Differential Diagnosis and Treatment of Children with Speech Disorder

Second Edition

EDITED BY
BARBARA DODD

Differential Diagnosis and Treatment of Children with Speech Disorder

Second Edition

Differential Diagnosis and Treatment of Children with Speech Disorder

Second Edition

Edited by

Barbara Dodd PhD
University of Queensland

W
WHURR PUBLISHERS
LONDON AND PHILADELPHIA

© 2005 Whurr Publishers Ltd (a subsidiary of John Wiley & Sons, Ltd)

First published 2005 by
Whurr Publishers Ltd
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, U.K
Telephone: (+44) 1243 779777
E-mail: cs-books@wiley.co.uk
Visit our Home page on www.wiley.com

Reprinted April 2006, March 2007, March 2008, February 2009, August 2010

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of Whurr Publishers Limited.

This publication is sold subject to the conditions that it shall not, by way of trade or otherwise, be lent, resold, hired out, or otherwise circulated without the publisher's prior consent in any form of binding or cover other than that in which it is published and without a similar condition including this condition being imposed upon any subsequent purchaser.

British Library Cataloguing in Publication Data

A catalogue record for this book
is available from the British Library.

ISBN 978 1 86156482 5 (PB)

Typeset by Adrian McLaughlin, a@microguides.net

Contents

Preface ix
General preface xii
Contributors xiii
Acknowledgements xiv

Part I Understanding Speech-disordered Children 1

Chapter 1 3

Children with speech disorder: defining the problem

Chapter 2 24

Children's acquisition of phonology

Chapter 3 44

Differential diagnosis of phonological disorders

Chapter 4 71

Childhood apraxia of speech

Chapter 5 83

Epidemiology of speech disorders

Chapter 6 100

The relationship between speech disorders and language

Part II Treatment of Phonological Disorders 117

Chapter 7 119

A problem-solving approach to clinical management

Chapter 8 140

A procedure for classification of speech disorders

Chapter 9 163

Phonological approaches to intervention

Chapter 10 182

Treating inconsistent speech disorders

Chapter 11 202

Childhood apraxia of speech: treatment case studies

Chapter 12 211

Clinical effectiveness

Part III Speech Disorders in Special Populations 231

Chapter 13 233

Phonological abilities of children with cognitive impairment

Chapter 14 244

Hearing impairment

Chapter 15 258

The relationship between auditory processing and phonological impairment

Chapter 16 275

Bilingual children with phonological disorders: identification and intervention

Chapter 17 **289**

Understanding the relationship between speech and language impairment and literacy difficulties: the central role of phonology

Appendices 305
References 313
Index 349

Preface

Ten years after the publication of the first edition of this book, a lot more is known about children with speech disorders. There are, however, crucial pieces of knowledge still missing. This new edition examines the problems challenging clinicians and researchers concerned with the nature of assessment and intervention for children with speech disorder. It attempts to clarify the salient issues, and provide critical summaries of current knowledge.

The writing of this book involved long discussions with colleagues who co-authored the chapters. The following issues were those that seem to be most important.

1. There are many ways of describing disordered speech. Each contributes information about particular aspects of children's surface error patterns. Description, however, has limited explanatory power. We know little about the extent to which different ways of describing disordered speech give rise to different intervention practice and different outcomes.
2. All research approaches come with a set of assumptions. Those assumptions have often been left unconsidered. For example, one strategy has been to break down the speech-processing chain into small units. Each unit is examined in detail and a causal relationship assumed between a deficit in one aspect of the speech-processing chain and disordered speech. Such assumptions are not always justified. There is a need for a 'whole child'-centred approach to explanation and intervention.
3. There has been a recent increase in the number of clinical efficacy studies available in the literature. One major debate concerns the relative merits of randomized control designs versus small-scale or case studies. While the former are important because they justify services, the latter can provide information about the best outcome for children

with different types of disordered speech. The literature, however, is limited by the assumption that there is one type of intervention practice that is best for all children. Further, follow-up studies to chart children's progress longitudinally once intervention has ceased are rarely done.

4. Children with a speech disorder experience intervention in context. That context involves child-specific factors (age, type of disorder, ability, attitude to their difficulty) and the language-learning environment. Both sets of factors affect the outcome of intervention. Children are not passive recipients of intervention that often focuses on obvious symptoms. They need to collaborate in the process. To do that, they need to understand what is happening and why it is happening.

