissement de la productivité; et un accès à de plus vastes options professionnelles et éducationnelles. Ces résultats mènent ultimement à une qualité de vie accrue.

L'intervention en CAA est souvent mieux réussie quand elle est offerte au sein d'une équipe interprofessionnelle, particulièrement dans le cas des clients qui présentent un handicap physique, sensoriel ou cognitif en plus de leur trouble de la parole ou du langage. Les orthophonistes devraient avoir une connaissance de base des rôles et responsabilités des autres professionnels envers les clients nécessitant une CAA, y compris, entre autres, les ergothérapeutes et physiothérapeutes, les psychologues, les enseignants et les ingénieurs en réadaptation.

Les systèmes de CAA devraient être établis en consultation avec le client, les membres de sa famille, ses prestataires de soins et autres personnes d'intérêt afin de s'assurer que le système répond aux besoins de communication et aux capacités du client et peut être utilisé de façon fonctionnelle dans les milieux où se trouve généralement le client.

Même si aucun test normalisé ne peut directement déterminer quel type de CAA une personne nécessite, l'intervention en CAA doit et devrait être offerte avec la même rigueur appliquée dans les autres domaines de la pratique clinique. Le but d'une évaluation est de déterminer les forces et les capacités du client, puis d'établir une stratégie pour faire fond sur ces forces. Selon chaque client, une évaluation pourrait comprendre l'évaluation des capacités actuelles et des besoins du client dans divers domaines, y compris le langage, la littératie, la mobilité, l'accès physique, l'audition et la vision (Beukelman et Mirenda, 2012b). Une évaluation devrait également prendre en compte le niveau de développement langagier actuel et futur, ainsi que les besoins de communication actuels et futurs, du client dans tous ses environnements et pour tous ses partenaires de communication. Il est évident que les domaines examinés lors d'une évaluation complexe de la CAA dépassent les limites de toute discipline à elle-seule. C'est pour cette raison qu'une méthode interprofessionnelle d'évaluation et d'intervention est essentielle afin d'atteindre des résultats positifs pour les clients.

Les évaluations sont généralement guidées par un cadre tel que le cadre SETT (Zabala, 2005), la Communication Matrix (Rowland, 2012), le modèle de Participation (Beukelman et Mirenda, 2012c, p. 109) et la théorie des réseaux sociaux (Blackstone et Hunt Berg, 2003a; Blackstone et Hunt Berg, 2003b).

Afin de déterminer l'intervention la plus appropriée pour un client, les spécialistes de CAA s'efforcent souvent de situer le client sur un continuum d'indépendance de la communication (Dowden, 1999). Ce continuum passe des communicateurs émergents (c'est-à-dire ceux qui communiquent à propos du moment présent à l'aide de gestes ou d'expressions faciales) jusqu'aux communicateurs indépendants (ceux qui sont en mesure de communiquer sur n'importe quel sujet avec n'importe quel partenaire). Le point central du continuum est le communicateur qui dépend du contexte, c'est-à-dire qui est capable de communiquer de façon symbolique, en autant que le contenu du message et/ou le partenaire de communication soient familiers. Les stratégies de CAA sont des moyens valides d'appuyer les clients à tous les points du continuum, y compris ceux qui pourraient avoir toujours besoin de l'aide d'un partenaire pour vivre une communication réussie.

Recommandations

Les recommandations ci-dessous visent à fournir des lignes directrices générales aux orthophonistes dont les clients pourraient bénéficier d'une intervention en CAA. Comme les outils et stratégies de CAA peuvent être efficacement incorporés à une variété de milieux cliniques et auprès de divers clients, cette liste de recommandations est très générale et organisée par sujets larges. Nous encourageons fortement les orthophonistes à obtenir de plus amples renseignements portant plus précisément sur leur clientèle.

Les recommandations ci-dessous sont organisées selon la population ou le besoin. Les recommandations dites « universelles » s'appliquent à tous les clients.

Recommandations universelles

1. Adopter une méthode axée sur le client qui reconnaît le client et, si approprié, le membre de la famille/prestataire de soins en tant que membre essentiel de l'équipe de soins.

