The University Of Sheffield.

This is a repository copy of *Can children with speech difficulties process an unfamiliar accent?*.

White Rose Research Online URL for this paper:
http://eprints.whiterose.ac.uk/1529/

Article:

Nathan, L. and Wells, B. (2001) Can children with speech difficulties process an unfamiliar accent? Applied Psycholinguistics, 22 (3). pp. 343-361. ISSN 0142-7164

https://doi.org/10.1017/S0142716401003046

Reuse

Unless indicated otherwise, fulltext items are protected by copyright with all rights reserved. The copyright exception in section 29 of the Copyright, Designs and Patents Act 1988 allows the making of a single copy solely for the purpose of non-commercial research or private study within the limits of fair dealing. The publisher or other rights-holder may allow further reproduction and re-use of this version - refer to the White Rose Research Online record for this item. Where records identify the publisher as the copyright holder, users can verify any specific terms of use on the publisher's website.

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

White Rose university consortium
Universities of Leeds, Sheffield & York

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk/

Applied Psycholinguistics **22** (2001), 343–361
Printed in the United States of America

Can children with speech difficulties process an unfamiliar accent?

LIZ NATHAN
University College London

BILL WELLS
University of Sheffield

ADDRESS FOR CORRESPONDENCE
Liz Nathan, Department of Human Communication Science, University College London, Chandler House, 2 Wakefield Street, London WC1N 1PF, U.K. E-mail: e.nathan@ucl.ac.uk

ABSTRACT
This study explores the hypothesis that children identified as having phonological processing problems may have particular difficulty in processing a different accent. Children with speech difficulties ($n = 18$) were compared with matched controls on four measures of auditory processing. First, an accent auditory lexical decision task was administered. In one condition, the children made lexical decisions about stimuli presented in their own accent (London). In the second condition, the stimuli were spoken in an unfamiliar accent (Glaswegian). The results showed that the children with speech difficulties had a specific deficit on the unfamiliar accent. Performance on the other auditory discrimination tasks revealed additional deficits at lower levels of input processing. The wider clinical implications of the findings are considered.

The study of developmental speech disorder, a frequent type of communication problem in young children (Enderby & Philipps, 1986; Law, Boyle, Harris, Harkness, & Nye, 2000), has become more concerned with the underlying speech processing mechanisms involved in the perception, production, and representation of speech than with a description based on phonological rules and simplifying processes (Dodd, 1995; Edwards, Fourakis, Beckman, & Fox, 1999; Hewlett, Gibbon, & Cohen-McKenzie, 1998; Stackhouse & Wells, 1997). The importance of this change of research focus is underlined by the fact that speech input deficits have been increasingly documented among children with speech disorders. However, input processing deficits are far from uniform across what is generally agreed to be a heterogeneous population (Bird & Bishop, 1992; Broen, Strange, Doyle, & Heller, 1983; Groenen, Maassen, Crul, & Thoonen, 1996; Rvachew & Jamieson, 1989). It is not clear what levels of processing and representation might be implicated in input deficits, although it has been argued that several aspects of processing could be compromised, either selectively or in combination (Stackhouse & Wells 1993, 1997).

© 2001 Cambridge University Press 0142-7164/01 $9.50

The studies of input processing cited here are concerned with how children discriminate sounds within their language environment or how they learn to represent and encode phonetic or phonological input. However, none directly addresses a fundamental aspect of speech processing: the way children extract phonological information from variable speech input and the way variability might be encoded or represented within the phonological system. How listeners process this variability is a question that has to be addressed by any model of speech processing, including models of typical and atypical speech development. Forrest, Chin, Pisoni, and Barlow (1994), in a study of how children with speech difficulties process word lists spoken by a single speaker compared to multiple speakers, argued that since our understanding of the relationship between speech production and speech perception in children with speech disorders is limited, it could be profitable to examine how these children process speech variability.

As Ryalls and Pisoni (1997) observed, research into speech variability poses many questions about how children acquire language in "real-world contexts" (p. 450). However, our knowledge of how adults and typically developing children process variation is limited. There is evidence that speech variability does influence one's ability to process speech. The cognitive load might be lower for a listener processing a single speaker compared to many speakers. Familiarity with a particular speaker or voice has been found to increase word identification (Nygaard & Pisoni, 1998), and children (aged 3–5) and adults are better at word identification when the stimuli are presented by a single speaker as opposed to multiple speakers (Ryalls & Pisoni, 1997).

Accent variation is one type of cross-speaker variability. Accent is defined by Chambers and Trudgill (1980) as "the way in which a speaker pronounces, and . . . refers to a variety which is phonetically and/or phonologically different from other varieties" (p. 5). Accent variation is particularly interesting to examine in relation to children's speech processing systems; young children's learning of their own language integrally involves establishing the phonological systems and phonetic realizations of a particular accent. The child acquiring a native language must, on the one hand, learn a phonological system corresponding to his or her environment and, on the other hand, develop the ability to process other accent systems to which he or she is likely to be exposed.

There is evidence that young children are generally able to acquire new/second languages proficiently, and that they can quickly learn the accents of new languages (Long, 1990). This ability to accommodate to new accents also occurs within their own native language, revealing a remarkable capability to adjust to language variation and, in particular, to acquire the segmental and prosodic features of new accent systems (Chambers, 1992; Payne, 1980). The extent of this proficiency is likely to be related to the age of the speaker, with a more native-like accent acquired the younger the speaker is when the new language/dialect is learned, although adaptation can also occur in adults (Munro, Derwing, & Flege, 1999). Thus, the study of developmental factors in relation to accent is central, and the relationship may reflect a sensitive period for language acquisition (Scovel, 1981). The importance of age in the acquisition of new accents is well attested, and the extent to which accent variation affects adults' detection, processing, and understanding of speech has also been explored (Flege, 1984;

Labov, 1989; Schmid & Yeni-Komshian, 1999); by contrast, research has only begun on how children understand unfamiliar accents or how they process accent variation.