This book hopefully addresses these, and related, issues in an accessible way for clinicians, students of speech-language pathology and researchers. Part I of the book deals with theory. Chapter 1 is an overview of the problems faced by clinicians working daily with large populations of children who mispronounce words. Chapter 2 provides a review of typical speech development and sets out new normative data for British and Australian children. Current theoretical approaches to the explanation of speech disorder are examined in Chapter 3. This chapter also presents psycholinguistic evidence for an approach to classification of disordered speech based on surface speech errors. Issues related to childhood apraxia of speech are discussed in Chapter 4. Chapter 5 presents an epidemiological study of 320 children with disordered speech. The final chapter in this section, Chapter 6, examines the relationship between speech and language disorders, reporting new experimental data.

Part II of this book focuses on intervention issues. Choosing between intervention options has become more complex as knowledge about speech disorders has increased. Chapter 7 sets out a schema for the decision-making process in clinical management. Clinical decisions must be based on assessment data, and Chapter 8 provides a procedure for the differential diagnosis of subgroups of speech disorder. The next three chapters in this section, Chapters 9, 10 and 11, each detail an approach to intervention that is appropriate for particular subgroups of speech disorder. Chapter 12 evaluates our approach to classification and intervention in a large randomized control trial. The results indicated that direct intervention is essential for children with speech disorder. Children make little or no progress when intervention is withheld. However, offering a single intervention approach for all speech-disordered children would seem to be inappropriate. The findings of the trial showed that intervention targeted to the specific nature of the deficit is effective, emphasizing the need for differential diagnosis of speech disorders.

The third part of this book focuses on special populations. Chapter 13 examines the relationship between phonological development and cognition in children with intellectual impairment. Auditory factors are considered in Chapters 14 (hearing impairment) and 15 (auditory processing). Chapter 16 examines bilingual children with speech disorder. This population provides opportunities for theoretical and clinical research. These opportunities are illustrated in two case studies. The final chapter reviews the literature on the relationship between spoken and written phonological disorders.

The preparation of this Second Edition has taken a year because most of the chapters are new, perhaps reflecting how much our knowledge has recently grown. Phonological development and disorders remain, for me, the most interesting aspect of child language. The ability to communicate is dependent upon the ability of children to ‘crack’ the phonological code so that they can understand other people, and pronounce words in a way that others can understand. That requires the interaction of sensory, cognitive-linguistic and motor skills. Phonological acquisition demonstrates children’s remarkable abilities and is therefore endlessly intriguing.

General preface

This series focuses upon disorders of speech, language and communication, bringing together the techniques of analysis, assessment and treatment which are pertinent to the area. It aims to cover cognitive, linguistic, social and educational aspects of language disability, and therefore has relevance within a number of disciplines. These include speech therapy, the education of children and adults with special needs, teachers of the deaf, teachers of English as a second language and of foreign languages, and educational and clinical psychology. The research and clinical findings from these various areas can usefully inform one another and, therefore, we hope one of the main functions of this series will be to put people within one profession in touch with developments in another. Thus, it is our editorial policy to ask authors to consider the implications of their findings for professions outside their own and for fields with which they have not been primarily concerned. We hope to engender an integrated approach to theory and practice and to produce a much-needed emphasis on the description and analysis of language as such, as well as on the provision of specific techniques of therapy, remediation and rehabilitation.

While it has been our aim to restrict the series to the study of language disability, its scope goes considerably beyond this. Many previously neglected topics have been included where these seem to benefit from contemporary research in linguistics, psychology, medicine, sociology, education and English studies. Each volume puts its subject matter in perspective and provides an introductory slant to its presentation. In this way we hope to provide specialized studies which can be used as texts for components of teaching courses at undergraduate and post-graduate levels, as well as material directly applicable to the needs of professional workers.

David Crystal
Ruth Lesser
Margaret Snowling

Contributors

Amanda Bradford-Heit, Private Practitioner, Biloela, Australia.

Jan Broomfield, Middlesbrough Primary Care Trust, NHS, UK.

Shula Chiat, University College London, UK.

Sharon Crosbie, University of Queensland, Australia.

Barbara Dodd, University of Queensland, Australia.

Gail Gillon, Canterbury University, Christchurch, New Zealand.

Alison Holm, University of Queensland, Australia.

Paul McCormack, Flinders Medical School, Adelaide, Australia.

Judith Murphy, Education Queensland, Australia.

Anne Ozanne, LaTrobe University, Melbourne, Australia.

Belinda Seeff-Gabriel, University College London, UK.

Carol Stow, Rochdale Primary Care Trust, NHS, UK.

Nick Thyer, University of Leeds, UK.

Anne Whitworth, University of Newcastle, UK.

Zhu Hua, University of Newcastle, UK.