2. Reconnaître qu'il n'existe aucun prérequis minimal d'ordre linguistique ou autre pour introduire un outil ou une stratégie de CAA de quelque sorte (Kangas et Lloyd, 1988).

3. Élargir ses connaissances de base portant sur :

    a. Les outils et stratégies de CAA appuyant la compréhension, y compris les horaires visuels, les appuis pictographiques et écrits pour le langage parlé, l'utilisation d'albums photos et l'utilisation modelée du propre système de CAA d'un client.

    b. Les outils et stratégies de CAA appuyant la communication expressive, y compris la prise de choix fondée sur les objets ou les images, les tableaux de communication, les tableaux alphabétiques, les appareils générateurs de parole fonctionnant par symboles et par texte, et les méthodes d'accès alternatives.

    c. Les stratégies de communication sans aide pour appuyer l'expression et la compréhension, y compris pointer, regarder, vocaliser, utiliser des gestes, des signes, des expressions faciales et le langage corporel.

    d. Les stratégies de communication par partenaire, y compris le ciblage oui/non et la présentation d'un choix écrit (Garrett et Lasker, 2013), le balayage aidé par un partenaire et l'utilisation de passeports/dictionnaires de communication (par exemple, voir http://www.communicationpassports.org.uk pour de plus amples renseignements (en anglais seulement)).

    e. Le modelage en tant que stratégie pour améliorer les habiletés de compréhension et de communication expressive (c.-à-d. la stimulation du langage aidée (*Aided Language Stimulation*) (Goossens, Crain, et Elder, 1992))

4. Tenir compte de l'ampleur totale des besoins, des capacités et des fonctions relatifs à la communication du client (Light, 1989), y compris faire des demandes, partager des observations, observer les règles d'étiquette et maintenir des relations sociales.

5. Tenir compte des quatre sphères de compétence en matière de communication, c'est-à-dire la communication opérationnelle, linguistique, sociale et stratégique (Light, 1989; Light 2003).

6. Cibler les besoins de communication face à face dans le monde réel du client. Si le client a besoin d'un système de communication à des fins sociales ou professionnelles, ce système devrait également combler ses besoins de communication électronique et à distance (p. ex., par téléphone, courriel et médias sociaux).

7. Concevoir des systèmes de CAA qui appuient les occasions de participation significative aux activités dans divers milieux (p. ex., à domicile, à l'école, au centre de réadaptation et dans la communauté).

8. Reconnaître que les interventions ciblant les partenaires de communication, par leur capacité de créer des occasions et des attentes de communication significatives, constituent un volet intrinsèque de la prestation de services en CAA (Ball et Lasker, 2013).

9. Concevoir des systèmes de CAA qui sont multimodaux, au besoin, afin de répondre aux besoins de communication du client dans différents milieux, avec différents partenaires, ou en fonction d'habiletés physiques qui changent au cours de la journée.

10. Envisager des moyens de CAA à basse technologie (non-électroniques) pour la communication expressive et la compréhension. Les appuis à basse technologie, y compris les tableaux de communication et les tableaux alphabétiques, peuvent agir comme système auxiliaire à un système à haute technologie, comme système de CAA primaire ou comme un élément d'un système multimodal pouvant être utilisé avec certains partenaires de communication ou dans certains contextes.

11. Inclure, si possible, l'essai d'au moins une pièce d'équipement avant l'achat.

12. Sélectionner l'équipement grâce à un processus de mise en correspondance des caractéristiques, c'est-à-dire que les besoins du client correspondent aux caractéristiques offertes par le logiciel, le matériel informatique et les capacités linguistiques du système de CAA (Shane et Costello, 1994, tel que cité dans Costello, Shane, et Caron, 2012).

13. Obtenir de l'information auprès des fournisseurs concernant les logiciels, l'équipement et les ressources, au besoin; paradoxalement, ne pas se fier aux fournisseurs pour la prise de décisions cliniques.

Recommandations pour la CSA et la littératie

L'orthophoniste devrait :

1. S'efforcer autant que possible de fournir un système qui comprend l'accès à l'épellation pour les clients qui ont certaines habiletés de littératie.

