An Chomhairle Náisiúnta um Oideachas Speisialta
National Council for Special Education

EVIDENCE OF BEST PRACTICE MODELS AND OUTCOMES IN THE EDUCATION OF DEAF AND HARD-OF-HEARING CHILDREN:

AN INTERNATIONAL REVIEW

By

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The National Council for Special Education was established under the Education for Persons with Special Educational Needs Act 2004 (EPSEN Act 2004) with effect from the 1st October 2005. The Council was set up to improve the delivery of education services to persons with special educational needs with particular emphasis on children.

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Note: Throughout this report, the symbol ♣ is used to set off text specifically related to Ireland, including observations from a site visit in November 2008. Those sections can be found quickly by searching the electronic version of the report.

For the deaf children of Ireland: Go raibh rath is séan oraith.

Foreword

The National Council for Special Education (NCSE) was formally established in 2005 under the Education for Persons with Special Education Needs Act 2004 (EPSEN) to improve the delivery of education services to persons with special educational needs, with particular emphasis on children.

Commissioning, conducting and publishing research to provide an evidence base to support its work are key functions of the NCSE. It is now widely acknowledged that research evidence has a very valuable role to play in the development of policy and practice. Reports from the NCSE research programme, including this one, will be key sources, amongst others, that will assist the NCSE in carrying out its work and in developing policy advice to the Minister for Education and Science on special education matters, another of the NCSE's statutory functions. The reports will also assist in identifying and disseminating to schools, parents and other appropriate stakeholders, information relating to best practice concerning the education of children with special educational needs.

This research report was commissioned to provide the NCSE with an international review of the literature relating to best practice in the education of deaf and hard-of-hearing children. The researchers have systematically compiled key lessons from a very broad range of international literature, and in addition, they have drawn from a study visit to Ireland which were undertaken as part of the review process. They have also identified a number of recommendations and implications arising for the Irish context, which the NCSE will now need to consider in carrying out its work and in developing its own policy advice to the Minister for Education and Science.

Pat Curtin,

Chief Executive Officer

National Council for Special Education

Glossary

Acoustic(s) – relates to the physical properties of sounds, in contrast with *auditory*[1], which refers to the sensation of sound as it is heard.

Amplification – Device that increases the level (or volume) of sounds so that they might be more easily heard by persons with hearing loss. Loudspeakers provide amplification and the term "personal amplification" is often used to refer to hearing aids.

Analogical Reasoning/Analogy – A logical process in which an individual assumes that because two things are alike in some respects, they will be similar in another; comparing things by focusing on their similarities.

Articulation – The way in which muscles of the speech production system move together to produce speech sounds; sometimes used to refer to the way in which hand/arm and related movements are coordinated to produce signs.

Associate Degree – A degree awarded by a post-secondary institution (in the US, usually a two-year college) for completing a specified course of study. These degrees are typically for professional or para-professional preparation.

Attachment (parent-child) – An enduring emotional bond between child and parent, often characterized as "secure", "avoidant", "insecure/ambivalent", or "disorganised/disoriented." Infants and toddlers who give evidence of secure attachment to caregivers generally show developmental advantages and use their attachment figure for reassurance in distressing or uncertain situations.

Auditory/Audition – Hearing or related to the sensation of hearing sounds.

Audiologist – Healthcare professional specialising in identifying, diagnosing, treating and monitoring disorders of the hearing and balance functions of the ear

[1]Words in italics have separate entries in this glossary.

Auditory Evoked Response Test (AER) – Hearing test in which EEG leads (sometimes called electrodes) are placed on the scalp to record specific brain waves that occur in response to sound. Brain waves in response to repeated sounds are "averaged" in order to determine a pattern that shows the level or volume necessary for a sound to be heard. The lowest sound level at which an AER can be obtained is used to estimate hearing sensitivity.

Auditory-Verbal Therapy (AVT) – An approach to building deaf and hard-of-hearing children's spoken language skills by focusing on listening and auditory input, especially during toddler and pre-school years. Visual communication is de-emphasised. This is a form of speech and language therapy and was not designed as an approach to providing information in educational settings.

Auditory Training – Specific training/therapy for learning to listen and for developing awareness and recognition of sounds, especially speech sounds. Typically provided by specially-trained and certified speech/language therapists, audiologists, or teachers of deaf/hard-of-hearing students.

Augmentative/Alternative Communication (AAC) – Devices used for communication by individuals with severe speech and spoken language disabilities, often persons with cognitive or motor disabilities. AAC is sometimes used to indicate use of gesture and even signs, but in this report it refers to use of pictures, communication boards, and similar devices.

Autism Spectrum Disorder (ASD) – A set of organically- or neurologically-based developmental disorders that include difficulties in communication (verbal and non-verbal) and social (relating to others) development, as well as production of stereotypical repeated actions and excessive need to follow routines. Symptoms typically appear by 18 months of age. Intellectual abilities and the severity of symptoms vary greatly across individuals.

Automaticity – The ability to do things without occupying the mind with the low level details required. It is usually the result of learning, repetition, and practice.

Auxiliary – A "helping verb" that helps to define the mood or tense of another verb to which it is linked. In English, these include but are not limited to "can", "may", "will", "shall", "must", "ought", "be", "have", "do".

Bilateral (hearing loss) – Refers to both sides, thus hearing loss in both ears.

Bilingual-Bicultural (or Sign/Bilingual) Programme – Educational approach for deaf children in which a *natural sign language* is modeled and expected to be the child's first language and primary means of communication, as well as to serve as the classroom language and provide a bridge to learning literacy (primarily in print form) in the hearing community's spoken language.

Canonical (Play) Sequences – Sequences of play behaviors that are produced in a specific, realistic order. For example: pretend to pour tea in cup, pretend to add a spoonful of sugar and stir, then raise cup to mouth as to drink.

Captions/Captioning - Text display of spoken words presented on a television, movie, computer, etc., screen to allow a deaf or hard-of-hearing viewer to follow the dialogue and the action of a program simultaneously.

Case Manager – Person who coordinates the services provided for an individual by multiple specialists.

Cochlear Implant (CI) – A device with both externally worn and surgically implanted parts that provide electrical stimulation to the hearing nerve endings (neurons) in the inner ear. The electrical stimulation of nerve endings is interpreted by the brain as sound. CIs can provide access to sound frequencies (or pitches) for which a hearing aid would be ineffective for persons with severe-profound hearing loss.

Co-enrolment - Placement of hearing and deaf students in the same classroom, but one in which a significant proportion of students (typically 30% or more) are deaf. A team of two or more teachers usually work with the class.

Cognition (Verbal or Nonverbal) – Thinking and problem-solving skills. May be used to refer to memory, sequencing abilities, integrating or relating varied information, envisioning solutions to problems, and other advanced abilities whether supported by language or non-language knowledge and skills.

Cohesion (Linguistic) – Use of grammatical and semantic elements that relate one idea of one statement to another in *discourse*.

Cohort – A group of individuals with at least one characteristic in common. For example, persons within a limited age group can be referred to as a cohort, or students who share a specific need can compose an educational cohort.

Co-morbidity – The presence of one or more disorders in addition to another disorder.

Complement Structures – In linguistics, usually refers to a sentence structure in which the words following the verb further define or tell something necessary to the sentence about the subject. Examples of sentences with subject complements include "Mr. Johnson is a teacher;" "He seems grouchy." Complement structures can also refer to objects of the verb in the sentence, as in, "They elected him class president."   Complements can also be clauses (that is, have their own subject and verb) as in "I know that she is intelligent."

Congenital – Present at birth but not necessarily genetic in origin; typically used to refer to hearing loss that is present at birth.

Copula – A "linking verb" such as a form of the verb "to be" ("is," "were") or "seem."

Correlational Research Designs – Research based on quantitative or numerical measurements, using procedures for identifying the presence and strength of association between sets of measurements.

Cued Speech (CS) – A system of manual signals (a specific set of hand shapes produced at specific locations around the face/upper body) that represent visually the *phonemes* or sounds of spoken language. Initially conceived as an aid to speechreading, it has been used in educational settings and, with modifications, to accompany various spoken languages.

Cytomegalovirus (CMV) – A virus related to the herpes virus that is common in most populations and frequently has no symptoms in healthy adults. It can cause hearing loss and other disabilities if contracted by a mother for the first time during her pregnancy and passed on to the infant at birth. Symptoms do not always appear immediately and the hearing loss may be *progressive*.

Deaf – (1) Audiologically, the condition of having a hearing loss in the severe-to-profound or profound range; (2) A member of a community that uses a Sign Language and shares a common bond of identity. When used to indicate a community or its members, the first letter of the word "Deaf" is capitalised.

Decibels (dB) - A measure of the level or volume of a sound. Hearing sensitivity can be measured in terms of decibels. Persons with "normal" hearing have hearing threshold (the lowest level at which sound is heard) close to 0 dB. Whisper is typically produced at about 15-25dB, and the level of a typical spoken voice message measures 65-70dB.

Decoding – Procedures used to figure out the meaning of a printed word not immediately recognised. Strategies to assist decoding include (a) *semantic*, or based on the meaning of other surrounding words, (b) *phonetic*, or based on knowing typical pronunciation of the letters in the word, (c) *syntactic*, based on knowledge of typical sentence structures.