Recent research has provided some evidence that accent variation can disrupt access to lexical representations. Nathan, Wells, and Donlan (1998) tested children, aged 4 and 7 years, on their ability to repeat and define words spoken in their own accent (London) and in an unfamiliar accent (Glaswegian). Data using the same materials and procedure has subsequently been collected from 5-, 6-, 8-, and 9-year-olds (Collins, 1998; Pate, 1998). Children in all age groups performed significantly more poorly on the unfamiliar accent in both repeating and defining the word appropriately. Older children performed significantly better than younger children on the tasks and showed a qualitatively different pattern of performance. In the definition task, most children tended to make errors of incorrect lexical access, based on phonetic confusions (e.g., defining the Glaswegian realization of *bear* [beɹ] as "my dad drinks it"), whereas younger children made more errors of failed lexical access (e.g., defining *church* as "eating"). An age-related difference was also apparent in the repetition task: younger children (particularly 4-year-olds) were more likely to make phonetic responses that were imitative of the Glaswegian accent (e.g., *church*, Glaswegian stimulus [tʃʌɹʔtʃ] realized as [tʃɔʔtʃ] or [tʃɒɹʔtʃ]) rather than make correct phonological repetitions in terms of their own London accent (e.g., [tʃʲɜːʔtʃʲ]). In the youngest age group, these types of phonetic responses were accompanied 61% of the time by failed lexical access (i.e., the child gave no accompanying definition or a highly implausible definition). These phonetic responses demonstrate that young children are influenced by the phonetic form of the variant input, choosing at times to imitate some aspects of the new form in the repetition task rather than process it within their own system; older children are much more likely to process unfamiliar phonetic stimuli within their own system.

It seems likely that intact auditory discrimination skills and accurate phonological representations are both important in performing this type of processing. If, as proposed by Hintzman (1986), phonological representations are characterized by a high level of detail, consisting of multiple traces of speech input, then processing accent variation could be dependent on how well specified the phonological representation is (i.e., whether a trace exists that corresponds to the particular variant accent form that the child is presented with). On the other hand, phonological representations can be viewed as abstract and relatively underspecified, thereby able to accommodate a range of variant input forms (Stackhouse & Wells, 1997, pp. 158–159). Under this scenario, when the child is exposed to an utterance in an unfamiliar accent, phonetic discrimination skills would be involved at an early stage of input processing. Figure 1 shows the input side of Stackhouse and Wells's model.

Phonetic discrimination is needed in order to extract the novel phonetic information from the word spoken in an unfamiliar accent: for instance, the particular quality of the rime of Glaswegian *bear*, [eɹ]. Once this has been extracted, it can be mapped onto a phonological unit in the child's accent and stored at phonological recognition – either onto the rime /ɛə/, giving correct access to the phonological representation of *bear*, or onto the rime /ɪə/, giving incorrect access

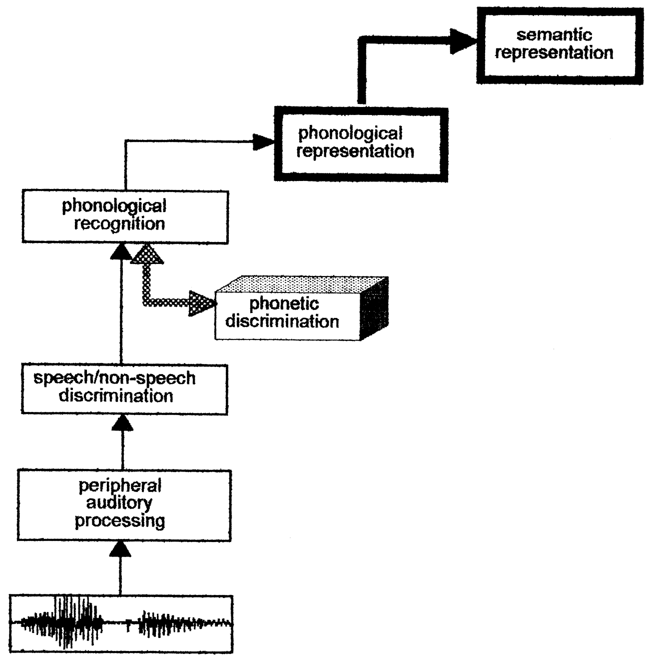

Figure 1. Stackhouse and Wells's (1997) speech processing model: Speech input processing.

to the phonological representation of *beer*. Alternatively, the child may fail to map the stimuli altogether, with no appropriate phonological representation accessed.

Under either scenario, the formation of language-specific phonological representations is likely to be influenced, or to have been influenced in the past, by bottom-up auditory discrimination abilities. There may also be a top-down influence from the size of the child's vocabulary: as a child's vocabulary grows, phonological representations become increasingly segmented and detailed in order to allow for sufficient differentiation between lexical items (Walley, 1993). Age differences in accent processing may therefore be attributable in part to the size of the lexicon.

Thus, it is likely that both bottom-up and top-down processing factors play a role in the development of phonological representations and the related ability to comprehend words spoken in unfamiliar accents. As children with speech and language impairments may have deficits in auditory discrimination, vocabulary development, or both, it can be hypothesized that they are likely to have difficulties in comprehending unfamiliar accents.

To address these issues, an experiment was designed that directly compared the performance of typically developing children to that of children with speech difficulties. Two versions of an auditory task were presented, one in the subjects' own accent and the other in an unfamiliar accent. For each condition, the child was presented with a series of pictures. On the presentation of each picture, the child heard a spoken stimulus and had to decide whether the spoken stimulus matched the picture (i.e., whether the picture had been named accurately). By asking whether the child had heard the lexical item that represented the picture, he or she was being encouraged to respond at a lexical level rather than a level of pronunciation (i.e., whether it sounded unusual or odd). This paradigm closely resembles a lexical decision task that requires subjects to decide whether a stimulus is a word or a nonword, a procedure that is used to study word recognition and the nature of the lexicon (Goldinger, 1996). In its use of pictures, the procedure parallels the one proposed by Locke (1980) for testing children with speech difficulties. For the purposes of this article, this task is referred to as an accent auditory lexical decision task. The act of rejecting a nonword is based on a lexical search: if the stimulus fails to match any item that the child has already stored in the lexicon, the stimulus must be rejected. As well as tapping processing levels, the present experimental task has functional currency: in the real world, the child has to be able to map variant phonetic stimuli onto stored representations in order to achieve successful lexical access.

In the own accent condition, the child was to perform a fairly standard lexical decision procedure, accepting as words or rejecting as nonwords phonetic stimuli presented in the native accent system of his or her speech community. In the unfamiliar accent condition, the child was asked to decide whether a phonetic stimulus, which differed from his or her own accent in its phonetic detail, nevertheless counted as a possible realization of a lexical item for which the child already had a stored representation. The task demanded that the child accept stimuli that contain permissible accent-related variation but reject those stimuli whose phonetic form does not count as a possible realization of a stored word, even within the unfamiliar accent.

What speech processing mechanisms might account for a child's decision to accept or reject stimuli in an unfamiliar accent? Poor performance on the unfamiliar accent condition could be associated with poor mapping from the variant phonetic stimulus onto phonological recognition, which contains the child's inventory of familiar, English phonetic patterns. According to Stackhouse and Wells (1997), there is a processing level – phonetic discrimination – where unfamiliar sounds can be discriminated and mapped onto the phonological units of the child's own accent (in phonological recognition). If this mapping fails to occur, successful lexical access cannot take place.