2. Appuyer le développement de la littératie chez les enfants et les adultes utilisant la CAA. La littératie joue un rôle crucial dans la réussite scolaire et l'accès à un emploi intéressant et satisfaisant (Erickson, 2003; McNaughton et Richardson, 2013). La littératie est également essentielle pour l'autonomie dans la gestion des affaires personnelles quotidiennes, y compris les activités d'achat, les transactions bancaires et la prise de décisions liées à la santé. Elle est également importante pour les loisirs et la qualité de vie.

3. Promouvoir et encourager le développement de la littératie aux fins de la communication face à face (Light et McNaughton, 2013; Light *et al.*, 2005). Le développement des habiletés de littératie, y compris l'orthographe, permet aux adultes et aux enfants qui utilisent la CAA de s'exprimer pleinement grâce à la production de messages nouveaux. L'orthographe est la méthode de production de langage la plus puissante.

4. Envisager l'utilisation d'appuis compensatoires lors des premières étapes du développement de la littératie ou de façon continue, selon les besoins du client.

5. Faire en sorte que les buts liés au langage et au développement de la littératie sont reflétés dans la conception et la mise en place d'un système de CAA (Sturm et Clendon, 2004; Fallon et Katz, 2008).

Recommandations pour la CSA auprès des enfants

Les services pour les enfants nécessitant une CAA sont complexes parce que non seulement les orthophonistes introduisent-ils un nouvel outil de communication avec un nouveau vocabulaire symbolique, mais ils appuient également le développement du langage en général. Par conséquent, les orthophonistes qui desservent les enfants nécessitant de la CAA devraient :

1. Instaurer la CAA de façon précoce, particulièrement pour encourager le développement du langage réceptif et permettre l'immersion au système de CAA (Kangas et Lloyd, 1988; Romski et Sevcik, 2005).

2. S'assurer que le système de CAA est conçu pour répondre aux besoins de communication immédiats de l'enfant, ainsi que pour appuyer la progression du développement langagier (Beukelman & Mirenda, 2012d; Goossens' *et al.*, 1992).

3. Agir en sachant que la CAA ne nuit pas au développement de la parole naturelle (Millar *et al.*, 2006; Romski et Sevcik, 2005).

4. Faire en sorte que l'enfant ait amplement d'occasions d'observer l'utilisation compétente du système de CAA (Romski & Sevcik, 1996). Ceci permettra à l'enfant utilisant la CAA, tout comme ses pairs au développement typique, de bénéficier de l'observation de communication fluente dans sa modalité expressive.

5. Travailler en collaboration avec la famille de l'enfant, son enseignant et les autres professionnels pour s'assurer que les recommandations de CAA correspondent à ses buts de langage, d'apprentissage et autres. À l'école, ces buts seraient souvent établis dans le plan d'enseignement individualisé de l'élève.

6. Analyser les habiletés et les patrons de communication et de participation des pairs de l'enfant pour adapter le vocabulaire et planifier la mise en place du système (Ball *et al.*, 1999; Banajee, Dicarlo, et Stricklin, 2003; Fried-Oken et More, 1992).

7. Tenir compte des besoins en termes du vocabulaire de base pour s'assurer que le système de l'enfant comprenne un mélange de vocabulaire développemental, environnemental et fonctionnel (Banajee *et al.*, 2003).

8. S'assurer que les partenaires de communication de l'enfant savent comment utiliser le système de CAA et comment interagir le mieux possible avec l'enfant utilisant le système.

Recommandations pour la CAA auprès des adultes

La fonction de communication des adultes peut être perturbée en raison d'un trouble acquis ou congénital, parfois accompagné de changements qui nécessitent que l'on envisage de nouveaux milieux et partenaires de communication, ainsi que l'enseignement des compétences sociales, fonctionnelles, stratégiques et linguistiques requises pour communiquer efficacement grâce à une ou plus qu'une nouvelle méthode (Light, 1989). Par conséquent, les orthophonistes travaillant auprès d'adultes nécessitant la CAA devraient :

1. Collaborer avec les clients et leurs partenaires de communication pour expliquer les nouvelles méthodes de communication, décrire comment ces méthodes peuvent leur être utiles et démontrer comment les utiliser (Thiessen et Beukelman, 2013).