Degrees (of hearing loss) – Refers to the level of sound needed for a person to perceive *auditory* information. Averaged over different frequencies, degrees of hearing loss are typically classified as "mild" (threshold at 26-40 db and difficulty hearing soft speech except in quiet settings), "moderate" (41-55db threshold and difficulty hearing most conversational-level speech, especially in noisy environments), "moderate-to-severe" (56 - 70 dB threshold and difficulty hearing speech unless it is very loud; with special difficulties in groups), "severe" (71-90dB threshold and inability to hear spoken conversations without amplification), "profound" (91+ dB threshold and typically inability to understand speech from listening alone, even when using amplification) .

Demographics – Characteristics of a population or a group, including but not limited to such aspects as age, ethnicity, gender, socio-economic status.

Discourse Rules– Discourse refers to a fairly extended communicative discussion or exchange; discourse rules, in part, represent expectations and conventions for turn taking in communicative exchanges.

Dyadic (Conversations/Interactions) – Involving two persons; often referred to when discussing mother-infant or parent-child interactions.

Dyslexia – A learning disability that is manifested by difficulties reading and spelling. It is not necessarily associated with hearing loss or with cognitive disabilities but is assumed to be neurological in origin.

Education for Persons with Special Education Needs Act of 2004 (EPSEN) – Legislation in Ireland that provides for education of persons with special education needs in an inclusive educational environment whenever possible and assures the rights of persons with special needs or disabilities to receive an education equal to that provided students in regular or general education.

Emergent Literacy – Characterises young (typically ages birth to 5 years) children's earliest reading and writing development prior to beginning formal literacy instruction.

Etiology – A cause or origin. Regarding hearing loss, an etiology could be genetic, an illness, or an environmental factor such as noise or a specific medication.

Evoked Otoacoustic Emissions Test (EOAE/OAE) – A non-invasive method that can be used to screen for hearing loss in the newborn infant period later. EOAEs are recorded by placing a small microphone in the external ear canal. The microphone records the sounds made by the inner ear when a stimulus sound is heard. EOAE testing is sensitive to hearing losses exceeding 35 dB, so this test is used to screen for hearing loss at that level or greater.

Experimental Project in Instructional Concentration (EPIC) – An intensive and highly-structured oral language training program developed at the Central Institute for the Deaf, St. Louis, Missouri, USA, during the 1980s to promote expressive and receptive language development of deaf and hard-of-hearing children.

Expressive Language – Production of language, including presentation through speech, signs, or writing.

False Positive Screening Results – Detection of something that is not truly present. In this situation, false positive screening results are those that indicate presence of a hearing loss that is, with further testing, found not to exist.

Fingerspelling – Using specific finger and hand shapes to represent letters of the alphabet and so to spell out words. The systems differ across cultures and sign(ed) languages. For example, the system used in the US represents all letters using only one hand while that in the UK uses both hands.

General (Regular) Education – Educational procedures and context initially designed for students without identified disabilities, that is the "general" population.

Gestational – Relates to the period of time during pregnancy and before the child's birth.

Gesture – Using movement of body, especially hands and arms, or face to express emotions and general meanings. This is distinct from use of signs or Sign Language in which hand and body movements represent specific units of language and have linguistic meaning.

Grammar/grammatical – Refers to rules by which language structures are ordered and combined. This general term includes *morphology* and *syntax*.

Grapheme – The basic unit in a written language: an alphabetic letter, a punctuation mark, or a numerical digit. In some *logographic* languages such as Chinese, a grapheme can represent an entire word.

Hard-of-Hearing – Generally used to refer to a hearing loss at a level that significantly limits but does not preclude perception of spoken language through audition alone. This term includes most people with hearing loss from mild to the severe range.

Hearing Aid – An electronic device that increases the volume or loudness of a sound to assist the wearer in hearing it. Contemporary hearing aids can be programmable and individualise the amount and frequencies (pitches) or sounds amplified as well as reduce background noise and electronic feedback.

Hearing-Impaired – Used by some persons to refer to the condition of having any level of hearing loss, although most typically in the range from mild to severe that is also called *hard-of-hearing*. Many persons who self-identify as members of a Deaf Community consider this term to have negative connotations.

Hearing threshold – The level expressed in *dBs* required for an individual to be aware of a specific sound.

Hierarchical Multiple Regression Analysis – Statistical analysis that measures the degree of relation or association between a predictor variable or factor (or a group of them) and an outcome variable or factor. When the analysis is hierarchical, the strength of association between one variable and an outcome variable is considered in light of the other associations.

Iconicity/Iconic – Signs, symbols, or gestures that "look like" the thing to which they refer.

Incidental Learning – Learning that occurs without apparent effort or reinforcement. Incidental learning often occurs when activities are observed taking place or when language is overheard .

Inflections/Inflectional Morphemes – A *morpheme* added to a word that changes its function. English has eight inflectional morphemes: -s (plural) and -s (possessive) are noun inflections; -s (3rd-person singular), -ed (past tense), -en (past participle), and -ing (present participle) are verb inflections; -er (comparative) and -est (superlative) are adjective and adverb inflections.

Inclusion/Inclusive (Educational Placement or Setting) – Refers to a philosophy of educating all students together in regular or general education settings regardless of the presence or absence of disabilities. The philosophy and policies which support it assume that methods and services will be used to provide for the varied learning needs of individual students.

Individualised Education Plan (IEP) – A written plan establishing an individual student's learning needs and expected achievements, as well as programming methods and support services to accomplish those outcomes. IEPs are prepared for each student with special learning needs based on detailed assessment of current skills and learning styles. They are typically the product of a team of educators, parents, other service providers, and (when appropriate) the student him- or herself.

Integration/Integrated (educational settings) – Refers (similarly to *Inclusion*) to educational settings in which students with disabilities participate in the same classrooms, schools, and educational activities as students without disabilities.

Interpreting/Interpreter – The process of translating between a spoken and signed language; the person who provides the translation.

Intervening Variables – A factor that is an intermediate or additional cause of an outcome; especially important when overlooked and not included in an analysis thus leading to a false conclusion about relations or associations between the variables that are included.

Intervention – A treatment or procedure the goal of which is to increase learning or to improve functioning.

Learning Disability – Specific disability that is thought to be organic or neurologically-based and affects an aspect of an individual's learning (especially language, sequencing, attention, or memory) despite otherwise typical intelligence or learning abilities. In some countries, the term is used more generally to refer to any type of learning difficulty, including those caused by cognitive limitations.

Lexicon – The vocabulary of a specific language or the items within an individual's vocabulary.

Literacy – The ability to use language to read or write.

Logographic – A written language such as Chinese or Japanese in which a *grapheme* or single symbol can represent a *morpheme* or a whole word. (Phonetically-based written representations also exist in these languages.)

Mainstreaming (Education Model) – A pattern of school placement in which children with disabilities attend a public school for part or all of the school day, sometimes in regular education classrooms with students without disabilities and sometimes in special classrooms within a regular or general education school.

Manually-Coded (Sign Systems) – Systems for signing in which many signs are "borrowed" from a naturally-existing sign language and others are created artificially to represent grammatical morphemes or other meaning units needed to allow signing to replicate the order of production and the syntax of a spoken language. These systems are not official languages, but have been used extensively in education of deaf children and are often accompanied by speech. They include Signed English, Signed Dutch, Signed French, etc.

Mean – The mathematical average of a group of numbers or scores.

Median – The middle value of a group of numbers or scores. One-half or 50% of the scores will fall below this number.

Mode/Modal – The value or number that occurs most frequently within a group.

Memory Processes – Mentally storing and retrieving information. Images or information can be kept in "short-term" memory for about 20 seconds and can be used in "working" memory to be further examined or processed. Information can be stored in "long-term" memory for indefinite periods, but retrieving that information can become more difficult with time.

Metacognition/Metacognitive – Individuals' awareness of their own mental processes and the subsequent ability to monitor, regulate, and direct those processes. This may be thought of as the ability to "think about thinking."

Metalinguistic/Metalinguistics – The ability to think about language, to comment upon it, to understand and articulate its rules.

Middle School – In the U.S., a school for students in 6-8th grades, approximately ages 12-14.

Minimal Hearing Impairment (MHI) – Hearing loss from 16 – 40 dB, thus falling within the level previously thought to be within the "mild" or even the "normal" range. MHI is also used to refer to *unilateral* hearing loss. Children with MHI may be at higher risk for language and educational difficulties than children with no measurable hearing loss.

Modified Directed-Reading Thinking Activity (MDRT) – A teaching procedure for increasing students' reading comprehension skills through activities prompting prediction, verification of prediction, judgment, and expanded application of ideas to other contexts and situations.

Monograph – A scholarly book, usually fairly short, that focuses on a single topic or related group of topics.

Morpheme – A word or part of a word that cannot be divided into a smaller meaningful part. Examples in English include some nouns ("hat") and other words that can stand alone ("of") and some grammatical units that are attached or "bound" to other words--such as the "-s" indicating plural and the "-ed" indicating past tense.

Narrative Structure – The sequence of events in a story: typically an introduction, presentation of a problem or difficulty, events leading to its resolution, and a conclusion.

Natural (or Native) Sign Language – A "true" Sign Language that has developed within a cultural group of Deaf persons over time. These languages (which include but are not limited to American Sign Language [ASL], British Sign Language [BSL] and Irish Sign Language [ISL]) are naturally adapted to production and perception characteristics of visual and manual modes. Their syntax systems (sign order and methods of expressing modifiers and other grammatical meanings) differ from those of spoken language, making simultaneous production with spoken language impossible.

Neonate/Neonatal – An infant from birth through the first 4 weeks or month of age.

Null Results/Findings – Instances in which a research procedure fails to find expected differences among groups or, conversely, fails to find a significant association or correlation between groups on characteristics or scores that are measured. May be referred to as "no statistically significant difference" or "no significant relation/correlation" among variables.