If, however, a child also performs poorly on the own accent condition, deficits might be occurring at different levels. It is possible that phonological representations are poorly or inaccurately specified, leading the child to reject words and/or accept nonwords as words, irrespective of whether the phonetic stimuli are presented in a familiar accent or an unfamiliar accent.

Alternatively, poor performance may be associated with deficits or a history of deficits at the level of phonological recognition. According to Stackhouse and Wells (1997), phonological recognition is the level tapped by word/nonword auditory discrimination tasks. Deficits at the level of phonological recognition are likely to result in the child developing poorly specified phonological representations, because the input from phonological recognition to phonological representations is faulty. Deficits in phonological recognition could also mean that on-line access to lexical phonological representations is less accurate. To examine whether this level of processing is implicated in the processing of unfamiliar accents, two additional tasks were administered; these involved auditory discrimination as opposed to auditory lexical decision (a same/different task and an ABX task). If the child is successful on the auditory discrimination tasks but fails on the unfamiliar accent lexical decision task, this would support the interpretation that the deficit is in phonetic discrimination. On the other hand, if the child performs poorly on these auditory discrimination tasks as well as on the accent auditory lexical decision task, it would not be possible to rule out deficits at the level of phonological recognition.

In summary, this article reports a study examining the speech input processing skills of children with speech difficulties and focuses in particular on their ability to process accent variation. Tasks were administered that tapped (a) phonological recognition, through auditory discrimination tasks; (b) phonological representations, through the familiar accent condition of the accent auditory lexical decision task; and (c) phonetic discrimination, through the unfamiliar accent condition of the accent auditory lexical decision task.

METHOD

Participants

Participants were identified from a cohort of children with and without speech difficulties who formed part of a longitudinal study (Stackhouse, Nathan, Goulandris, & Snowling, 1999). Four-year-old children with speech difficulties had been referred to this project by speech and language therapists in the London area. These children had obvious and significant speech difficulties but no obvious direct cause. A significant speech difficulty was defined as a score of more than one standard deviation below the mean on an articulatory naming task: the Edinburgh Articulation Test (Anthony, Bogle, Ingram, & McIsaac, 1971). They had no hearing impairment, no associated medical condition (e.g., epilepsy, a named syndrome), and no severe receptive or pragmatic language difficulties; all were monolingual English speakers. This definition permitted the inclusion of not only children who might be diagnosed as having a phonological impairment, but also children who might receive the diagnosis of developmental verbal dyspraxia/apraxia of speech. This was motivated by the theoretical and clinical difficulties involved in delineating clearly between these two putative subgroups of developmental speech disorder (Stackhouse, 1992; Stackhouse & Wells, 1997).

The control children were selected from the schools attended by the children with speech difficulties. They had no speech or language difficulties, no history of speech and language problems, no known hearing impairments, no specific or general learning difficulties, and no obvious medical condition (e.g., epilepsy). They were also monolingual English speakers.

From this cohort, 18 children with speech difficulties and 18 typically developing children were selected one year after they had been referred to this larger study. The control group had a mean age of 5;09 (range 5;03–6;05) (6 girls, 12

Table 1. *Means and standard deviations of age, nonverbal ability, and word repetition skill by group*

	Speech-disordered group ($n = 18$)	Control group ($n = 18$)
Age	5.69 (.36)	5.93 (.29)
Block Design	11.07 (2.43)	11.43 (1.65)
Picture Completion	12.20 (1.70)	12.71 (2.13)
Word Repetition[a]	51.89 (20.54)	93.30 (5.01)

[a]Percentage of consonants correct.

boys) and the speech-disordered group had a mean age of 5;11 (range 5;01–6;04) (5 girls, 13 boys). The two groups did not differ significantly on age or nonverbal ability (see Table 1). All children had performed within normal limits on the nonverbal measures of the Block Design and Picture Completion Tests (Wechsler, 1992), administered one year earlier.

The children who were originally selected with speech difficulties still had current speech difficulties. Current speech difficulty was defined as a score of at least one standard deviation below the control children's mean on a word repetition task. This task consisted of 20 low-frequency words of one to five syllables in length (e.g., *squeak, drummer, anchovy, librarian, electricity*). Stimuli were presented via a tape recording, but one "live" repetition was allowed if the child failed to respond to a stimulus or requested a repetition. All responses were transcribed in phonetic script at the time and were recorded for later reliability checks. The percentage of consonants correct was calculated (after Shriberg & Kwiatkowski, 1982).

The children's language skills were also assessed as part of the longitudinal study. The following language skills were tested: measures of expressive language (The Renfrew Bus Story, Renfrew, 1995; Renfrew Action Picture Test, Renfrew, 1988); naming (Snowling, Van Wagtendonk, & Stafford, 1988); receptive language (Test for Reception of Grammar, Bishop, 1983); and receptive vocabulary (British Picture Vocabulary Scale, Dunn, Dunn, Whetton, & Pintilie, 1982). The speech-disordered and control groups scored significantly differently on all these measures, revealing associated language difficulties in the speech-disordered group (means, standard deviations, and t tests are reported in Table 2).

Accent auditory lexical decision task

Design and stimuli. An auditory lexical decision task with pictures was designed with two accent conditions. Condition 1 was a version of the participants' own accent (London), and condition 2 was an unfamiliar accent (Glaswegian). A Glaswegian accent was chosen as the unfamiliar accent because Glasgow is geographically remote from London, where the children lived, and because the accent has a number of striking phonetic and phonological differences from that of London and from more standard varieties of Southern British English. These

Table 2. *Means and standard deviations of the speech-disordered group and the control group on language measures*

	Speech-disordered group		Control group		*T* value
Renfrew Bus Story (information score)	21.67	(8.87)	29.44	(6.26)	–3.04**
Renfrew Bus Story (MLU)	8.08	(2.52)	11.06	(2.38)	–3.64***
Renfrew Action Picture Test (information score)	31.75	(2.95)	34.06	(3.73)	–2.06*
Renfrew Action Picture Test (grammar score)	19.44	(3.96)	25.50	(5.06)	–4.0***
Naming task	7.94	(2.10)	12.39	(3.27)	–4.85***
British Picture Vocabulary Scale (standard score)	94.83	(12.68)	109	(10.13)	–3.57***
Test for Reception of Grammar (number of blocks)	10	(2.93)	12.94	(1.95)	–3.47***

*$p < .05$; **$p < .01$; ***$p < .001$.

include systemic and realization differences in the vowels and the occurrence of post-vocalic /r/ (Stuart-Smith, 1999; Wells, 1982). Two word lists of 12 items were designed in both accents (London Regional Standard and Glaswegian); items were selected from a previous experiment where words were matched across lists by word frequency and phonological vowel (see Nathan et al., 1998, for details about the design; see also the Appendix for the test items). All stimuli were one syllable in length. One-syllable words were selected to ensure close matching across lists: many of the matchings consisted of minimal pairs. As the stimuli were presented visually as well as auditorily, only words that could be pictorially represented were selected from the lists used in the earlier study. Nonwords were derived by changing the voicing, place, or manner of articulation of one consonant of target words. Nonwords were matched across the list in how they were changed (e.g., *box* and *mox*). The same Glaswegian informant from the Nathan et al. study was used.