2. Mettre en place des systèmes de CAA d'une façon qui perturbe le moins possible les patrons de comportement établis du client et qui fait participer le client au processus décisionnel dans la plus grande mesure du possible. Ceci facilitera probablement l'adoption du système et réduira le risque qu'il soit abandonné.

3. Prévoir les changements des fonctions physiques, cognitives ou autres lors du travail auprès de clients avec un diagnostic progressif, par exemple la SLA et l'aphasie primaire progressive (Ball, Beukelman, et Bardach, 2007; King, Alarcon, et Rogers, 2007).

4. Envisager un système de CAA pour les adultes avec des besoins à court terme, par exemple à la suite d'une trachéostomie (Zubow et Hurtig, 2013), ou qui reçoivent une thérapie pour recouvrer une parole naturelle fonctionnelle et nécessitent un système temporaire (Weissling et Prentice, 2010).

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Title Page: This page should include the full title of the manuscript, the full names of the author(s) with academic degrees, each author's affiliation, and a complete mailing address for the contact author. An electronic mail address also is recommended.

Abstract: On a separate sheet of paper, a brief yet informative abstract that does not exceed one page is required. The abstract should include the purpose of the work along with pertinent information relative to the specific manuscript category for which it was submitted.

Key Words: Following the abstract and on the same page, the author(s) should supply a list of key words for indexing purposes.

Tables: Each table included in the manuscript must typedwritten double-spaced and placed at the end of the document. Tables should be numbered consecutively beginning with Table 1. Each table must have a descriptive caption. Tables should serve to expand the information provided in the text of the manuscript, not to duplicate information.

Illustrations: All illustrations to be included as part of the manuscript must also be submitted in their original file format separate from the manuscript. High resolution (at least 300 dpi) files in any of the following formats must be submitted for each graphic and image: JPEG, TIFF, AI, PSD, GIF, EPS or PDF. For other types of computerized illustrations, it is recommended that CJSLPA production staff be consulted prior to preparation and submission of the manuscript and associated figures/illustrations.

Legends for Illustrations: Legends for all figures and illustrations should be typewritten (double-spaced) on a separate page with numbers corresponding to the order in which figures/illustrations appear in the manuscript.

Page Numbering and Running Head: The text of the manuscript should be prepared with each page numbered, including tables, figures/illustrations, references, and appendices. A short (30 characters or less) descriptive running title should appear at the top right hand margin of each page of the manuscript.

Acknowledgements: Acknowledgements should be typewritten (double-spaced) on a separate page. Appropriate acknowledgment for any type of sponsorship, donations, grants, technical assistance, and to professional colleagues who contributed to the work, but are not listed as authors, should be noted.

References: References are to be listed consecutively in alphabetical order, then chronologically for each author. Authors should consult the most current edition of the APA publication manual for methods of citing varied sources of information. Journal names and appropriate volume number should be spelled out and italicized. All literature, tests and assessment tools, and standards (ANSI and ISO) must be listed in the references. All references should be double-spaced.

Potential Conflicts of Interest and Dual Commitment

As part of the submission process, the author(s) must explicitly identify if any potential conflict of interest or dual commitment exists relative to the manuscript and its author(s). Such disclosure is requested so as to inform CJSLPA that the author or authors have the potential to benefit from publication of the manuscript. Such benefits may be either direct or indirect and may involve financial and/or other non financial benefit(s) to the author(s). Disclosure of potential conflicts of interest or dual commitment may be provided to editorial consultants if it is believed that such a conflict of interest or dual commitment may have had the potential to influence the information provided in the submission or compromise the design, conduct, data collection or analysis, and/or interpretation of the data obtained and reported in the manuscript submitted for review. If the manuscript is accepted for publication, editorial acknowledgement of such potential conflict of interest or dual commitment may occur within the publication.

Participants in Research Humans and Animals

Each manuscript submitted to CJSLPA for peer-review that is based on work conducted with humans or animals must acknowledge appropriate ethical approval. In instances where humans or animals have been used for research, a statement indicating that the research was approved by an institutional review board or other appropriate ethical evaluation body or agency must clearly appear along with the name and affiliation of the research ethics and the ethical approval number. The review process will not begin until this information is formally provided to the Editor.