Oral-Motor Coordination – Coordination of movements of muscles used in eating, swallowing, and production of vocalizations and speech.

Orthography /Orthographics – Representation of the sounds of a language in written/printed form.

Pedagogy/Pedagogical – Principles, methods or activities in teaching or instruction.

Peer Review – A scholarly process in which independent reviewers, typically experts in the field, evaluate the value of a manuscript or article. In general, journals and other periodicals that use peer reviews to guide acceptance of submitted papers receive greater scholarly respect and resulting publications are thought to be of higher scholarly quality than those not using peer review.

Perception – The awareness or understanding of something received through one or more senses. *Auditory* perception is the ability to identify and attach meanings to sound.

Peripheral Visual Field – The portions of what an individual sees that are on the periphery or the outside areas, farthest from the center of focus.

Phonics – Associating letters or groups of letters with the sounds or *phonemes* that they represent. A skill often taught for young hearing children to use in learning to read and pronounce written words.

Phonology/Phonemes – The system of sounds that make up a language and the rules for their combination. Individual sound units specific to a language are referred to as "phonemes". However, "phonology" is also sometimes used to refer to the system of visual/manual units that make up a Sign Language.

Pragmatics – The aspect of language that refers to its functional use. This includes knowing rules for turn taking during communication, understanding the intentions of a speaker's messages, and deriving meaning from language based on the context in which it is produced and received.

Progressive (Hearing Loss) – A hearing loss that becomes more severe or more pronounced over time.

Qualitative Research – Research that, instead of being based on quantitative measures to test a specific hypothesis, is open ended, descriptive and conducted in naturalistic environments. Such research typically focuses on identifying processes and the meanings various persons ascribe to an event or phenomenon instead of focusing on outcome measures. Data are often based on careful and extended observations, interviews, case studies, or life histories. Initially most often used in sociology and anthropology, qualitative research has increased in education and special education since the 1960s.

Randomisation – A method of assigning subjects, participants, or students to various experimental groups in which each individual has an equal chance to be placed in any specific group. See *Randomised Clinical Trials*.

Randomised Clinical Trials (RCTs) - A research study in which participants are assigned randomly (by chance) to separate groups, with and without a specific intervention. Neither participants nor the scientists, educators, or medical personnel involved should know whether a participant is in the experimental group which is receiving the treatment being studied.

Raven's Standard Progressive Matrices – A test of non-verbal cognitive skills that requires abstract reasoning based on visual (pictured) items. The "Standard" test is the first that was devised. There are also "Coloured" and "Advanced" versions.

Real Time Text – Immediate (within a second) typing of or transferring to print language that is being spoken. This allows text to be used in *captioning* or in a "conversational mode" like voice.

Receptive Language – The ability to understand language.

Relational Processes – Cognitive processes or problem solving in which attention is paid to two or more dimensions or ideas and the relations or associations among them.

Reliability – The degree to which a test or measurement will produce the same or highly similar results over various trials.

Research designs – Specific plans for the structure and conduct of a research study.

Rime – Words or syllables that rhyme.

Scaffolding behaviours – Adult behaviors (especially between parent and child or teacher and child) that prompt or promote increasingly sophisticated behaviors from a child.

Schematic Representation – A structural diagram, especially one that uses pictures or drawings to show how a process or procedure occurs.

Semantics – Meanings of words and longer expressions (sentences, paragraphs) in language.

Sequential Processes (Memory) – Remembering and recalling items occurring or presented in a specific order.

Sensory Integration - A neurological process by which information received by various senses is associated or organised, and an organised response or output behavior is produced.

Shared Reading – An approach in which an expert reader (parent, teacher, etc.) models, in a highly interactive way, reading a book or similar material with a relatively unskilled (usually young) beginning reader.

Sign Bilingual Programme – (See *Bilingual-Bicultural*)

Simultaneous Communication (SimCom) – Use of signs produced simultaneously or nearly-simultaneously with speech. Often referred to as *Total Communication (TC)*, but see below regarding important distinctions.

Single Subject Intervention Design – Assessment or research plan focused on an individual or an individual case (such as a classroom). Changes in a target behavior are measured, recorded, and compared over time when an intervention (for example, a new curriculum approach) is conducted.

SNA – Special Needs Assistant

Soundfield Frequency-Modulated (FM) Systems – An *amplification* system in which the speaker uses a microphone that broadcasts his or her voice through a wireless transmitter to a receiver in a hearing aid worn by an individual. FM systems are used frequently in classrooms to allow a student to hear the instructor's voice better. The microphone-to-receiver transmission of the speaker's voice reduces interference from background noise.

Speechreading – Using visual perception of movements of a speaker's mouth and other facial expressions and movements (in combination with underlying understanding of the language that is being produced) to interpret a message being spoken. This is sometimes referred to as "lipreading." It has been estimated that only about 30% of the sounds of English can be perceived and identified using this approach alone.

Standard Deviation – A measure of how "spread out" or varied a group of data or numbers is. One standard deviation below or one above the mathematical average (or mean) should contain 34% of the numbers or scores in a group.

Symbol/Symbolic – Something that represents something else through convention or mental association. For example, language consists of symbols that represent objects, actions, and ideas. "Symbolic play" includes use of imagination or pretend in which actions are mentally planned and sequenced or in which one object stands for or represents another.

Syntax/Syntactic – Rules for the orderly and ordered combination of words and meaning elements or *morphemes* of a language to produce sentences and longer connected units.

Tactile – Transmitted through the sense of touch or sensation of vibration.

Temporal – Related to time or changing with time.

Theory of Mind (ToM) – An individual's ability to understand what another person will think - or to attribute mental states such as knowledge or emotion to another person.

Total Communication (TC) – An educational philosophy that makes use of all potential sources of linguistic communication, including sign, speech, print, and hearing amplification or other technologies.

Traditional Oral Programme – Educational method aimed toward deaf and hard-of-hearing children's developing spoken language production and reception abilities. Traditionally, the method includes use of amplification devices such as hearing aids, speech reading to visually supplement available hearing, and a systematically structured instructional approach.

Unilateral (Hearing Loss) – Hearing loss on only one side, that is, in one ear.

Universal Newborn (Hearing) Screening (UNHS) – Screening hearing tests are used to separate the newborn population into two groups: (1) a large group with low probability of hearing loss; (2) a smaller group with a higher probability of hearing loss. Those in the second group are then tested more thoroughly to confirm or rule out hearing loss and to provide more information about the degree and profile of any hearing loss that is identified. Screening is "universal" if all infants born in a country or specific area are provided the initial screening tests regardless of evidence of risk factors.

Validity – The degree to which a test or procedure measures the concept or ability that it purports to measure. For example, tests of non-verbal skills are typically considered to provide more valid estimates of a deaf child's cognitive abilities than those based on use and understanding of language.

Visual-Manual (Modality/Language) – Refers to *natural sign languages* or sign systems which are produced using hand shapes, facial expressions, and/or body postures and thus are received through the visual modality.

Visual Phonics – A multisensory approach for teaching *phonological* awareness and *phonics* to children with hearing loss and, occasionally, to hearing children with speech or literacy difficulties. The system uses hand shapes that mimic what the mouth, teeth, and tongue do when a speech sound is produced. This is combined with attention to the sound itself, a written symbol, and the printed word.

What Works Clearinghouse – A service established in 2002 by the U. S. Department of Education's Institute of Education Sciences which collects and disseminates research-based information about the outcomes of academic interventions, curricula, and specific teaching methods.

Best Practice Issues and Highlights

The impact of early hearing loss on children's ability to reach their developmental and educational potentials is highly significant. Page 23[1]

Effective early intervention can apparently greatly ameliorate, although not eliminate, the barriers to learning faced by deaf and hard-of-hearing children – at least during the early years of life. Page 24

Lesser degrees of hearing loss have expected negative effects on language and literacy development – effects not completely resolved by use of amplification. Page 25

The low incidence of childhood hearing loss and the presence of additional disabilities result in a highly heterogeneous student population with widely varied needs. Page 26

Without early identification and intervention, countries pay a much higher monetary price for rehabilitation and support services than they would pay for universal newborn screening and early intervention. The price levied against children's futures cannot be estimated. Page 34

Identification and intervention decrease but do not negate effects of hearing loss on development. Page 39

There has been no indication of overall negative effects on social-emotional functioning from early identification. Page 41

Early identification and intervention are known to ameliorate developmental delays, but most children with hearing loss continue to reach pre-school age with significant language delays. Page 47

To the extent that language delay limits children's experiences to interact with other children and with adults, their exposure to new information and to learn about others is further limited. Page 48

[1] Page numbers reference relevant discussions in the text.