The accent used by this informant accords closely to the description of a Glaswegian accent given by Wells (1982). Systemic differences include a lack of three pairwise phonological oppositions between distinctive monophthongs: [ʊ] and [u] → [ʏ], [æ] and [ɑː] → [ɑ], [ɒ] and [ɔː] → [ɔ]. The collapse of these contrasts includes the loss of the vowel quality differences and the length difference found in the London accent. Phonetic realizational differences include:

London		*Glaswegian*
[ɑɪ]	=	[ʌi]
[əʊ]	=	[o]
[æʊ]	=	[ʌʏ]
[ɛɪ]	=	[e]
[ɛː]	=	[eɹ]
[ɜ̟ː]	=	[ʌɹ]

As the last two items illustrate, the Glaswegian accent is rhotic for many speakers, including our informant: the informant uses a post-alveolar approximant following the vowel in words such as *bird* and *fork*. This contrasts sharply with the London accent, where the post-alveolar approximant is only found prevocalically. Features common to both the Glasgow and the London accent, as represented by the informants, include the use of a glottal stop without lingual closure for the consonant at the end of words (e.g., *kite* and *coat*) and the preglottalization of coda voiceless stops (e.g., *sock* and *rope*). In both accents, this is one of the features that serves to distinguish pairs such as *lock* and *log* or *rope* and *robe*, particularly as in both accents the final stop consonant is phonetically voiceless in both words of the pair.

Procedure. The two lists were recorded on audiotape in both accents for presentation and played back on a Phillips AQ6350 tape recorder. Line drawings of each item were presented. Although the items were all familiar words, the examiner checked whether the child recognized the pictures before the main task: the child either named the picture or, if unsure of the picture, repeated what the examiner named. The child was asked to look at the picture and decide if a prerecorded word was the name of that picture (e.g., a picture of a *box* is presented and the child hears "mox" or "box"). The child simply responded "yes" or "no" to each item presented. Two spoken stimuli were presented with each picture for half the items, and three spoken stimuli were given for the other half (their order randomized). The third presentation, which could be either correct or incorrect (i.e., "box" or "mox"), was introduced to reduce the possibility of the child predicting the next presentation, but this item was not scored. One practice item was administered first when corrective feedback was given as appropriate (though children found the task straightforward). Half the children received list A in the London accent and list B in the Glaswegian accent, while the other half of the group received list A in the Glaswegian accent and list B in the London accent in order to control for the effect of individual stimuli. The order in which the accent was presented was randomized (i.e., some children received the London accent first, while other children received the Glaswegian accent first).

Short extracts from two Mr. Men books (Hargreaves, 1971, 1976) were prerecorded, one by the London Regional Standard speaker and the other by the Glaswegian speaker, and presented prior to the relevant word list. This served to familiarize the participants to the voice of presentation. In particular, listening to the unfamiliar accent gave the children controlled exposure to the Glaswegian phonological system. This was done to ensure that the task that followed would test the child's ability to process items from a different phonological system rather than interpret exotic phonetic forms.

The task was administered as part of a larger test battery (see Stackhouse et al., 1999), which consisted of the language measures, the auditory discrimination tasks, and the measures of phonological awareness and literacy skills. The test battery took approximately two hours; the accent tasks required approximately 20 minutes of this time. Testing was carried out over a series of short sessions in a quiet room of the child's school or home. The accent tasks were, where possible, administered in their entirety during one session. All tasks were carried out by the first author, a qualified speech and language therapist.

Auditory discrimination tasks

In addition, two experimental auditory discrimination tasks were administered. The tasks were presented live by the first author. The speaker was from North London, with an accent close to Received Pronunciation but with some features of London Regional Standard (Wells, 1982).

Same/different task. This auditory discrimination task (from Bridgeman & Snowling, 1988) comprised 10 pairs of words and 10 pairs of nonwords, equally divided into two lists (A and B). The pairs of words differed by either a feature change (e.g., /t/–/s/, as in *plate/place* or [jɛɪt/jɛɪs]) or a sequence change (e.g., /st/–/ts/, as in *placed/plates* or [jɛɪst/jɛɪts]). The child was asked to say whether the pair of stimuli (words or nonwords) spoken by the tester sounded the same or different. The task was modeled using the child's name to ensure that the concepts of same/different were understood. Three additional practice items were also administered, during which corrective feedback was given.

ABX task. This task consists of 24 pairs of nonwords in two parallel forms, lists A and B. Two toy monkeys were introduced to the child: "These monkeys talk: this monkey is going to say something, then this monkey is going to say something else, something different. This monkey says /glɛb/ [experimenter points to the first monkey], this monkey says /glɛv/ [experimenter points to the second monkey]. Which one said /glɛb/?" The child is expected to point to the first monkey. Corrective feedback was given as necessary for the four practice items. The cue phrases were phased out by saying the nonword stimulus as each monkey was pointed to and asking, "Who said X?" The task items were then presented with no cue phrases; general encouragement was given, but no feedback.

RESULTS

As all the speech input tasks had forced choice responses, raw scores were transformed to values of d', which is an unbiased measure of sensitivity (Macmillan & Creelman, 1991). A d' score was calculated based on each subject's hits and false alarms. The hit rate was defined as the proportion of words to which the subject correctly responded "yes," and the false alarm rate was the proportion of nonwords incorrectly identified as words (i.e., also a "yes" response). Hits and false alarm rates are estimates of the probability of "yes" responses conditional on the possible outcomes. The values of d' were calculated, as described in Macmillan and Creelman (1991), according to the task design (i.e., a yes/no, same/different, or ABX paradigm). When a subject scored 0% or 100%, the total possible responses for each type of response was doubled and one error was assumed (S. Rosen, personal communication, April 2000) before d' was calculated, in order to avoid infinite d' values (see also Macmillan & Creelman, 1991, p. 10). Table 3 shows d' means, standard deviations, and ranges of scores by group for the two conditions.