Acknowledgements

The authors listed in this book have contributed a great deal more than the words written. They all have a passion for research and a commitment to providing best clinical practice. I have been extremely fortunate to have been able to work with them, and they have cheerfully tolerated my obsession with phonological disorders over many years. The many children, with typical and atypical phonological development, who have fuelled the research and collaborated in the data collection, deserve admiration as well as thanks. Two contributors, Sharon Crosbie and Alison Holm, have been especially important. I hope that they think of this book as being as much theirs as mine, and that their effort has been worthwhile. Mistakes are, of course, my responsibility despite additional help from Peter Dodd, Beth McIntosh, Helen Grech, Sue Franklin, Irmgarde Horsley and Margaret Leahy.

PART I

UNDERSTANDING SPEECH-DISORDERED CHILDREN

CHAPTER 1

Children with speech disorder: defining the problem

BARBARA DODD

Communication disability can be defined as an impaired ability to use spoken and written language to express thought or to understand others' language. Most children who are referred for clinical assessment of a communication difficulty have a speech disorder. Their speech is difficult or impossible to understand because it is characterized by many mispronunciations of words. However, these children are far from being a homogeneous group. They differ in terms of the severity of their difficulty, the underlying cause of the disorder, the characteristics of their speech errors, the degree to which other aspects of their language, such as syntax, semantics and pragmatics, are involved, and their response to treatment. They also differ in terms of their response to their impaired ability to communicate: some seem unaware of their lack of intelligibility; others withdraw socially or become overtly frustrated by their difficulty in making themselves understood.

Broomfield and Dodd's (2004a) incidence survey in the UK found that 6.4% of otherwise normal children had a speech disorder in the absence of any other sensory, cognitive or physical difficulty. Incidence is the number of new cases referred in a given population during a specified time (Enderby and Phillip, 1986). Prevalence figures ('the total number of people with [a disorder] at any one time in a given population', Enderby and Phillip, 1986, p. 152) for speech disorder range from 2% to 25% of the normal preschool/school population (e.g. Kirkpatrick and Ward, 1984; Enderby and Phillip, 1986; Shriberg et al., 1999; Law et al., 2000). To these children, whose disorder is specific to speech and/or language, must be added those whose speech difficulty is part of a more general handicap, such as hearing impairment or physical or intellectual disability. Chapter 5 describes the epidemiology of speech disorder, examining factors that might place children at risk: gender, socio-economic status, family history of communication impairment and family size.

There are, however, difficulties with most of the epidemiological data available. Different research groups use different criteria for the identification of speech disorder (Broomfield and Dodd, 2004b). In addition, the term ‘speech disorder’ encompasses a heterogeneous population. It includes, among others, children who have a lisp (i.e. misarticulation of /s/) but whose speech is intelligible, those whose speech is unintelligible due to omissions and substitutions of speech sounds in words but who can articulate all sounds perfectly in isolation, those born with an anatomical anomaly, such as cleft palate, who develop disordered speech despite surgical repair, children who have had earlier periods of impaired hearing but who currently have no hearing loss, children with motor speech disorders, children who have suffered emotional trauma and children from impoverished language-learning environments. Shriberg (2003, p. 502) argues that ‘accurate differential diagnosis of a patient’s disorder, including information on both original and maintaining causes, is necessary to determine the optimum form and content of treatment’. Despite consensus about the need for a classification system for developmental speech disorders (e.g. US National Institute of Health’s 2003 call for research on classification), as yet there is no agreed approach to classification that would allow better clinical management.

Approaches to the classification of speech-disordered children

Age of acquisition

In some cases, it is obvious at birth that a child is at serious risk for a later speech disorder (e.g. children with intellectual disability such as Down syndrome, those with hearing impairment, anatomical anomalies and physical disabilities, such as cerebral palsy). These are congenital disorders. Other children’s disorders emerge during the first years of life, when they fail to develop speech at the appropriate age, their errors are atypical of normal development or their rate of development is so slow that their phonology becomes delayed in comparison to that of their peers. Most children are referred for assessment of a speech disorder during their third or fourth year (see Chapter 5). This group is categorized as having a developmental disorder. In some cases, children whose speech and language development has followed a normal path acquire a speech disorder due to accident (e.g. head injury) or illness (e.g. meningitis leading to hearing loss). Thus, one major classificatory division is between congenital, developmental and acquired disorders.