There is little evidence that participation in traditional oral programming results in deaf and hard-of-hearing children attaining literacy achievements equivalent to those of hearing peers. Page 51

Available studies show some children make age-appropriate progress using one of the oral approaches; however, even proponents note that many, if not most, do not. Page 51

Cochlear implants have increased the average rate of language development and the average rate of speech skill development by profoundly deaf children in oral programming compared to that of their peers who use hearing aids. Page 53

Even with early cochlear implantation, language abilities remain on average below those of hearing peers. Page 53

The degree to which orally-focused education can reliably provide adequate support for the emergence and development of literacy and academic skills remains in question. Page 56

No existing studies have employed designs rigorous enough to produce evidence-based judgments of the effectiveness of auditory-verbal therapy. Page 57

Despite reports of children who acquire spoken language at near-typical rates, many children in auditory-verbal programming do not. Page 60

As with conclusions about potential viability of traditional oral and auditory-verbal methods for supporting language and literacy development, however, positive outcomes of use of Cued Speech seem to depend upon early experience and a great deal of parent motivation and support. Page 65

Despite improved auditory access, the signals received from cochlear implants are not as clear as those received by hearing children. Page 65

Despite its success in supporting literacy skills in children who learn French, Cued Speech has never been shown to provide similar support for literacy skills in English. Page 66

Continuing difficulties in literacy development among deaf and hard-of-hearing children using oral methods led to what has been termed "total communication" (TC) or "simultaneous communication" (SimCom), that is a manual code for expression of spoken language. Page 66

Results from several studies looking at classroom learning have indicated that in the hands of a skilled user, simultaneous communication (speech and sign together) can be as effective as other forms of communication at middle-school through university levels. Similar studies have not been conducted with younger students. Page 70

Expressive use of signs supports, and is not detrimental to, children's use of speech when diagnosis and intervention occur early. Page 71

Parent and/or school use of manually-coded English provide significant support for lexical development—but the average functioning of deaf and hard-of-hearing children, even when early identification and intervention are provided, remains in the "low average" range, somewhat below that of hearing children of the same age. Page 74

Continuing reports of below-expected performance on literacy and academics by children exposed to total or simultaneous communication led to the establishment of sign bilingual programmes in which natural sign languages are expected to be the first language of deaf children. Page 77

After two decades of sign/bilingual programming across many countries, deaf children still have not matched the literacy achievement of their same-age hearing peers. Page 84

Children whose preferred language was a natural sign language had larger vocabularies than those children who showed no such preference; children with deaf parents, and thus with early and consistent exposure to sign language, had larger sign vocabularies than those without such exposure. Page 85

Small class sizes have traditionally been deemed necessary for working with deaf students so that individualisation can occur and visual lines of sight are clear, but models where classes are combined with co-teachers may provide viable alternatives when teachers are skilled at sign language and are sensitive to students' visual needs. Page 88

Findings of a positive relationship between skills in a native sign language and a spoken language replicate findings for children who are hard-of-hearing. Page 89

Spoken English can be used in small literacy group sessions with children for whom it is useful. Flexibility and individualisation of language and support services are key. Page 90

Full implementation of a sign/bilingual model of education requires specialised training and skills in teaching staff. Page 91

Deaf learners typically have strengths in visual processing and a deaf-centred approach to teaching may stress some different aspects of development and skill development than programmes based on models of hearing students' learning styles. Page 92

Although there are emerging reports of early spoken language development by children receiving cochlear implants during their first year, generally age-appropriate emergence of language is most effectively supported by sign language or signing systems, which are more readily perceptually accessible. Page 94

Use of signs allows early communication between parent and child and helps to build conversational skills while providing access to information. Page 94

The acquisition of communication and language skills at age-appropriate or close to age-appropriate times is a necessary requisite for continued development, and preventing delays is more important than the specific method or modality used. Page 95

Parent involvement and support of an approach is a critical factor in the deaf child's success, as is the quality of educational support provided to family and child. Page 95

Advances in technology, including early identification and intervention, use of improved hearing aids based on more specific testing, and use of cochlear implants by children with the most severe hearing loss have increased the amount and quality of auditory information available and, as a consequence, the children's potential for use of spoken language. Page 95

Literacy activities themselves promote language development and the two can be mutually supportive. Pages 96

Structured, shared-reading activities are worthy of further study with deaf and hard-of-hearing children and their families but, meanwhile, appear to build parent confidence in the shared reading process. Pages 99

In addition to reports of increases in linguistic and emergent literacy skills, children with hearing loss who participate in shared reading activities show high motivation for reading as well as emerging writing activities, sometimes using these skills spontaneously to assist when "through-the-air" communication fails. Page 101

There is considerable individual variation in the degree to which phonological knowledge is attained by deaf and hard-of-hearing children and the degree to which it supports their literacy development. Page 104

It is necessary for specific instruction in phonology to occur if it is to effectively support literacy in the spoken language. Page 105

Visual Phonics appears be a helpful aid in phonological development regardless of the language modality typically used for communication purposes. Page 106

Deaf children's vocabulary delays are due in part to their lack of experiences overhearing conversations around them and also probably due to parents and other adults using restricted vocabularies with them because of lowered expectations or the adults' own lack of vocabulary in sign. Page 110

Automaticity in word recognition and comprehension is enhanced when children also have multiple means of representing a word's meaning, that is when they know its printed, spoken, and signed expression. Page 111

Vocabulary growth is higher for children using total communication compared to those in oral-only programmes if they received their implants early – before age five. Page 112

Although it is consistently pointed out that vocabulary instruction needs to occur in meaningful contexts as opposed to simple drill and practice or definition memorisation, it is also agreed that it should be specifically addressed and cannot be expected to develop sufficiently without direct instruction. Page 114

In addition to the auditory benefits of cochlear implants per se, the age at which auditory information becomes available also affects language and cognitive development. Page 116

Deaf children apparently can co-ordinate input from cochlear implants with that from signing to create a more complete syntactic system. Page 117

Converging findings indicate positive benefits to literacy from:

1. Explicit instruction in strategies for comprehension
2. Teaching narrative structure or story grammar
3. Using modified directed-reading thinking activities
4. Using approaches to activate and build background information before reading activities
5. Using reading materials that are high-interest, well-written and have not been simplified grammatically or in vocabulary choice
6. Providing specific activities to build vocabulary knowledge
7. Using connected text instead of sentences in isolation to provide instruction in syntax or grammar
8. Encouraging the use of mental imagery while reading
9. Teaching students to look for key words to assist in text comprehension.

Pages 118-119

Practices that prompt application of cognitive processes and promote reading as a problem-solving activity are fruitful in increasing literacy skills. Page 120

Deaf students need systematic and explicit instruction on strategies for comprehending text. Page 121

Teaching of writing in classes for deaf and hard-of-hearing children may militate against learning to build expression of cohesive and coherent meaning across levels of text because strong emphasis is placed on producing basic sentence structures. Page 123

Even students with access to oral English through audition have difficulties in various aspects of writing and probably need instructional support from both the general educator and the teacher of deaf… as with reading, there appears to be need for a balanced approach in which direct instruction and pragmatic, freely-produced opportunities for writing are provided. Page 126

Vocabulary development requires exposure to a rich language environment and, especially in the case of children with hearing loss, direct instruction to build word knowledge. Page 127

Sign vocabulary acquired before cochlear implantation supports rather than impedes acquisition of spoken vocabulary, and the introduction of new words in sign as well as speech supports their acquisition in spoken form. Page 127

To be effective for mathematics problem solving, basic number concepts and skills need to be practised until they become automatic. Deaf and hard-of-hearing children may have fewer opportunities to practise these skills and thus their transition to automaticity may be hampered. Page 131

Future teachers of deaf students should have a required course to assure they know mathematics content, how students learn such concepts, and how to teach maths effectively. Page 132

Use of pictorial mental representations during problem-solving indicates only a surface understanding of the problem; use of schematic representations, which also include relations between entities in mathematics problems, may need to be explicitly taught to deaf students. Page 136

Teachers' ability to communicate well in the language used by their students clearly represents "best practice" in deaf (as well as general) education settings. Page 139

Taking an active problem-solving approach in which students analyse multiple methods and explain potential solutions has strong research support among older deaf students. Page 139

Deaf students have been shown to succeed in process-oriented, activity-based science programmes with low verbal demands. Page 141

Writing activities, although lengthening the time required for each lesson, provide important insights about individual students' grasp of science information and processes. Page 143

Collaborative learning, in which students communicate among themselves and participate fully in discussions with the teacher about science problems and topics, can be especially helpful for learning. Page 144

Successful teachers tend to have training in the subject matter being taught and to be knowledgeable about the learning styles and patterns of students with hearing loss. Page 147

Embedding writing within science projects appears to promote and consolidate benefits from activities, even though students' writing skills are typically delayed. Creative writing focused on science concepts and ideas appears to be helpful, with the focus on effective communication instead of the mechanics of grammar. Page 147

Group discussion and direct communication with the teacher are especially valued as methods for acquiring science knowledge by deaf and hard-of-hearing students. Page 147

Practically, separate schools may be better equipped to handle the needs of children with multiple disabilities but, theoretically, comparisons of academic outcomes in the two settings are inherently invalid because the children who attend them will be different, a priori. Page 151

In contrast with findings for students with cognitive or emotional disabilities for whom achievement has been found to be supported more in mainstream classes than in special classes, no functionally significant effect has been found for students with hearing loss. Page 152

Ongoing assistance and resource teaching are needed if children with hearing loss are to continue being placed in mainstream classrooms. Page 153

To provide necessary support, teachers of deaf and hard-of-hearing students must be prepared to work closely with general education teachers. This may well require that they be knowledgeable about curriculum approaches used in general education classrooms. Page 154

Deaf students in Ireland believe they are able to learn much more than is expected of them and want academic expectations raised. Page 154

Research provides some support for benefits from sign intervention activities for hearing children in school with deaf children and no evidence of negative outcomes. Page 158

Although the co-enrolment model has apparent value in providing experiences for deaf and hard-of-hearing and hearing children to get to know each other and to learn from each other, there is not yet consistent evidence of academic benefits. Page 158

Preferential seating, use of personal and soundfield frequency-modulated (FM) systems, and presentation of important material in writing followed by frequent checks of comprehension are important supports needed when students with hearing loss (especially those depending upon spoken language) are integrated with hearing students. Page 162

There is a convergence of administrative opinion – although not in the conclusions of data-based research – that participation in general education settings benefits deaf students. Page 165