Similar to research involving human participants, CJSLPA requires that work conducted with animals state that such work has met with ethical evaluation and approval. This includes identification of the name and affiliation of the research ethics evaluation body or agency and the ethical approval number. A statement that all research animals were used and cared for in an established and ethically approved manner is also required. The review process will not begin until this information is formally provided to the Editor.

Renseignements à l'intention des collaborateurs

La Revue canadienne d'orthophonie et d'audiologie (RCOA) est heureuse de se voir soumettre des manuscrits de recherche portant sur la communication humaine et sur les troubles qui s'y rapportent, dans leur sens large. Cela comprend les manuscrits portant sur les processus normaux et désordonnés de la parole, du langage et de l'audition. Nous recherchons des manuscrits qui n'ont jamais été publiés, en français ou en anglais. Les manuscrits peuvent être tutoriels, théoriques, synthétiques, pratiques, pédagogiques ou empiriques. Tous les manuscrits seront évalués en fonction de leur signification, de leur opportunité et de leur applicabilité aux intérêts de l'orthophonie et de l'audiologie comme professions, et aux sciences et aux troubles de la communication en tant que disciplines. Par conséquent, tous les manuscrits sont évalués en fonction de leur incidence possible sur l'amélioration de notre compréhension de la communication humaine et des troubles qui s'y rapportent. Peu importe la catégorie, tous les manuscrits présentés seront soumis à une révision par des collègues afin de déterminer s'ils peuvent être publiés dans la RCOA. La Revue a établi plusieurs catégories de manuscrits afin de permettre la meilleure diffusion possible de l'information portant sur la communication humaine et les troubles s'y rapportant. Les catégories de manuscrits comprennent :

Tutoriels : Rapports de synthèse, traités ou exposés de position portant sur un sujet particulier dans un cadre théorique ou clinique.

Articles : Manuscrits conventionnels traitant de recherche appliquée ou expérimentale de base sur les questions se rapportant à la parole, au langage ou à l'audition et faisant intervenir des participants humains ou animaux.

Comptes rendus cliniques : Comptes rendus de nouvelles procédures ou méthodes ou de nouveaux protocoles cliniques portant particulièrement sur une application directe par rapport aux questions d'identification, d'évaluation et de traitement relativement à la parole, au langage et à l'audition.

Comptes rendus sommaires : Semblables aux notes de recherche, brèves communications portant sur des conclusions préliminaires, soit cliniques soit expérimentales (appliquées ou fondamentales), pouvant mener à une étude plus poussée dans l'avenir. Ces comptes rendus se fondent typiquement sur des études à petit « n » ou pilotes et doivent traiter de populations désordonnées.

Notes de recherche : Brèves communications traitant spécifiquement de travaux expérimentaux menés en laboratoire. Ces comptes rendus portent typiquement sur des questions de méthodologie ou des modifications apportées à des outils existants utilisés auprès de populations normales ou désordonnées.

Comptes rendus d'expérience : Comptes rendus décrivant sommairement la prestation de services offerts en situations uniques, atypiques ou particulières; les manuscrits de cette catégorie peuvent comprendre des comptes rendus de dépistage, d'évaluation ou de traitement.

Courrier des lecteurs : Forum de présentation de divergences de vues scientifiques ou cliniques concernant des ouvrages déjà publiés dans la Revue. Le courrier des lecteurs peut avoir un effet sur notre façon de penser par rapport aux facteurs de conception, aux confusions méthodologiques, à l'analyse ou l'interprétation des données, etc. Comme c'est le cas pour d'autres catégories de présentation, ce forum de communi-cation est soumis à une révision par des collègues. Cependant, contrairement aux autres catégories, on recherchera la réaction des auteurs sur acceptation d'une lettre.