Table 3. *Means, standard deviations, and ranges of scores of the two conditions of the accent auditory lexical decision task by group (d′ and bias (c) scores)*

	Speech-disordered group ($n = 18$)			
	d′		*c*	
	M(SD)	Min–Max	*M(SD)*	Min–Max
London	2.36 (.72)	1.11–4.08	–.12 (.04)	–2––.06
Glaswegian	1.42 (.90)	0–3.16	–.07 (.05)	–16–0
	Control group ($n = 18$)			
	d′		*c*	
	M(SD)	Min–Max	*M(SD)*	Min–Max
London	2.42 (.53)	1.11–3.16	–.12 (.03)	–16––.06
Glaswegian	2.55 (.57)	1.75–3.5	–.13 (.03)	–.18––.09

Accent auditory lexical decision task

A repeated-measures ANOVA was conducted with accent (two levels: London and Glaswegian) as the within factor and group (two levels: speech-disordered and control) as the between factor. Two significant main effects were uncovered: accent, $F(1, 34) = 10.16$, $p < .01$, and group, $F(1, 34) = 9.36$, $p < .005$. There was also a significant interaction of Accent × Group, $F(1, 34) = 17.64$, $p < .001$. Simple effects exploring the interaction showed that there was a significant difference between accents for the speech-disordered group, $F(1, 34) = 27.29$, $p < .001$, but no significant difference between accents for the control group, $F(1, 34) = .51$, *ns*; that is, the speech-disordered group performed significantly worse than the control group on the Glaswegian condition compared to the London condition.

There was a significant difference between the two groups on the Glaswegian condition, $F(1, 34) = 20.12$, $p < .001$. A majority of the speech-disordered group (66.7%) scored at least one standard deviation below the control group's mean on the Glaswegian condition. There was, however, no difference between the control group and the speech-disordered group on the London condition, $F(1, 34) = 0.07$, *ns*; only 16.7% of the speech-disordered group scored at least one standard deviation below the control group's mean.

Error analysis. Two types of errors were possible in the accent auditory lexical decision task: erroneously rejecting a word and erroneously accepting a nonword. The pattern of errors is shown in Table 4. In the Glaswegian condition, there were more errors in rejecting words than in accepting nonwords. In the London condition, there were more errors in accepting nonwords than in rejecting words (there was only a negligible number of errors in rejecting words).

Table 4. *Means and standard deviations of types of errors by group on the accent auditory lexical decision task* (*d′ score*)

	Speech-disordered group ($n = 18$)	Control group ($n = 18$)
London NW accept	2.56 (2.01)	2.00 (1.28)
London RW reject	1.06 (1.26)	1.11 (1.37)
Glaswegian NW accept	1.78 (1.96)	.89 (1.02)
Glaswegian RW reject	4.94 (2.84)	1.78 (1.44)

Note: NW accept: accepts a nonword as a word; RW reject: rejects a word (thinks it is a nonword).

Table 5. *Means, standard deviations, and ranges of scores of the same/different task and the ABX task* (*d′ score*)

	Speech-disordered group ($n = 18$)		Control group ($n = 18$)	
	M(SD)	Min–Max	*M(SD)*	Min–Max
Same/different	2.57 (1.04)	.8–3.92	3.25 (.85)	1.13–3.92
ABX	.95 (.97)	−1.12–2.12	2.33 (1.12)	−1.12–3.24

To verify whether there was a bias towards one type of response, response bias scores were calculated (Macmillan & Creelman, 1991). A paired samples t test was then calculated that compared response bias scores across the conditions. This showed a significant difference in bias according to whether the stimuli were presented in a Glaswegian or London accent, $t\ (35) = 2.62$, $p < .05$. Response bias did not differ significantly between the control group and the speech-disordered group in the London condition, $t\ (34) = -.19$, *ns*, but did differ significantly between the groups in the Glaswegian condition, $t\ (34) = -4.11$, $p < .001$.

Performance on other auditory measures

Means and standard deviations for the same/different and ABX tasks are reported in Table 5. Independent samples t tests revealed significant differences between groups. The control group scored better than the speech-disordered group: ABX, $t\ (34) = 3.98$, $p < .001$, and same/different, $t\ (34) = 2.15$, $p < .05$.

DISCUSSION

The results of our study showed that the children with speech output difficulties had a specific deficit on the unfamiliar accent task compared to the familiar accent task. They also performed poorly on the two auditory discrimination tasks. The implications of this pattern of performance are now explored.

The speech-disordered group performed less accurately than the control group in a Glaswegian version of an auditory lexical decision task with pictures, compared to one presented in their own accent. Accent variation disrupted their ability to identify accurately whether a word had been spoken correctly. The speech-disordered group performed similarly to the control group on the London version of the task. Therefore, on this matched task, accent discriminated between the speech-disordered group and the control group. This suggests that the speech-disordered group did not have a general and pervasive difficulty arising from grossly inaccurate phonological representations: if that had been the case, they would have also performed worse than the control group on the own accent condition, since both tasks involved rejecting nonwords that were phonetically similar to real words stored in the lexicon.

In the Glaswegian condition, the speech-disordered group showed a significant bias toward erroneously rejecting words (i.e., treating them as nonwords). The Glaswegian form of the word that was presented as the stimulus was so different from the child's own representation of the word that, on occasion, no lexical item was triggered or accessed. According to Stackhouse and Wells's (1997) model, this suggests that the difficulty the children had with the Glaswegian condition lay in the discrimination of the unfamiliar phonetic features of the Glaswegian stimuli and the mapping of these variant forms onto the child's phonological units that are stored at the level of phonological recognition (see Figure 2).

In the London condition, the children with speech difficulties were able to map the phonetic stimulus onto the appropriate phonological units stored at phonological recognition. This enabled the appropriate phonological representation to be accessed. Because the stimuli are familiar, phonetic discrimination can be bypassed (see Figure 2).

To summarize the findings of the accent tasks: when the accent was unfamiliar, the performance of the children with speech difficulties dropped. This suggests that their processing of accent-related variability was specifically disrupted. However, significant group differences were also found on the two auditory discrimination measures (same/different and ABX). What does performance on these two tasks tell us about the children's speech input skills? It could suggest that children with speech difficulties do, indeed, have problems at the level of phonological recognition, as demonstrated by their performance on the auditory discrimination of similar sounding words and nonwords. Their speech input difficulties thus involve both phonetic discrimination and phonological recognition.