Time and opportunities must be provided for communication between teachers and other providers of services for deaf students. Page 166

More research is needed on methods of matching child needs with environmental supports and the benefits of various methods in the preparation of general and special education teachers in existing models of academic integration. Page 167

Deaf and hard-of-hearing children are likely to be easily distracted visually. Mothers of deaf children have been observed to use a specialised set of attention-directing and maintaining behaviours with deaf infants and toddlers. Classroom activities and space planning will require similar strategies. Page 174

Information presented verbally (in speech or in sign) to deaf students in an instructional situation must be paced to allow learners time to look away from the speaker/signer to attend to any visual aids presented as supportive information. Page 175

Teachers of deaf students need to be especially alert to gaps in understanding and help students recognise and respond appropriately. Page 176

Although there is considerable within-group variability in sequential and visuospatial memory, deaf children, particularly those using sign language, may have need for accommodations or for direct instruction in the use of sequential processes in tasks such as reading. Page 179

Relatively short-term cognitive training programmes can lead to gains in measures of reading, mathematical computation and concepts, and nonverbal cognitive skills. Page 182

Even at college age, deaf and hard-of-hearing students cannot be expected to spontaneously use well-developed problem-solving strategies. Instruction in strategies and devices to help students take time to visualise problem solutions can increase the frequency of success. Page 182

Differences in cognitive functioning between deaf and hearing children are likely to affect learning and can only be accommodated if teachers recognise them. Page 184

For children with multiple disabilities, interventions need to be family-focused and involve a team of specialists based on child and family needs. A case manager should be available to co-ordinate services because the needs of these children are so complex. Page 186

Deaf and hard-of-hearing children suspected of having learning disabilities are often placed in classes for children with hearing loss, but their special difficulties with integration of information and delays in language development (regardless of modality of input) beyond those expected for their linguistic experience are thought to require a highly structured educational environment for optimal academic development. Page 190

Reliable and valid assessment of learning disability in a deaf or hard-of-hearing child presents special difficulties and must employ varied methods and measures. Page 190

Curricula developed to facilitate development of deafblind children stress building relationships between the child and caregivers, gradually building awareness in the child of others, and supporting transition of communication behaviours from the concrete to the symbolic level. Page 193

Current educational philosophies for children with multiple challenges emphasise individual differences instead of such categorisation. Page 196

A person-centred approach is based on identifying the strengths and learning abilities of each individual student, motivating factors, environments and contexts in which learning is facilitated and specific instructional procedures that best promote learning. Page 196

1. Project Aims and Methodology

This report reviews the literature concerning evidence-based best practice models and outcomes in the education of deaf and hard-of-hearing children, with special reference to Ireland. The project included four particular tasks:

1. To provide a review of international literature on the educational models for deaf and hard-of-hearing children that demonstrate evidence-based outcomes for the child

2. To identify the extent to which education and health services need to be co-ordinated in meeting the needs of this cohort

3. To draw on the findings and, taking into account the provision of education in an inclusive setting, make recommendations on the best provision of this service in Ireland to inform national policy and also consider the needs of educators in this regard

4. Provide an overview of the implications for the practical implementation of such recommendations in the context of the current Irish education and health systems.

The project was guided by an agreement that:

> the literature review will be comprehensive and critical, utilising periodicals, books, and other available resources [and will] consist primarily of information obtained from peer-reviewed professional sources and governmental reports (that is from government agencies, educational entities, funding bodies, etc) *that include verifiable outcome data.* Anecdotal and non-reviewed reports may be considered, but will be identified as such insofar as reliability and validity generally cannot be determined for such materials *(italics added).*

The literature review and preparation were conducted by Professor Marc Marschark of the Center for Education Research Partnerships at the National Technical Institute for the Deaf, a faculty of Rochester Institute of Technology in Rochester, New York (USA), and Honorary Professor in the Moray House School of Education at the University of Edinburgh and the School of Psychology at the University of Aberdeen (Scotland), and Dr Patricia E Spencer, recently retired from the Department of Social Work at Gallaudet University and formerly of the Gallaudet Research Institute.

On the collection of references for the literature review, beyond their personal libraries and databases, the authors utilised a variety of resources. First, they searched the primary scholarly journals containing information relevant to the topic. These included periodicals such as the *American Annals of the Deaf,* the *Journal of Deaf Studies and Deaf Education, Ear & Hearing*, the journals of the *American Speech-Hearing-Language Association*, the *Journal of Special Education*, and *Exceptional Children*. They utilised the US government's PubMed online database, Rochester Institute of Technology's Einstein electronic database system, electronic resources of the University of Edinburgh and University of Aberdeen, and the HighBeam system. Searches used key terms such as *deaf, deaf education, special education, sign/bilingual education, oral education, auditory-verbal,* and *multiple disabilities* – especially as they were linked to the topics of literacy, early identification, mathematics, science, inclusion and other issues relevant in educating deaf children. The investigators obtained many references from existing monographs and relevant edited books and occasionally called on colleagues around the world for others when the data sources were not clearly identified elsewhere.

Investigators in deaf education would acknowledge that their subject generates far more literature than one can put high confidence in. For that reason, the attached review carefully distinguishes what we know, what we do not know, and what we only think we know (but for which we lack empirical evidence). Except where specific issues are raised or qualifications made in the attached report, all material included is drawn from studies the investigators believe are credible. Conclusions and/or claims associated with investigations that do not follow from reported methods and results are not included here, even if they were stated by the authors.

Because of the questionable validity of some research (which frequently is cited regardless of reliability or validity), the review includes a section entitled Research/Evaluation Designs Relevant to the Examination of an Evidence Base for Education of Deaf and Hard-of-Hearing Students. This aims to help orient the reader to statistical/design issues in the existing literature. In addition, some studies are reported in greater or lesser detail than others so the reader may have a clear understanding of the relevance of particular methodologies and the implications of results.

To understand the current state of affairs on educating students with hearing loss in Ireland, Prof Marschark and Ms Patricia Sapere of the Center for Education Research Partnerships made a site visit in November 2008. They saw two schools for the deaf and three integrated settings in which the deaf and hard-of-hearing were being educated. They met school administrators, parents and teachers of deaf children, visiting teachers, special educational needs organisers (SENOs), and students themselves. In group and private meetings, they also met personnel from the Department of Education and Science and representatives from several Deaf advocacy groups.

Drafts of this report benefited from reading and critique by internal teams at the National Council for Special Education and the Center for Education Research Partnerships as well as two anonymous, external reviewers.

2. The Context of Education for Deaf and Hard-of-Hearing Children in Ireland

As science, medicine, educational theory, and technology have advanced over recent decades, there has been a global re-examination of existing instructional methods and academic placements for children who are deaf and hard-of-hearing and others with special education needs. Most noteworthy perhaps have been:

1. The recognition in the 1960s that natural sign languages such as Irish Sign Language are true languages rather than gestural systems

2. The advent of early newborn/neonatal hearing screening and early intervention for children with significant hearing losses

3. The development of cochlear implants

4. And recent descriptions of academically-relevant cognitive differences between deaf and hearing individuals.

Accompanying such changes, sometimes proactively and sometimes reactively, have been legislative initiatives in a variety of countries intended to ensure that these children, and others with special needs, receive appropriate educational and other services.

In Ireland, the Education for Persons with Special Education Needs Act of 2004 (EPSEN) was passed to ensure:

> in a manner that is informed by best international practice, for the education of people with special educational needs, to provide that the education of people with such needs shall, wherever possible, take place in an inclusive environment with those who do not have such needs, to provide that people with special educational needs shall have the same right to avail of, and benefit from, appropriate education as do their peers who do not have such needs, to assist children with special educational needs to leave school with the skills necessary to participate, to the level of their capacity, in an inclusive way in the social and economic activities of society and to live independent and fulfilled lives, [and] to provide for the greater involvement of parents of children

> with special educational needs in the education of their children…

Although full implementation of the Act was indefinitely deferred in late 2008, it created the National Council for Special Education (NCSE) which has been working to collect and examine information on "best international practice" for persons with special education needs and current, relevant practices and infrastructure within Ireland. To the extent that these activities and the EPSEN Act are able to inform stakeholders and move educational practice forward, Ireland has the opportunity to be at the forefront of innovation and responsiveness to the needs of all of its citizens. For up to 2,000 deaf children in Ireland, EPSEN offers the potential for enhanced academic outcomes, greater opportunities for gainful and fulfilling employment, and more alternatives for integrating into the larger society to whatever extent and in whatever manner desired.

Currently, services relevant to early intervention, including identification of hearing loss, pre-school intervention and early audiological support, are under the auspices of the Department of Health and Children. Educational services are provided by the Department of Education and Science. The Education Act 1998 mandated that it is the Minister's responsibility

> (a) to ensure, subject to the provisions of this Act, that there is made available to each person resident in the State, including a person with a disability or who has other special educational needs, support services and a level and quality of education appropriate to meeting the needs and abilities of that person…

According to parents and educational personnel interviewed during the November 2008 site visit, however, the education of children with hearing loss is inconsistent at best, partly due to the lack of trained personnel, but especially due to lack of co-ordination of services between the two Departments responsible for service provision. This divided responsibility can result in diagnoses of hearing loss typically not occurring as early as is technically (and inexpensively) possible, few if any children receiving significant early intervention or pre-school experiences, and limited use and understanding of hearing aid technology in the classroom and at home.

The following review demonstrates the internationally recognised importance of all these areas for children with hearing loss.