Severity

A study of 20 speech-disordered children showed that the percentage of consonants produced correctly on a standard assessment ranged between 21% and 98% (Garrett and Moran, 1992). It seems obvious that one simple way of categorizing children with speech disorder is in terms of the severity of their disorder: mild, moderate and severe (Shriberg et al., 1997b). However, in most clinical reports the severity rating assigned is subjective and dependent on the clinician's experience. They have yet to agree criteria for labelling severity of a particular type of language sample (e.g. imitation vs. conversation vs. picture naming) in terms of the three major categories and their hybrids (mild-moderate and moderate-severe).

Some procedures provide arbitrary cut-off points between categories in terms of the number of consonants in error. Shriberg et al. (1997a) report that the percentage consonants correct (PCC) metric, calculated from a 5–10-minute conversational speech sample, is psychometrically robust. The results are categorized such that a PCC of > 90% indicates a mild classification, 65–85% indicates mild-moderate impairment, 50–65% suggests a moderate-severe impairment and < 50% indicates a severe speech disorder. Shriberg et al. (1997a) list concerns about the reliability and validity of the PCC metric. The speech sample obtained may be inadequate and, if conversational, certain highly frequent sounds (e.g. /s/) will be more heavily weighted. Omissions and substitutions will be weighted equally with distortion of speech sounds, although the three error types effect on intelligibility differs. Vowel sounds are not included; and there is a need for standardization data that take age and gender into account. While Shriberg et al. (1997a) provide data that alleviate some of these concerns, the PCC metric, although important in describing the level of difficulty, provides little useful information for differential diagnosis of subgroups of speech disorders.

The process of differential diagnosis was described by Peterson and Marquardt (1990) as the integration of information from the result of measurement of speech behaviour with contextual information (e.g. from case history and other professionals' reports) to identify the causal and maintenance factors specific to an individual's disorder. Identification of a cause–effect relationship allows the distinction between speech disorders that have similar surface characteristics, but differ in terms of prognosis (i.e. the need for and outcome of intervention), and the type of intervention that is appropriate. There seems to be no evidence that severity measures discriminate between subgroups of children with speech disorder in terms of the type of intervention indicated, or outcome.

Aetiology

The application of the medical model to the classification of communication disorders has a long tradition in speech and language pathology. It is important to identify the aetiology of a child's speech difficulty, if that is possible. A major diagnostic distinction is between those children whose disorder is caused by organic factors and those for whom no organic aetiology can be identified. This latter group is often described as having a 'functional disorder'. It is the role of physicians (and other professionals such as audiologists and clinical psychologists) to diagnose the disease states, neurological lesions and anatomical anomalies that disable the speech production mechanism (Perkins, 1977). In some cases the cause of the disordered speech is relatively easy to identify: hearing loss, anatomical anomalies (e.g. inadequate velo-pharyngeal closure leading to nasal emission), intellectual disability (e.g. Down syndrome) and neurological lesions leading to motor speech disorders (e.g. the dysarthria associated with cerebral palsy), or aphasia with phonological involvement. However, the proportion of speech-disordered children for whom a clear-cut organic cause can be identified is relatively small. Most children are eventually assigned to the 'functional' category (Gierut, 1998).

Shriberg (1982) argues that 'functional' is a default classification for children showing no significant deficits in structural, cognitive or psychological systems and that classification systems must be developed that include all children. He proposes that speech-disordered children should be diagnostically categorized in aetiological 'families':

- Speech mechanism (i.e. including subtypes where causality is associated with hearing, motor speech or craniofacial involvement).
- Cognitive-linguistic factors (i.e. including subtypes where causality is associated with general intellectual ability and receptive and expressive linguistic ability).
- Psychosocial factors (i.e. including both caregiver and school input, plus child-specific factors such as aggression and maturity).

The major difficulty associated with aetiological classification systems is that it is rarely possible to establish a single causal factor. Fox et al. (2002) attempted to categorize 66 speech-disordered children according to Shriberg's (1982) system. Around half the children were unable to be classified under any one of the causal factors listed. For example, in one case study of a phonologically disordered child (Leahy and Dodd, 1987), three possible causal factors were apparent:

1. The child had had a series of middle-ear infections during early childhood, and although several audiological assessments showed no significant loss, it was still likely that her auditory acuity fluctuated.

2. There was a strong family history of developmental phonological disorder that indicated a heredity factor.
3. Several environmental factors may have contributed to the disorder's maintenance (e.g. a highly verbal elder sibling who 'translated' for her sister).

While the notion of multiple causality is clinically important, classification systems that fail to discriminate between the majority of speech-disordered children are of limited usefulness for differential diagnosis and clinical management. Further, children with unintelligible speech sometimes become behaviourally disturbed (socially withdrawn or aggressive) or provoke changes in others (e.g. adults reducing the complexity of their language). By the time a child is referred for assessment of a phonological disorder, it is often impossible to determine causal from consequential psychosocial factors objectively.