Our location of the children's difficulties at lower input levels of the speech processing model is consistent with findings by Groenen et al. (1996). They compared the performance of 8-year-old Dutch children, diagnosed as having developmental apraxia, on what they termed measures of "auditory processing" and "phonetic processing." They administered an identification task and a discrimination task, using a seven-step [b–d] continuum. The identification task was thought to test phonetic processing because the child had to classify each stimulus (from somewhere along the continuum) using a phonemic judgment of which endpoint the stimulus most closely resembled; the discrimination task,

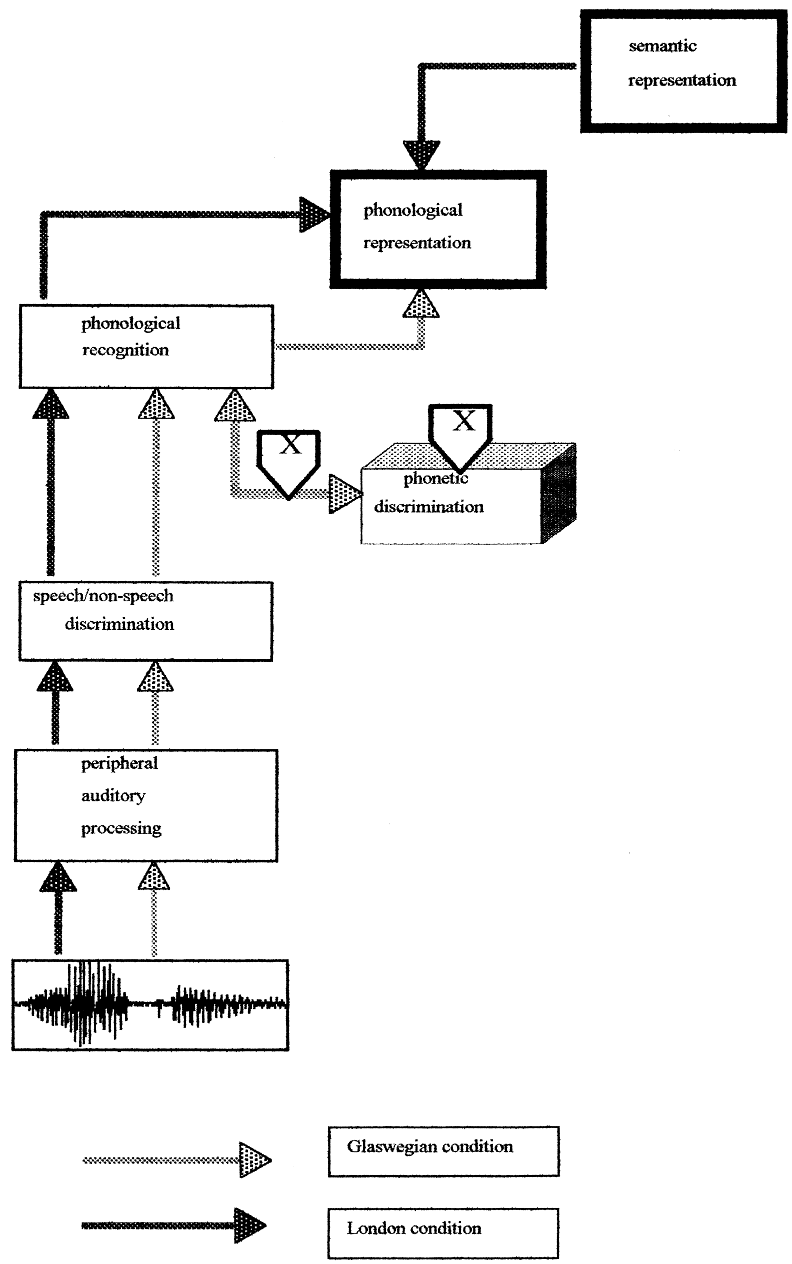

Figure 2. Stackhouse and Wells's (1997) speech processing model showing the processing routes used for the London and Glaswegian conditions and the postulated loci of difficulty for the speech-disordered group.

although it contrasted points along the same continuum as in the identification task, was thought to tap auditory processing ability as well as phonetic processing. The results showed that children with the diagnosis of developmental apraxia were poorer than controls at discriminating monosyllabic words. However, they performed equivalently to controls on the identification task using the same continuum; according to the authors, this indicated that their phonetic processing ability was intact but their auditory processing was impaired. By contrast, our findings do not support those of Bird and Bishop (1992), who argued that the input deficit of their sample of 14 children with speech difficulties lay with the ability to perceive phoneme constancy and was reflected in reduced awareness of the internal structure of phonological strings.

The results of our study show that locating the speech input processing deficit at a single level is problematic. The way these skills is measured is crucial. A comparison of performance across the accent tasks reveals deficits at the level of phonetic discrimination, but performance on the other auditory measures shows deficits at the level of phonological recognition.

While our interpretation of the results has been in terms of the developmental information processing model of Stackhouse and Wells (1997), alternative interpretations are equally possible. For example, from the perspective of Hintzman's (1986) multiple trace model, it could be argued that lower level auditory discrimination deficits impede the child with speech difficulties in identifying distinct accent variants and thus in storing traces of those variants. When subsequently exposed to such variants, the child therefore fails to recognize them.

Although the child's lexical knowledge (e.g., size of vocabulary) might influence performance on the accent lexical decision tasks, our interpretation of the results has emphasized the role of bottom-up auditory factors rather than top-down lexical factors in accounting for the poorer performance of the children with speech disorders. This is because the children with speech disorders showed a specific deficit in the unfamiliar accent condition. If lexical knowledge had been the key factor, we would have expected to find a depressed performance on the own accent condition as well. At the same time, the children in the experimental group had depressed language scores, including scores on lexical measures. On the basis of the present data, it is not possible to tell whether this is merely a correlation or whether there is a causative relationship between poor accent processing and slow lexical development. For instance, we might speculate that the poor auditory abilities of these children, which include a depressed ability to process variant input forms of lexical items (e.g., when the word is spoken in an unfamiliar accent), could lead to weak lexical development.

Finally, the performance of the control children merits comment. There was no difference in their performance on the unfamiliar accent condition compared to the familiar accent condition. This result suggests that typically developing children, aged 5 and 6 years, are capable of interpreting accent-related variation accurately. At first sight, this appears at odds with earlier findings that children between the ages of 4 to 9 have difficulties with an unfamiliar accent (Collins, 1998; Nathan et al., 1998; Pate, 1998). The accents selected were the same, preceding stories were also given, and the items used in this task were a subset of the words used in the repetition/definition task. The informant used for the Glaswegian condition was also the same as for the other studies, although the London informant was a different speaker. The most likely explanation for the discrepancy in results therefore lies in the task design. In the present study, unlike the earlier studies, pictures were used. The use of pictures undoubtedly makes the task much easier because it reduces the lexical search that is needed: the child simply had to compare the stimulus to his or her lexical representation of the picture. In the repetition/definition task with no pictures, used by Nathan et al. (1998), the child had to conduct a wider lexical search than in the accent auditory lexical decision task, where the choice was limited by the picture. This resulted in more instances of failed lexical access.