As described in the next section, there are reported to be about 2,000 children of school age in Ireland with hearing losses sufficient to interfere with normal teaching-learning activities. At present three categories of educational placement exist for these children: separate programmes (schools for the deaf); special classes/units within regular schools; and regular classrooms. According to Department of Education and Science figures, over three-quarters of deaf and hard-of-hearing students are enrolled in regular classrooms, receiving varying levels of support from resource teachers, visiting teachers and special needs assistants (SNAs). The Visiting Teacher Service, an initiative of the Department of Education and Science, provides services for these and visually-impaired children. According to the Visiting Teacher Service information leaflet (2007) it provides advice and support to ensure that the needs of children and young people with hearing and visual impairment are met. This service is available at pre-school, primary, post-primary and at third level. Such a service may include:

- Guidance and support to pre-school children and their parents in the home
- Specialist teaching, support and monitoring
- Advice on curricular and environmental implications, including the use of assistive technology
- Supporting, advising, training and liaising with parents, teachers and other professionals
- Ensuring reasonable accommodations are provided to post-primary students by the State Examinations Commission
- Advising and liaising with disability and access officers to ensure appropriate supports at third level.

Although policy for the education of deaf students is the responsibility of the Department's special education section, day-to-day administrative and management responsibility resides with the Directorate of Regional Services through its regional office network which includes 10 geographic teams managed locally by senior inspectors attached to each relevant regional office. During the 2008-09 school year, 32 visiting teachers (permanent and temporary) provided services to pre-school children and students with special needs. Typical caseloads ranged from 60 to 90 students of varying ages.

According to the Department, visiting teachers have significant experience in special needs education. Professional development in specific areas is encouraged with the assistance of the Special Education Support Service. The Department indicates that the visiting teacher service:

> …works in partnership with parents of pre-school children with hearing impairment, visiting their homes and/or meeting them in groups to inform, advise and offer guidance in matters pertaining to their education and overall development and in helping their children to derive maximum benefit from the educational opportunities available. [Visting teachers] give tuition, where appropriate, to pre-school children, and assist them in the acquisition of perceptual, cognitive, social and communication skills. They also advise on the available technologies and check the use of hearing aids on an ongoing basis… visit schools/centres of learning and work with individual students, in partnership with the principal teachers, class teachers, learning support teachers, resource teachers and ancillary staff… give advice and guidance on individual education planning, curriculum implementation, teaching/learning strategies, specialist teaching equipment and materials, on evaluation and assessment and on specific approaches to cognitive, linguistic, physical, social and emotional development, and monitor the progress and attainment of children and young people with hearing impairment… [and] are available to advise personnel working with children with hearing impairment (including those attending special schools), and are available to advise staff in third level institutions and post-school training facilities which may have students with hearing impairment.

Parents and education professionals (including service staff) interviewed during the November 2008 site visit indicated that visiting teachers had varying levels of knowledge and experience of deaf education, language alternatives for their pupils and relevant technologies. As a result, there was considerable sentiment that the service had greater potential.

According to an unpublished 2007 report obtained from the NCSE, there were three primary schools for the deaf in Ireland, and special classes in seven schools served 41 students with hearing loss in 2006-2007. Data from an unpublished 2009 DES report indicate 10 programmes with special classes, serving 43 such students. Information obtained from school principals during the November 2008 site visit indicated that all classes with deaf and/or hard-of-hearing children are to receive visiting teacher support (although one class reportedly was not as of November 2008). A minority receive support from a speech-language therapist. Visits from visiting teachers generally are irregular, but apparently always occur when requested by school personnel. Discussions with school principals during the site visit have revealed there are no designated special classes for students beyond primary level, although some students receive secondary education within primary settings. The unpublished 2007 report from the NCSE indicated that all three schools for the deaf also were serving post-primary students. One post-primary programme serving students with hearing loss is embedded in a regular school setting (listed as a special class serving seven students in 2009 DES data), providing sign language interpreting and other support services within the regular classroom and tutoring and other services in separate classrooms[2]. The Department of Education and Science reports 191 students enrolled in three schools for the deaf, all of which have designated secondary programmes. According to parents and teachers, students with hearing loss over age 18 who are in need of additional secondary education cannot receive such schooling in regular classrooms, but must transfer to schools for the deaf. Implications of school placement for academic and social growth are considered within the research review below.

[2] Outside of the school setting, there is an Irish Sign Language Tuition service available to families of children with hearing loss.

One finding from the 2008 site visit should be noted since it is of critical importance for the future of deaf education in Ireland. Unfortunately, it does not arise in the review of existing literature. In all interviews with students, whether or not teachers were present, students reported that academic expectations for them were too low. They indicated that they needed to be challenged more and provided with higher quality education and support services if they were to succeed in school and find employment. Such statements are illuminating on the metacognitive awareness of deaf and hard-of-hearing students concerning their own academic progress and, at a more human level, signal that these are individuals striving to be successful and to lead rewarding lives.

3. Introduction: Issues and Demographics

Hearing loss in childhood is relatively infrequent and technically considered a "low incidence" condition (Mitchell & Karchmer, 2006). For example, a national survey by the UK Medical Research Council of the Institute of Hearing Research in Nottingham of children aged nine to 16 in 1998 found the incidence of hearing impairment greater than 40 decibles (dB) (a level labelled "moderate" and historically considered of educational significance) was only about 1.65 per 1,000 live births. Statistical adjustments to account for expected under-reporting, thus including children whose hearing loss is not present at birth but is progressive during their early years, have suggested the incidence could be as high as 2.05 per 1,000 (Fortnum, Barton, & Summerfield, 2001; Fortnum, Summerfield, Marshal, Davis, & Bamford, 2007), still representing a very small portion of the population. This is similar to an estimate from the Wessex Universal Hearing Screening Trial Group (1998) of 0.9 to 1.0 per 1,000 births, with a rate of 2.5 per 1,000 births projected when including children with lesser degrees of hearing loss (unilateral and mild losses less than 40dB, which are increasingly thought to be indicators of risk for language and education development (Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007) [3]. Figures from the United States (Mehl & Thomson, 2002) and from Australia (Johnston, 2003) are within this same range.

Rates of child hearing loss are relatively low in highly-industrialised western countries, but obtaining accurate counts of children with hearing loss in any particular country is always difficult. Ireland is no exception. Discrepancies in estimates vary for several reasons including because some children with severe disabilities along with hearing loss might be included in categories other than "hearing impairment", children with minimal or mild hearing losses may be overlooked, and some who function well in mainstream classrooms (that is who do not receive special services) or have left school may not be counted at all regardless of their hearing thresholds. Data drawn from the 2006 Irish National Disability Survey reported 3,283 children up to 17 years who had hearing-related difficulties in

[3] Even hearing losses of 16 to 25dB (minimal hearing impairments or MHI) "potentially affect communication, learning, social development, and academic achievement" (Goldberg & Richburg, 2004, p152), especially during the earlier grades.

everyday activities ranging from "a moderate level" to "cannot do at all". Of those, 55.6 per cent were reported to have had their hearing losses from birth. The incidence of significant hearing loss was reported to be slightly higher in boys (1,774) than girls (1,509). These figures are based on a 2006 population estimate of 4,070,500 including 57,600 individuals with "a hearing disability". The number of children in Ireland aged 0-17 was not available, however, and hence prevalence figures could not be calculated.

On school-aged children, the survey indicated there were about 2,000 deaf and hard-of-hearing students, an estimate that appears in other reports. An unpublished 2007 report provided by the NCSE, had indicated 928 children receiving education services: 706 in mainstream, 181 in schools for the deaf, and 41 in units for the deaf. Another 184 children were reported to be enrolled in pre-school programmes served by the Visiting Teachers Service. All of those children were referred to in the 2007 report as "deaf" but apparently included those who were hard-of-hearing. Data for this report, provided by DES and NCSE in April 2009 (for 2008-09), indicated 967 school-aged children with hearing impairment receiving services: 731 in the mainstream (NCSE figures), 191 in the three schools for the deaf (DES figures), and 45 in special classes in mainstream schools (DES figures).

Importantly, the definition of who receives special education services provided by the Department shows:

> Pupils with a hearing impairment have a hearing disability that is so serious to impair significantly their capacity to hear and understand human speech, thus preventing them from participating fully in classroom interaction and from benefiting adequately from school instruction. The majority of them have been prescribed hearing aids and are availing of the services of a Visiting Teacher. *(This category is not intended to include pupils with mild hearing loss).* [Italics in the original].

This limitation may be significant because, as will be described later, recent evidence indicates that even children with "mild" or "minimal" hearing losses are at risk academically. Similarly, according to information provided by the NCSE (June, 2009), "all pupils in primary schools with low achievement in English or mathematics, including those with mild hearing loss, are eligible for additional teaching support under the general allocation model (GAM). Pupils in post-primary schools who have low achievement in English or mathematics are eligible for learning support". Thus, children with mild hearing losses may receive additional services, but only after they have already fallen behind academically in the two areas that have been demonstrated to be of greatest challenge for students with hearing loss (see below). Insofar as the evidence clearly indicates that these children are at risk, they would be served more effectively, efficiently, and economically if such service was provided proactively.