More recently, Shriberg (2002) argued that emerging research predicts that speech disorder of unknown origin is genetically transmitted. It follows that there is a need for epidemiological data that allow the identification of phenotypes (symptomatology that might be associated with specific genetic anomalies). Shriberg (2002) is seeking acoustic phenotypes for six aetiological subtypes of child speech disorders of currently unknown origin: genetic alone, history of otitis media with effusion (OME), apraxia, dysarthria, psychosocial and residual errors. Speech disorder may have a genetic component (Felsenfeld and Plomin, 1997) and the search for phenotypes may allow gene therapy techniques in the future. Most speech disorders, however, can be effectively treated without knowledge about genetic status. As yet, however, there is no information about how genetic subtyping would alter clinical management of speech-disordered children. The difficulties apparent with the aetiological approach to classification remain unchanged.

Nation and Aram (1984) interpret the diagnostic process in a broader sense than is usually associated with a medical model, where symptomatology identifies an underlying cause that is then targeted in treatment. Although they emphasize the importance of understanding the range of aetiological factors that contribute to the onset of a disorder, as well as the role of current factors that contribute to its maintenance, they argue that diagnosis involves other essential processes. Client management involves evaluating evidence from a variety of sources and determining whether intervention is necessary and, if so, the form it should take. Such evidence must include a description of the speech disorder. Nation and Aram (1984) argue that the first goal of diagnosis is to determine the nature and extent of the speech disorder in terms of its variation from the norm in degree and type, as well as the effect of the disorder on the child. Description of speech disorders necessitates linguistic analyses.

Linguistic symptomatology

Early studies investigating classification systems based upon linguistic typologies yielded little information. For example, both Arndt et al. (1977) and Winitz and Darley (1980) tested large groups of children, seeking associations between speech errors and independent variables, such as measures of language, motor skills, auditory discrimination and oral stereognosis. Only one reliable association was found (i.e. between high-frequency hearing loss and fricatives). One explanation for the general failure to find reliable relationships between type of errors and other speech-related abilities is that the linguistic typologies used focused on which speech sounds were in error (i.e. a taxonomic analysis). The major difficulty with this way of describing errors is that whether or not a particular phoneme is in error is often dependent upon its phonetic context. Consider the examples below:

[pun]	spoon	[soʊ]	snow
[tɒp]	stop	[sɪŋ]	swing
[kɪp]	skip	[sɪpəz]	slippers

A taxonomic analysis would result in /s/ having an error rate of 50% and would allow no prediction of when /s/ would be deleted. An alternative method of description that focuses on error patterns specifies how, and in what phonetic context, a particular phoneme or group of phonemes will be in error. For the examples above, a phonological error pattern analysis would state: ***in /s/ plus C (consonant) clusters, if C is a plosive then /s/ deletes, but if C is a continuant, C deletes***. Such statements are precise and allow prediction of how words not in the sample would be produced.

The terms ***phonological process*** and ***phonological rule*** often used to describe phonological error patterns are currently used less frequently. The terms tended to be used inconsistently in the literature. For example, Fey (1992) uses the terms as synonyms, whereas Elbert (1992) defines a 'phonological process' as a 'systematic sound change that effects a class of sounds' and a rule as 'a formal statement of a process' (p. 235). The use of the terms is also associated with generative phonology, a theoretical account of phonological development and disorders that is no longer widely held (Stemberger, 1992). The regularities or 'patterns' in children's speech are now often considered to be due to other mental operations rather than to children's active hypothesis formation about phonology, which was a tenet of generative phonology (Stoel-Gammon, 1992a). In this book, we will generally refer to 'error patterns' as descriptions of the regularities in children's phonologies.

Phonological error pattern analyses have been used to describe normal developmental errors of young children (e.g. Smith, 1973), children with functional speech disorders (Compton, 1970; Broen, 1982; Dunn and Davis, 1983) and groups of children with impaired hearing (Dodd, 1976b) and intellectual impairment (Dodd, 1976a). Many children's speech errors can be described by patterns that are typical of those used by younger children who are acquiring phonology normally (Leonard, 1973). That is, their errors reflect delay, rather than disorder. Other children produce systematic errors that are bizarre (Dunn and Davis, 1983; Leonard, 1985). Examples of such error patterns are: *the omission of all word initial consonants* (Shriberg, 1982), *the marking of all intervocalic consonants with a glottal stop, and marking consonant clusters with a bilabial fricative* (Leahy and Dodd, 1987). These error patterns do not usually occur during typical phonological acquisition (see Chapter 2) and can therefore be classified as atypical or non-developmental (see Appendix 1 for a list of typical developmental error patterns and some common phonologically disordered error patterns). Another subgroup of children with phonological disorder has also been identified by clinicians. These children make inconsistent errors, so that every time they say a word it may be pronounced differently (e.g. umbrella as [ʌbwɛlə], [ʌmbɛdə] and [ʌmbɛlə]). It is not possible to describe inconsistent errors in terms of specific phonological patterns, although sometimes general patterns can be identified (e.g. inconsistency affects only alveolar sounds). Children who make inconsistent errors are sometimes classified as having apraxia of speech in childhood (e.g. Forrest, 2003, but see Chapter 4).