Présentation de manuscrits

Pour soumettre un article, les auteurs doivent utiliser le système de soumission électronique de l'ACOA à l'adresse **http://powerreview3.aptaracorp.com/journals/sac-oac/**. Si vous ne pouvez pas utiliser le système électronique, veuillez envoyer par courriel un fichier Word contenant le manuscrit, y compris tous les tableaux, les figures ou illustrations et la bibliographie. Adressez le courriel au rédacteur en chef à l'adresse **elizabeth.fitzpatrick@uottawa.ca**.

On doit joindre aux exemplaires du manuscrit une lettre d'envoi qui indiquera que le manuscrit est présenté en vue de sa publication. La lettre d'envoi doit préciser que le manuscrit est une œuvre originale, qu'il n'a pas déjà été publié et qu'il ne fait pas actuellement l'objet d'un autre examen en vue d'être publié. Les manuscrits sont reçus et examinés sur acceptation de ces conditions. L'auteur (les auteurs) doit (doivent) aussi fournir une attestation en bonne et due forme que toute recherche impliquant des êtres humains ou des animaux a fait l'objet de l'agrément d'un comité de révision déontologique. L'absence d'un tel agrément retardera le processus de révision. Enfin, la lettre d'envoi doit également préciser la catégorie de la présentation (i.e. tutoriel, rapport clinique, etc.). Si l'équipe d'examen juge que le manuscrit devrait passer sous une autre catégorie, l'auteur-contact en sera avisé.

Toutes les présentations doivent se conformer aux lignes de conduite présentées dans le publication Manual of the American Psychological Association (APA), 6e Édition. Un accusé de réception de chaque manuscrit sera envoyé à l'auteur-contact avant la distribution des exemplaires en vue de la révision. La RCOA cherche à effectuer cette révision et à informer les auteurs des résultats de cette révision dans les 90 jours de la réception. Lorsqu'on juge que le manuscrit convient à la RCOA, on donnera 30 jours aux auteurs pour effectuer les changements nécessaires avant l'examen secondaire.

L'auteur est responsable de toutes les affirmations formulées dans son manuscrit, y compris toutes les modifications effectuées par les rédacteurs et réviseurs. Sur acceptation définitive du manuscrit et immédiatement avant sa publication, on donnera l'occasion à l'auteur-contact de revoir les épreuves et il devra signifier la vérification du contenu dans les 72 heures suivant réception de ces épreuves.

Organisation du manuscrit

Tous les textes doivent être écrits à double interligne, en caractère standard (police de caractères 12 points, non comprimée) et sur papier 8 ½" X 11" de qualité. Toutes les marges doivent être d'au moins un (1) pouce. Un fichier électonique du manuscrit doit être présenté directement au rédacteur en chef. L'identification de l'auteur est facultative pour le processus d'examen : si l'auteur souhaite ne pas être identifié à ce stade, il devra préparer un fichier électronique dont la page couverture et leas remerciements seront voilés. Seuls les auteurs sont responsables de retirer toute information identificatrice éventuelle. Tous les manuscrits doivent être rédigés en conformité aux lignes de conduite les plus récentes de l'APA. Ce manuel est disponible dans la plupart des librairies universitaires et commerciaux. En général, les sections qui suivent doivent être présentées dans l'ordre chronologique précisé.

Page titre : Cette page doit contenir le titre complet du manuscrit, les noms complets des auteurs, y compris les diplômes et affiliations, l'adresse complète de l'auteur-contact et l'adresse de courriel de l'auteur contact.

Abrégé : Sur une page distincte, produire un abrégé bref mais informateur ne dépassant pas une page. L'abrégé doit indiquer l'objet du travail ainsi que toute information pertinente portant sur la catégorie du manuscrit.

Mots clés : Immédiatement suivant l'abrégé et sur la même page, les auteurs doivent présenter une liste de mots clés aux fins de constitution d'un index.

Tableaux : Tous les tableaux compris dans un même manuscrit doivent être écrits à double interligne sur une page distincte. Les tableaux doivent être numérotés consécutivement, en commençant par le Tableau 1. Chaque tableau doit être accompagné d'une légende et doit servir à compléter les renseignements fournis dans le texte du manuscrit plutôt qu'à reprendre l'information contenue dans le texte ou dans les tableaux.