The impact of early hearing loss on children's ability to reach their developmental and educational potential is highly significant. Despite strong efforts to provide supportive programming for deaf and hard-of-hearing students over the past century (Moores, 2001), academic achievement levels remain significantly delayed compared to those of hearing children. This pattern persists despite evidence that nonverbal cognitive potential is similar for children with and without hearing loss (Braden, 1994; Maller, 2003). For example, Allen (1986) and Traxler (2000) reported that the median level of reading comprehension for deaf and hard-of-hearing school leavers in the US approximated that of hearing children at fourth grade level (age nine). In addition, deaf and hard-of-hearing school-leavers were shown to function at only the 80th percentile of the average maths score of hearing students. That means that students aged 17 or 18 with hearing loss obtain mathematics scores like those of hearing students in the fifth or sixth year of school (aged 10 to 12). Although performance on "word" or story mathematics problems is the most delayed, delays are also present in calculation skills (Kelly & Mousley, 2001; Mitchell & Qi, 2007; Traxler, 2000; Wood, Wood, & Howarth, 1983). These difficulties in literacy and mathematics clearly affect this cohort's abilities to acquire information and skills in other academic areas.

The future need not be as bleak as this description suggests, however. Significant advances in recent decades promise much improved academic performance. An example is the practice of identifying hearing loss during infancy and of providing immediate support to families. Where effective intervention is provided, average language and early literacy functioning of young children with hearing loss has been found to fall within the range for hearing children, albeit the "low average" range (eg Moeller, 2000; Yoshinaga-

Itano, 2003). Effective early intervention can apparently greatly ameliorate, although not eliminate, the barriers to learning faced by deaf and hard-of-hearing children – at least during the early years of life. Ireland, however, lags significantly behind other western countries in establishing programmes to identify hearing loss early and in the provision of early intervention services by trained personnel. During the site visit, educational personnel indicated that the audiologist makes first contacts when a child is identified as having a significant hearing loss. S/he informs parents and school personnel. This notification should trigger the assignment of a visiting teacher who will help to co-ordinate services for the child within the educational system. The visiting teacher also may provide early intervention in the home, although parents have reported this is extremely variable.

Another advance that promises benefits for children with hearing loss is recognition that natural sign languages are as complex and sophisticated as spoken languages (eg Emmorey, 2002; Stokoe, 1960). It has been shown repeatedly that deaf children given a fluent model of sign language from their early months can acquire language (albeit in the visual-manual modality) at a rate that matches that of their hearing peers (eg Meadow-Orlans, P Spencer, & Koester, 2004; P Spencer & Harris, 2006). Advanced language skills in sign also have been found to associate with higher literacy skills both in children who depend primarily on sign (eg Padden & Ramsey, 2000; Strong & Prinz, 2000) and those who use signed and spoken language with the support of cochlear implants (eg L Spencer, Gantz, & Knutson, 2004).

Along with general societal acknowledgment of the rights and potentials of persons with hearing loss, this recognition of natural signed languages has led to more flexibility in how language support is provided to families and their children during the early years and provides increased access to learning. In addition, advances in technology (including more sophisticated hearing aids and cochlear implants), especially in combination with early identification of hearing loss, allow many more deaf children access to information from spoken language than has been the case historically (eg Geers, 2006; P Spencer & Marschark, 2003).

These developments are resulting in more children having potential for developing receptive and expressive skills in spoken language. Such flexibility, in turn, is expected to allow access to a wider range of social and academic settings and increase achievement levels, but it also increases the diversity of children in academic settings.

Much evidence indicates positive effects of these newer technologies on speech and spoken language, and evidence is emerging about their support for early literacy development (eg Geers, 2006: L Spencer & Olson, 2008). Positive effects are not universal, however, and there continues to be active research concerning factors that interfere with or attenuate effectiveness for individual children. Although advances in technology have definitely improved the situation for many deaf and hard-of-hearing students, they have not resolved the difficulties faced by even those children considered "successful" users (eg, of cochlear implants; Pisoni, Conway, Kronenberger, Henning, & Anaya, in press). It should be kept in mind, therefore, that cochlear implants are used for children with profound hearing loss (and occasionally those with severe hearing loss), but are not appropriate for those with lesser degrees of hearing loss. Further, most research available has indicated that using a cochlear implant gives a profoundly deaf child access to information from sound that is similar to that of a child with a moderate-to-severe hearing loss who uses a hearing aid (eg Blamey, 2003). Current research reviews (eg Goldberg & Richburg, 2004; Moeller, Tomblin et al, 2007) point out that even lesser degrees of hearing loss ("minimal" to "moderate" losses) have negative effects on language and literacy development – effects not completely resolved by use of amplification. Practical information concerning cochlear implantation for children and adults in Ireland can be found on the website of the National Cochlear Implant Programme at Beaumont Hospital at http://www.beaumont.ie/depts/support/cochlear. Beaumont also houses the National Paediatric Cochlear Implant Programme.

The degree of hearing loss in most children falls within the mild to moderate range, as opposed to severe or profound (Moeller, Tomblin et al, 2007). These children typically can hear and express spoken language to an extent, but may require amplification from hearing aids and their performance will be negatively affected in noisy environments. Children whose hearing loss is in the severe-to-profound or profound range typically are unable to process spoken language signals without the use of cochlear implants (see P Spencer & Marschark, 2003, for a review). The range of functional hearing within the population called "deaf or hard-of-hearing", therefore, results in heterogeneity in needs for language input and, to a great extent, in the types of educational environments most conducive to learning. Differences in the age at which hearing loss occurs also contribute to heterogeneity of needs and performance within this population. Children who initially are hearing but who lose it either gradually or suddenly during the first years of life often retain more attention and sensitivity to sound than their counterparts who are congenitally deaf (Marschark, Lang, & Albertini, 2002). These differences complicate the design and delivery of educational services.

Further complication results from the relatively high incidence of additional disabilities in students with hearing loss. Based on existing literature, Moores (2001) estimated that incidence to be as high as 30-40 per cent in the general population of deaf children, while Shallop (2008) reported it to range from 39-54 per cent among children with cochlear implants. These complications may include cognitive, motor, social-emotional, visual, attention and specific learning disabilities. In short, any complicating factor known to occur in the hearing student population may also co-occur with hearing loss. Adding to the complexity of the educational picture, it is generally concluded that the combined effects of multiple disabilities are multiplicative and not merely additive (Jones & Jones, 2003; Knoors & Vervloed, 2003; van Dijk et al, in press). Unfortunately, due in part to the varied characteristics of children with hearing loss plus an additional disability, there is little research base in this area to guide educational approaches.

In general, the low incidence of childhood hearing loss and the presence of additional disabilities result in a highly heterogeneous student population with widely varied needs. Fortnum et al (2007) have pointed out that this complicates systematic group-based research and evaluation. The fact that in most countries random assignment to various educational treatments is not possible according to ethical guidelines also makes traditionally-preferred evaluation designs difficult to implement and interpret. As a result, despite a large number of research and evaluation publications that have addressed varied developmental and educational issues of deaf and hard-of-hearing students, it is rarely possible to draw firm conclusions on the basis of a single or even a small group of reports. Instead, it is necessary to survey the full range of information available and look for convergent findings across a number of investigations in which conditions or approaches differ. This report is intended to do just that, with the aim of offering an evidence-based guide to support implementation of the Education for Persons with Special Educational Needs Act (2004).

The following section addresses the types of research and evaluation designs available and helpful in surveying data from published studies relevant to identifying educational implications and programming for students with hearing loss. Subsequent sections address specific topics, looking for convergent findings to guide practice. In many cases, a lack of convergence indicates that much more must be learned.

4. Research/Evaluation Designs Relevant to the Examination of an Evidence Base for Education of Deaf and Hard-of-Hearing Students

It is increasingly recognised that educational practice, for general and for special populations, needs to be based on scientifically-valid evidence of successful interventions. Yet, the Council for Exceptional Children, the pre-eminent US advocacy group for children with disabilities, states on its website:

> While the [US] law requires teachers to use evidence-based practices in their classrooms, the special education field has not yet determined criteria for evidence based practice nor whether special education has a solid foundation of evidence-based practices. Also, those teaching strategies that have been researched are difficult for teachers to access (http://www.sped.ced.org, accessed September 24, 2008).

In fact, there remains considerable argument about what characterises acceptable evidence in best practices and education.

Some agencies, for example the What Works Clearinghouse sponsored by the US Department of Education's Institute of Education Sciences (http://ies.ed.gov, accessed June 6, 2008), have taken a conservative approach, stressing randomised experimental group designs (or randomised clinical trials) as the "gold standard" for evidence-based practice. The What Works Clearinghouse emphasises the value of such studies but does not rely solely on them. It utilises a complicated system for determining if a methodology "meets standards", "meets standards with reservations," or "does not meet standards". The system includes the level of research, the amount of research (is there just one excellent study? a plethora of good studies?), whether all the studies agree or the evidence is conflicting, the overall effect sizes among the studies considered, and so on. Ratings are holistic, based on a combination of evaluation methods (Easterbrooks, in press).

Studies with acceptable randomised clinical trial designs are difficult and expensive to implement, however, especially with lower-incidence populations. Accordingly, the

Council for Exceptional Children's Division of Research reminds researchers that methodologies must be chosen to address appropriately the type of question asked. It points out that four different research and evaluation methodologies are used in special education:

1. Qualitative designs (Bogdan & Biklen, 2003; Odom et al, 2005)
2. Correlational designs (Thompson, Diamond, mcwilliam, Snyder, & Snyder, 2005)
3. Single subject designs (Horner et al, 2005; Tripodi, 1998), and
4. Experimental or RCT (randomised clinical trials designs) (Campbell & Stanley, 1966; Gersten, Fuchs, Coyne, Greenwood, & Innocenti, 2005).