Dodd (1995) proposes a classification of subgroups of functional speech disorders.

1. *Articulation disorder*: an impaired ability to pronounce specific phonemes, usually /s/ or /r/, the child always producing the same substitution or distortion of the target sound in words or in isolation irrespective of whether the sound is spontaneously produced or imitated. That is, the child has a phonetic disorder.
2. *Phonological delay*: all the error patterns derived to describe a child's speech occur during normal development but are typical of younger children.
3. *Consistent phonological disorder*: consistent use of some non-developmental error patterns. Most children who use non-developmental rules also use some developmental rules that may be appropriate for their chronological age, or delayed. They should nevertheless be classified as having a consistent disorder, since the presence of unusual, non-developmental error patterns signals impaired acquisition of the phonological system's constraints.
4. *Inconsistent phonological disorder*: children's phonological systems show at least 40% variability (when asked to name the same 25 pictures

> on three separate occasions within one session). Multiple error forms for the same lexical item must be observed since correct/incorrect realizations may reflect a maturing system.

Table 1.1 provides a summary of research into the prevalence of the subgroups in English and other languages. Around half of speech-disordered children have delayed phonology, a quarter consistently makes some atypical errors and the remaining quarter is equally distributed between articulation and inconsistent disorder.

Table 1.1 Subgroup prevalence across languages

		% Children Identified			
Language (N)	*Reference*	*Articulation*	*Delay*	*Consistent*	*Inconsistent*
English (55)	Dodd et al. (1989)	14	56	12	16
English (320)	Broomfield and Dodd (2004b)	12.5	57.5	20.6	9.4
Cantonese (17)	So and Dodd (1994)	11.8	47.1	29.4	11.8
German (84)	Fox and Dodd (2001)	5	61	20	14
Mandarin (33)	Zhu Hua and Dodd (2000b)	3	55	24	18
Spanish (20)	Goldstein (1995)	10	65	25	not assessed

Classifying children in terms of their surface phonological error patterns has clinical potential. The same subgroups are identified, irrespective of the language learned, giving the classification system cross-language validity. Stackhouse and Wells (1997), however, argue that each child's phonological difficulty is unique.

Psycholinguistic deficits

The ability to learn how to speak intelligibly is dependent upon a complex set of mental operations. Even a simple model of the speech-processing chain requires that children be able to: hear, discriminate relevant (language-specific) phonemic distinctions, store words accurately in short- and long-term memory, adduce the regularities of the phonological system being learned (e.g. that /ŋ/ does not occur word initially in English), apply phonological and phonetic constraints in planning speech output, and execute complicated fine-motor actions accurately.

The advent of psycholinguistic models of the speech-processing chain has provided a way for researchers to map the interactions between input, the cognitive-linguistic mental processes organizing verbal units and output. Baker et al. (2001) argue that psycholinguistic models can also influence clinical practice and offer a new way of conceptualizing speech impairment. Models of the speech-processing chain vary in complexity. For example, Grundy (1989) offers a simple model for the explanation of functional speech disorders: they may be either articulatory (a disorder of phonetic speech production) or phonological (a linguistic disorder). Phonological disorder may result from the impaired operation of the mental processes serving ‘either the productive, or the perceptive, or the organizational mechanisms of speech’ (p. 257). The model, however, does not provide information concerning the type of disordered phonology associated with breakdown at each of the three levels.

Winitz (1975) identifies five levels of breakdown in the speech-processing chain:

1. *Auditory input*: including hearing impairment, impaired discrimination between speech sounds or an impoverished language-learning environment.
2. *Phonological*: an impairment of attention, reasoning or memory, or low motivation leading to a linguistic disorder in abstracting the phonological constraints of speech production.
3. *Systematic phonetic*: a breakdown between the phonological system and the articulatory system where the phonetic specifications for speech-sound production are inaccurate (i.e. the blueprint or template for production of a particular sounds would result in distorted articulation, such as a lisp).
4. *Articulatory planning*: an impaired ability to formulate sequences of speech sounds that make up an utterance (i.e. childhood apraxia of speech).
5. *Motor execution*: an impairment of motor execution due to peripheral neurological dysfunction (i.e. dysarthria).