The discrepant results are therefore likely to be attributable to task differences. This highlights how the processing of accent-related variation under experimental conditions interacts with the demands of a particular task. If the demands of the task are low and the possible responses are restricted, a typically developing child should be able to overcome any ambiguity. The speech-disordered group, however, was able to process the London condition appropriately but was unable to make such compensations in the Glaswegian condition. Variability, therefore, seems to have an even greater impact on children with speech difficulties than on typically developing children.

Summary and clinical implications

This study has highlighted the importance of examining the processing of accent-related variability in children with speech difficulties. The results suggest that we should look beyond a surface description of speech disorder to examine the more subtle speech processing skills of this population, including different aspects of speech input processing, such as the ability to process different kinds of speech variability. As this study was limited to the processing of single words and nonwords, it is important that future research examine how other factors, such as context, might help the child when processing unfamiliar accents. The present study has shown how subtle difficulties with the processing of accent variation can block lexical access. Thus, this is an important variable to consider when assessing children's speech processing and language skills clinically, as well as when designing and implementing therapy tasks.

APPENDIX

Word and nonword stimuli presented for the London and Glaswegian accent conditions

List A						List B					
Word	London	Glaswegian	Nonword	London	Glaswegian	Word	London	Glaswegian	Nonword	London	Glaswegian
bird	[bɜ̟ːd̥]	[bʌr̥d̥]	*dird*	[dɜ̟ːd̥]	[dʌr̥d̥]	*girl*	[gɛːʊ]	[gɪrl]	*dirl*	[dɛːʊ]	[dɪrl]
coat	[kʰʌʉ̞ʔ]	[kʰo̞̟ʔ]	*toat*	[tʰʌʉ̞ʔ]	[tʰo̞ʔ]	*boat*	[bʌʉ̞ʔ]	[bo̞ʔ]	*doat*	[dʌʉ̞ʔ]	[do̞ʔ]
fork	[fɔ̝ʊʔk]	[fɔɹʔkʰ]	*sork*	[sɔ̝ʊʔk]	[sɔɹʔkʰ]	*walk*	[wɔ̝ʊʔkʰ]	[wɔʔkʰ]	*ralk*	[ɹɔ̝ʊʔkʰ]	[rɔʔkʰ]
sock	[sɒʔk]	[sɔʔkʰ]	*tock*	[tʰɒʔk]	[tʰɔʔkʰ]	*box*	[bɒʔks]	[bɔʔks]	*mox*	[mɒʔks]	[mɔʔks]
mouse	[mæ̝ʊs]	[mʌ̟ʏs]	*bouse*	[bæ̝ʊs]	[bʌ̟ʏs]	*mouth*	[mæʊf]	[mʌ̟ʏθ]	*bouth*	[bæʊf]	[bʌ̟ʏθ]
hand	[hæ̃nd̥]	[hand̥]	*fand*	[fæ̃nd̥]	[fand̥]	*sand*	[sæ̃nd̥]	[saːnd̥]	*shand*	[ʃæ̃nd̥]	[ʃaːnd̥]
bite	[bɑɪʔ]	[bʌɪʔ]	*pite*	[pʰɑɪʔ]	[pʰʌɪʔ]	*kite*	[kʰɑɪʔ]	[kʰʌ̟iʔ]	*gite*	[gɑɪʔ]	[gʌ̟iʔ]
soap	[sʌɤ̟ʔp̚]	[soʔpʰ]	*foap*	[fʌɤ̟ʔp̚]	[foʔpʰ]	*rope*	[ɹʌɤ̟ʔp̚]	[ɹ̝oʔpʰ]	*wope*	[wʌɤ̟ʔp̚]	[woʔpʰ]
food	[fʉd̥]	[fʏd̥]	*vood*	[vʉd̥]	[vʏd̥]	*boot*	[bʉːʔt̚]	[bʏʔ]	*poot*	[pʰʉːʔ]	[pʰʏʔ]
wave	[wɛ̞ɪv̥]	[weːv̥]	*lave*	[lɛ̞ɪv̥]	[leːv̥]	*game*	[gɛ̞ɪm]	[gem]	*bame*	[bɛ̞ɪm]	[bem]
nurse	[nɜ̟ːs]	[nʌɹ̥s]	*surse*	[sɜ̟ːs]	[sʌɹ̥s]	*church*	[tʃʲɜ̟ːʔtʃʲ]	[tʃʌɹʔtʃ]	*turch*	[tʰɜ̟ːʔtʃʲ]	[tʰʌɹʔtʃ]
bath	[b̥ɑːf]	[b̥aːθ]	*gath*	[g̥ɑːf]	[gaːθ]	*path*	[pʰɑːf]	[pʰaːθ]	*kath*	[kʰɑːf]	[kʰaːθ]

ACKNOWLEDGMENTS

The longitudinal study from which the participants were selected was funded by the North Thames Regional Health Authority and was set up in collaboration with Camden and Islington Community Health Care Services NHS Trust, the Nuffield Hearing and Speech Centre, London, Barnet Health Care NHS Trust, and Enfield Community Care NHS Trust. Thanks are extended to all the participants in the study, the schools that the participants attended, and the two informants from London and Glasgow. We would also like to thank our colleagues, Jana Dankovičová, Rachel Rees, Stuart Rosen, Joy Stackhouse, Marcin Szczerbinski, and two anonymous reviewers.

REFERENCES

Anthony, A., Bogle, D., Ingram, T. T. S., & McIsaac, M. W. (1971). *Edinburgh Articulation Test*. Edinburgh: Churchill Livingstone.

Bird, J., & Bishop, D. V. M. (1992). Perception and awareness of phonemes in phonologically impaired children. *European Journal of Disorders of Communication, 27*, 289–311.

Bishop, D. (1983). *Test for the Reception of Grammar*. University of Manchester, Department of Psychology.

Bridgeman, E., & Snowling, M. (1988). The perception of phoneme sequence: A comparison of dyspraxic and normal children. *British Journal of Disorders of Communication, 23*, 245–252.

Broen, P. A., Strange, W., Doyle, S. S., & Heller, J. H. (1983). Perception and production of approximant consonants by normal and articulation-delayed preschool children. *Journal of Speech and Hearing Research, 26*, 601–608.