Illustrations : Toutes les illustrations faisant partie du manuscrit doivent être annexer avec chaque exemplaire du manuscrit. Chaque manuscrit doit être accompagné d'un fichier électronique pour chaque image et graphique en format JPEG, TIFF, AI, PSD, GIF, EPS ou PDF, compression minimale 300 ppp. Pour les autres types d'illustrations informatisées, il est recommandé de consulter le personnel de production de la RCOA avant la préparation et la présentation du manuscrit et des figures et illustrations s'y rattachant.

Légendes des illustrations : Les légendes accompagnant chaque figure et illustration doivent être écrits à double interligne sur une page distincte et identifiées à l'aide d'un numéro qui correspond à la séquence de parution des figures et illustrations dans le manuscrit.

Numérotation des pages et titre courant : Chaque page du manuscrit doit être numérotée, y compris les tableaux, figures, illustrations, références et, le cas échéant, les annexes. Un bref (30 caractères ou moins) titre courant descriptif doit apparaître dans la marge supérieure droite de chaque page du manuscrit.

Remerciements : Les remerciements doivent être écrits à double interligne sur une page distincte. L'auteur doit reconnaître toute forme de parrainage, don, bourse ou d'aide technique, ainsi que tout collègue professionnel qui ont contribué à l'ouvrage mais qui n'est pas cité à titre d'auteur.

Références : Les références sont énumérées les unes après les autres, en ordre alphabétique, suivi de l'ordre chronologique sous le nom de chaque auteur. Les auteurs doivent consulter le manuel de l'APA le plus récent pour obtenir la façon exacte de rédiger une citation. Les noms de revues scientifiques et autres doivent être rédigés au long et imprimés en italiques. Tous les ouvrages, outils d'essais et d'évaluation ainsi que les normes (ANSI et ISO) doivent figurer dans la liste de références. Les références doivent être écrits à double interligne.

Conflits d'intérêts possibles et engagement double

Dans le processus de présentation, les auteurs doivent déclarer clairement l'existence de tout conflit d'intérêts possibles ou engagement double relativement au manuscrit et de ses auteurs. Cette déclaration est nécessaire afin d'informer la RCOA que l'auteur ou les auteurs peuvent tirer avantage de la publication du manuscrit. Ces avantages pour les auteurs, directs ou indirects, peuvent être de nature financière ou non financière. La déclaration de conflit d'intérêts possibles ou d'engagement double peut être transmise à des conseillers en matière de publication lorsqu'on estime qu'un tel conflit d'intérêts ou engagement double aurait pu influencer l'information fournie dans la présentation ou compromettre la conception, la conduite, la collecte ou l'analyse des données, ou l'interprétation des données recueillies et présentées dans le manuscrit soumis à l'examen. Si le manuscrit est accepté en vue de sa publication, la rédaction se réserve le droit de reconnaître l'existence possible d'un tel conflit d'intérêts ou engagement double.

Participants à la recherche – êtres humains et animaux

Chaque manuscrit présenté à la RCOA en vue d'un examen par des pairs et qui se fonde sur une recherche effectuée avec la participation d'être humains ou d'animaux doit faire état d'un agrément déontologique approprié. Dans les cas où des êtres humains ou des animaux ont servi à des fins de recherche, on doit joindre une attestation indiquant que la recherche a été approuvée par un comité d'examen reconnu ou par tout autre organisme d'évaluation déontologique, comportant le nom et l'affiliation de l'éthique de recherche ainsi que le numéro de l'approbation. Le processus d'examen ne sera pas amorcé avant que cette information ne soit formellement fournie au rédacteur en chef.

Tout comme pour la recherche effectuée avec la participation d'êtres humains, la RCOA exige que toute recherche effectuée avec des animaux soit accompagnée d'une attestation à l'effet que cette recherche a été évaluée et approuvée par les autorités déontologiques compétentes. Cela comporte le nom et l'affiliation de l'organisme d'évaluation de l'éthique en recherche ainsi que le numéro de l'approbation correspondante. On exige également une attestation à l'effet que tous les animaux de recherche ont été utilisés et soignés d'une manière reconnue et éthique. Le processus d'examen ne sera pas amorcé avant que cette information ne soit formellement fournie au rédacteur en chef.

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