The levels identified do not operate as discrete units; rather, they interact with one another through feedback loops. The strength of Winitz’s (1975) model is that it discriminates between broad categories of speech disorder (articulation, phonology, dyspraxia and dysarthria). The problem is that most speech-disordered children fall into the phonological category. There is a need for a model that explains the differences between phonologically disordered children.

Stackhouse and Wells (1997) developed a framework that linearly lists the abilities underlying speech production (see Figure 1.1). An impaired ability to carry out one of the mental operations included is argued to affect speech output. Stackhouse and Wells’s (1997) approach relies on thorough assessment, based on their psycholinguistic framework, that identifies each child’s strengths and weaknesses in the speech-processing chain. The deficits then become the focus of therapy.

While this approach has theoretical strengths, the diagnostic process is lengthy and not readily applicable in a clinical setting. As Stackhouse and Wells (1997) point out, further ‘studies of speech processing in normally

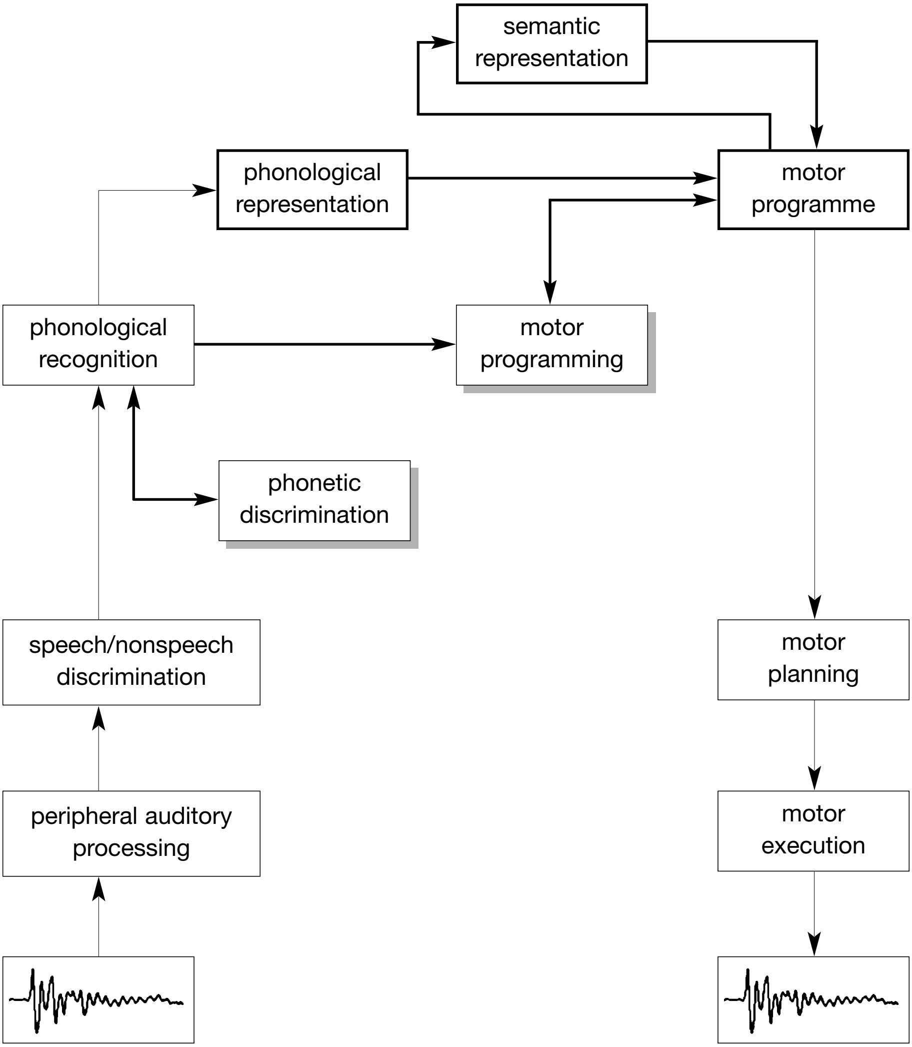
semantic representation
phonological representation
motor programme
phonological recognition
motor programming
phonetic discrimination
speech/nonspeech discrimination
motor planning
peripheral auditory processing
motor execution

Figure 1.1 Stackhouse and Wells's (1997) model.