Chambers, J. K. (1992). Dialect acquisition. *Language, 68*, 673–705.

Chambers, J. K., & Trudgill, P. (1980). *Dialectology*. Cambridge: Cambridge University Press.

Collins, T. (1998). A developmental study of the effects of accent variation on single word comprehension in eight and nine year old children. Unpublished Bsc. speech sciences project, University College London, Department of Human Communication Science.

Dodd, B. (1995). *Differential diagnosis and treatment of children with speech disorder*. London: Whurr Publishers.

Dunn, L. M., Dunn, L. M., Whetton, C., & Pintilie, D. (1982). *The British Picture Vocabulary Scales*. Windsor: NFER-Nelson.

Edwards, J., Fourakis, M., Beckman, M. E., & Fox, R. A. (1999). Characterizing knowledge deficits in phonological disorders. *Journal of Speech, Language and Hearing Research, 42*, 169–186.

Enderby, P., & Philipps, R. (1986). Speech and language handicap: Towards knowing the size of the problem. *British Journal of Disorders of Communication, 21*, 151–165.

Flege, J. E. (1984). The detection of foreign accent by American listeners. *Journal of the Acoustical Society of America, 76*, 692–707.

Forrest, K., Chin, S. B., Pisoni, D. B., & Barlow, N. N. (1994). Talker normalization in normally articulating and phonologically delayed children: Methodological considerations. *Research on spoken language processing* (pp. 229–259). Indiana University.

Goldinger, S. D. (1996). Auditory lexical decision. *Language and Cognitive Processes, 11*, 559–567.

Groenen, P., Maassen, B., Crul, T., & Thoonen, G. (1996). The specific relation between perception and production errors for place of articulation in developmental apraxia of speech. *Journal of Speech, Language and Hearing Research, 39*, 468–482.

Hargreaves, R. (1971). *Mr. Tickle*. Manchester: World International Publishing.

(1976). *Mr. Strong*. Manchester: World International Publishing.

Hewlett, N., Gibbon, F., & Cohen-McKenzie, W. (1998). When is a velar an alveolar? Evidence supporting a revised psycholinguistic model of speech production in children. *International Journal of Language and Communication Disorders, 33*, 161–176.

Hintzman, D. L. (1986). "Schema Abstraction" in a multiple-trace memory model. *Psychological Review, 93*, 411–428.

Labov, W. (1989). The limitations of context: Evidence from misunderstandings in Chicago. *Chicago Linguistic Society, 25*, 171–200.

Law, J., Boyle, J., Harris, F., Harkness, A., & Nye, C. (2000). Prevalence and natural history of primary speech and language delay: Findings from a systematic review of the literature. *International Journal of Language and Communication Disorders, 35*, 165–188.

Locke, J. (1980). The inference of speech perception in the phonologically disordered child. Part II: Some clinically novel procedures, their use, some findings. *Journal of Speech and Hearing Disorders, 45*, 445–468.

Long, M. H. (1990). Maturational constraints on language development. *Studies in Second Language Acquisition, 12*, 251–285.

Macmillan, N. A., & Creelman, C. D. (1991). *Detection theory: A user's guide*. Cambridge: Cambridge University Press.

Munro, M. J., Derwing, T. M., & Flege, J. E. (1999). Canadians in Alabama: A perceptual study of dialect acquisition in adults. *Journal of Phonetics, 27*, 385–403.

Nathan, L., Wells, B., & Donlan, C. (1998). Children's comprehension of unfamiliar regional accents: A preliminary investigation. *Journal of Child Language, 25,* 343–365.

Nygaard, L. C., & Pisoni, D. B. (1998). Talker-specific learning in speech perception. *Perception and Psychophysics, 60*, 355–376.

Pate, E. (1998). A developmental study of the effects of accent variation on single word comprehension in five and six year old children. Unpublished Bsc. speech sciences project, University College London, Department of Human Communication Science.

Payne, A. (1980). Factors controlling the acquisition of the Philadelphia dialect by out-of-state children. In W. Labov (Ed.), *Locating language in time and space*. New York: Academic.

Renfrew, C. E. (1988). *Renfrew Action Picture Test* (3rd ed.). Oxford: Language Test Publisher.

(1995). *The Renfrew Bus Story* (3rd ed.). Oxford: Language Test Publisher.

Rvachew, S., & Jamieson, D. G. (1989). Perception of voiceless fricatives by children with a functional articulation disorder. *Journal of Speech and Hearing Disorders, 54*, 193–208.

Ryalls, B. O., & Pisoni, D. B. (1997). The effect of talker variability on word recognition in preschool children. *Developmental Psychology, 33,* 441–452.

Schmid, M., & Yeni-Komshian, G. (1999). The effects of speaker accent and target predictability on perception of mispronounciations. *Journal of Speech, Language and Hearing Research, 42*, 56–64.

Scovel, T. (1981). The recognition of foreign accents. In J.-G. Savard & L. LaForge (Eds.), *Proceedings of the 5th Congress of the International Association of Applied Linguistics*. Quebec: University of Laval Press.

Shriberg, L., & Kwiatkowski, J. (1982). Phonological disorders III: A procedure for assessing severity of involvement. *Journal of Speech and Hearing Disorders, 47*, 256–270.

Snowling, M., Van Wagtendonk, B., & Stafford, C. (1988). Object naming deficits in developmental dyslexia. *Journal of Research in Reading, 11*, 67–85.

Stackhouse, J. (1992). Developmental verbal dyspraxia I: A review and critique. *European Journal of Disorders of Communication, 27*, 19–34.

Stackhouse, J., Nathan, L., Goulandris, N., & Snowling, M. (1999). The relationship between speech disorders and literacy problems: Identification of the at risk child. Report on a 4 year longitudinal study.

Stackhouse, J., & Wells, B. (1993). Psycholinguistic assessment of developmental speech disorders. *European Journal of Disorders of Communication, 28*, 331–348.

(1997). *Children's speech and literacy difficulties: A psycholinguistic framework*. London: Whurr Publishers.

Stuart-Smith, J. (1999). Glasgow: Accent and voice quality. In P. Foulkes & G. Docherty (Eds.), *Urban voices: Accent studies in the British Isles*. Sevenoaks: Edward Arnold.

Walley, A. C. (1993). The role of vocabulary development in children's spoken word recognition and segmentation ability. *Developmental Review, 13*, 286–350.

Wechsler, D. (1992). *Wechsler Preschool and Primary Scale of Intelligence–Revised* (*WPSSI-R UK*) (3rd ed.). London: The Psychological Corporation.

Wells, J. C. (1982). *Accents of English: Vol. 2. The British Isles*. Cambridge: Cambridge University Press.