speaking children are essential for understanding the nature of speech ... problems in children' (p. 336). More research is needed to describe when typically developing children acquire the mental operations included in the psycholinguistic framework. Some of the skills identified in the framework are not well developed in young children (e.g. phonological awareness). Two other problems are apparent: evidence is needed concerning the model's predictive power (i.e. outcome of intervention for specific profiles of deficit), and, from a clinical perspective, Stackhouse and Wells's rejection of any classification system for speech disorder is problematic. If every child presents with a unique speech disorder, then it is difficult to develop and evaluate intervention approaches. Given that around 70% of children on a paediatric caseload will have a speech difficulty, not being able to easily discriminate between subgroups of disorder complicates clinical decision-making (e.g. prioritization for intervention, planning length of episode of care). Research evidence is needed concerning all approaches that classify or account for speech disorders.

Approaches to explanation of speech disorder

Describing speech-disordered children in terms of severity, age of acquisition, causal factors or linguistic symptomatology is unsatisfactory. None of these approaches explains speech disorder (i.e. describes the mental operations that result in speech difficulties). An important strength of the psycholinguistic approach is that it potentially allows a range of interactive deficits that can underlie speech disorder. However, while the complexity of the speech-processing chain makes it logically imperative to assume that speech production can be impaired in a variety of ways, researchers often favour one-dimensional explanations. There seem to be three categories of explanation:

1. *Oro-motor skills*: children gradually master the intricacies of sequencing complex articulatory movements (e.g. Green et al., 2002). That is, developmental and speech disordered errors reflect limited oro-motor control (Hewlett, et al., 1998) which may reflect a more general motor immaturity.
2. *Input skills*: children gradually master the ability to discriminate differences between speech sounds of their native language (e.g. Edwards et al., 2002). Some children fail to learn to perceive differences the phonetic differences between sounds (Tallal and Piercy, 1973), leading to pronunciation and language difficulties.
3. *Cognitive-linguistic ability*: children's ability to process accurately perceived speech information changes over time. Different candidate processes have been identified: phonological working memory (Adams and Gathercole, 2000), lexical representation (Elbro, 1993) and phonological constraint derivation (Dodd and Gillon, 1997).

Oro-motor skills

Developmental errors and phonologically disordered errors may be linked to children's ability to plan and execute complex sequences of fine oro-motor movements required for the articulation of speech. Some developmental phenomena, however, provide counter evidence. Smith (1973) reports a common occurrence in the development of phonology where a child can pronounce a word's sound sequence correctly but only when the target is another word. For example, *puddle* realized as [pʌgəl] but *puzzle* pronounced as [pʌdəl]. Another well-documented phenomenon is the ability of children to imitate words correctly that they produce spontaneously in error. For example, [glædɪs] for *Gladys* in imitation, but [dædi] in spontaneous speech (Dodd, 1995). Cross-linguistic studies of phonological development provide additional counter evidence. For example, affricate speech sounds [tʃ, dʒ] are argued to be acquired late by English-speaking children because of the oro-motor complexity of their articulation. However, Putonghua-speaking children acquired both sounds very early, perhaps because of their salience in Putonghuan phonology (Zhu Hua and Dodd, 2000a).

Such examples suggest that oro-motor limitations cannot be the sole explanation for developmental errors. Despite this, recent research based on the oro-motor hypothesis (McCune and Vihman, 2001) argues that production skills established in the babbling stage influence the phonetic realization of early words. They claim that children establish 'vocal motor schemes' that are automatic plans for consonants that influence the error types made in early development. The data cited, however, are limited to first words and show considerable individual variation for the 12 children studied who were under two years of age. McCune and Vihman (2001) hypothesize that the phonetic templates established for first words are gradually expanded to provide plans for words using additional consonants and a variety of syllable structures.

An oro-motor account for errors made by speech-disordered children is more complex. Children with dysarthria, childhood apraxia of speech and anatomical anomalies such as cleft palate have obvious articulatory difficulties. Nevertheless, these children are a small proportion of children with speech difficulties. Most children have 'functional' difficulties that are unexplained by neurological, anatomical or intellectual impairment. Studies using electro-palatography (EPG) have shown that some children make articulatory distinctions between sounds that are heard as identical. For instance, the pattern of contact between tongue and palate in the production of /t/ and /k/ is consistently different even though both are perceived as /t/ (Hewlett et al., 1998). Such substitutions, however, account for only a proportion of disordered errors. Children also omit sounds and syllables, have constrained syllables (e.g. where all word initial sounds are realized as /h/) and make inconsistent errors (where one target word can be realized by a different number of syllables, and a variety of syllable shapes and sound sequences).