Each of these can, when carefully implemented, provide evidence of the effectiveness of educational practices. Qualitative research designs, for example, can provide detailed descriptive knowledge, especially related to *processes* of learning – how or why change is occurring. Although information produced by qualitative research (observational studies, informal interview studies, personal reports or life histories) is not expected to be generalisable, consumers of that research should be provided with enough information to judge to what extent it is applicable to their own specific situations (Brantlinger, Jimenez, Klingner, Pugach, & Richardson, 2005). Lang and Albertini (2001) have pointed out that qualitative designs can be especially useful with small populations where it is difficult to set up controlled experimental studies.

Correlation designs do not produce results that can be definitely interpreted as showing cause and effect. Thompson et al (2005) propose, however, that they can inform evidence-based practice when conducted using sophisticated statistical (eg structural equation modelling) or logical methods to exclude alternative interpretation of findings. Much of the evidence base in deaf and hard-of-hearing-related research has employed correlational designs, using multiple regression techniques to explain or account for portions of variance in outcomes by potential intervening variables[4].

[4] Multiple regression entails using multiple independent variables at one time, alternately holding all but one of the variables constant in order to determine which accounts for the greatest proportion of variance in the dependent variable. Once the effects of that most powerful predictor are removed, the process is repeated to determine the second most powerful predictor, and so on, until a criterion (usually $p < .05$) is reached.

Both types of experimental designs, randomised clinical trials and single subject, can produce directly-relevant cause-and-effect information. In the first instance, outcomes are compared for randomly-selected equivalent groups with and without a selected intervention – with the goal of being able to generalise results. Generalisation is impaired without random assignment, however, thus reducing the usefulness of this approach in naturalistic education settings.

Quasi-experimental research, using existing groups and attempting to statistically control for existing differences expected to affect outcomes is a more frequently-used approach in education. In single-subject designs, individuals (often in sequence) serve as their own controls as interventions are provided and withheld according to set patterns. This approach can supply useful information about the effectiveness of interventions for individual students and, when properly aggregated, identify intervention results across students with varying characteristics.

Regardless of the methodology used, evidence of successful practices relies on thorough conceptual grounding in existing literature, documentation of acceptable reliability and validity of all measurements, control of potential intervening variables and threats to design validity, documentation that interventions or practices being assessed are implemented as planned and in uniformly competent ways, use of multiple measures, and (when statistical approaches are used) assurance that the number of participants allows the identification of effects, or provides sufficient statistical power (Gersten et al, 2005). Dependence only upon randomised clinical trial designs, and even on correlational designs, is inherently limited with populations in special education, not only due to the small number of students identified as having a specific disability but also because of the greater variability in special as opposed to regular education groups. Donovan and Cross (2002) pointed out that establishing equivalent groups in samples comparing interventions with special education populations is complicated by the differing degrees of disability in specified groups and also by over-representation of minority groups in some special education populations. These difficulties are amplified when students identified as deaf or hard-of-hearing are considered.

4. Research/Evaluation Designs Relevant to the Examination of an Evidence Base for the Education of Deaf and Hard-of-Hearing Students

Kluwin and Noretsky (2005) have noted that given the limitations and complications of conducting research with the deaf and hard-of-hearing student population, it is necessary to look across studies and various study designs to identify convergent ideas as well as to shed light on assumptions that fail to be supported across various studies. This recommendation is consistent with those of the above papers on special education in general. The sections that follow, therefore, provide a synthesis of information gathered across a variety of settings and using a variety of research methods in order to define what is known about promising and evidence-based practices in deaf education and, perhaps as important, what continues to need investigation.

The detail provided for individual studies in the following review varies for several reasons. First, although randomised clinical trial type studies usually can be described relatively succinctly, qualitative studies and others that go beyond straightforward evaluations of learning following discrete experimental manipulation(s) may need greater explanation so the reader may understand what was done and appreciate their likely validity and reliability. Second, as noted earlier, except for several instances in which specific issues are raised or qualifications noted, all review material is drawn from studies the investigators believe to be credible. Toward this end, most research considered comes from peer-reviewed publications, primarily scholarly journals. Other investigations described in book chapters and conference presentations (for instance posters with follow-up printed materials) have been reported when sufficient detail has allowed evaluation of their credibility. Third, investigations involving creation or relatively long-term evaluation of specific educational programmes/interventions, longitudinal studies of development, and large-scale studies that included examination of variables in multiple domains necessarily require greater elaboration. Fourth, as noted earlier conclusions and/or claims included in various reports that did not follow from reported methods and results are not included in this literature review. At the same time, the synthesis of findings obtained over decades of investigation provided clarification of some earlier findings, both positively and negatively, that allowed us to go beyond the original conclusions. This endeavour is inherently risky, because there may be aspects of a study not described originally that could qualify current re-interpretation.

To avoid such over- or mis-interpretation and provide sufficient information for others to draw their own conclusions, greater detail was sometimes necessary.

Finally, two other qualifications to the present review are worth noting, insofar as they may assist readers in having a better sense of the true weight of the research reviewed. Most obviously perhaps, it may appear that there are issues either missing from this review or considered in less detail than might be expected. Although oversight on the part of the present authors is certainly possible, it is more likely that such domains simply lack as much credible research as is commonly believed. For example, as will be seen below, despite frequent claims for the value of auditory-verbal therapy and bilingual education, each lacks sufficient empirical evidence to support any broad-based implementation. At the same time, several areas of investigation described in this report will be found to include contradictory findings from different studies.

Wherever possible, likely explanations for such contradictions are provided. There is no way of knowing, however, how many studies have failed to demonstrate the utility of any particular experimental manipulation or intervention (for instance Cued Speech in support of English literacy), because null results are unlikely to be published either due to lack of clarity in the reasons for null findings or because they fail to support an investigator's theoretical orientation. Both of the latter situations are regrettable, but they do exist.

5. Neonatal Identification of Hearing Loss and Early Intervention Services

Within the developed world, the availability of early identification and specialised audiological, language and educational interventions to ameliorate the consequences of congenital or early-onset hearing loss represents the expected standard of care. Without such interventions, children with hearing loss will experience significant delay or disruption to the development of their language and communication abilities, their social and emotional development and, ultimately, their educational achievement and life options (Leigh, Newall, & Newall, in press). Despite a report from the Universal Neonatal Hearing Screening Working Group (2004, available at http://www.hse.ie) indicating the many benefits of universal newborn/neonatal hearing screening, such services appear to be sorely lacking in Ireland. During the November 2008 site visit, parents, educators and other service providers reported that audiological and speech/language personnel were particularly scarce, with little or no infrastructure that could begin to support early newborn hearing screening. Many special education needs organisers and teachers of young children lack the training necessary to direct parents to useful, unbiased information and, as a result, opportunities to accommodate the needs of infants and toddlers with significant hearing losses are missed. During site visit interviews parents were very vocal in the belief that they had been ill-informed about programmes and services for their deaf children, particularly in the early years. Many given diagnoses on their child's hearing losses were then left to fend for themselves. They reported not being told about language choices and educational programming options or informed of resources for their own acquisition of Irish Sign Language. They, like others, felt visiting teachers did not provide full information, but indicated only a single educational option (usually the regular classroom and spoken language). In general, the (hearing) parents were angry and frustrated with the status of deaf education in Ireland.

Although some appear unaware of it, an Irish Sign Language home tuition scheme is available for families that include "deaf sign dependent pre-school and school-going children"[5]. The Department of Education and Science states, however, that the "ISL

[5] From September 2006 August 2, 2007, 60 children were sanctioned for home tuition. From September 2007 to September 2008, 90 children were so sanctioned.

scheme is only sanctioned to pupils from two years up to 18 years and is not extended past 18 years". This makes it less likely that deaf infants and toddlers of hearing parents will have the opportunity to be immersed in sign language as a first language, even when it is most appropriate. "Sign dependence" presumably refers to prior lack of benefit from spoken language, a "failure model" not supported by research described below. Rather, the evidence to be presented clearly indicates that early exposure to sign language (for children with and without cochlear implants) is consistently beneficial, regardless of children's eventual language orientation, and there is no evidence that it is ever harmful. Further, parents' application for home tuition must be "supported by a recommendation for ISL from the visiting teacher for the deaf", a potentially problematic situation given the lack of visiting teacher expertise in this area described earlier.

Leigh et al (in press) state:

> The notion that children will develop their language and communication, cognitive, and social skills more effectively if intervention is commenced very early is grounded in the premise that there is an optimal period for the development of certain cognitive and linguistic abilities...

In the absence of early identification and intervention, countries pay a much higher monetary price for rehabilitation and support services than they would pay for universal neonatal hearing screening and early intervention. The price levied against children's futures cannot be estimated. The issue of early identification and intervention in Ireland is complicated by the fact that the Department of Education and Science ultimately will be saddled with a very high cost for supporting children with significant hearing losses because of the absence of services provided by the Department of Health and Children. As indicated in the 2004 report of the Universal Neonatal Hearing Screening working group, the success of such a programme will depend on a mechanism for screening the target population as well as a system for providing efficient and effective follow-up diagnostic hearing assessments and subsequent intervention services. These services likely will have to come from health and education sources. Many developing countries adopt an alternative approach that Ireland might consider given the current recession. Targeted newborn hearing screening contrasts with universal screening in focusing on at-risk children and families. This reduces the number of children to be screened while significantly reducing the number of false positive screening results (which have to be followed up). It thus can result in substantial cost cuts overall and per infant identified with hearing loss, but it also is likely to fail to identify more than half of infants with significant congenital hearing losses (Leigh et al, in press).

5.1 Early testing and family reactions

As late as 1990, the average age for identification of congenital hearing loss in the US was around 24 months (Culpepper, 2003). At that time, identification efforts were primarily based on registries or hospital-administered questionnaires designed to identify infants at high risk for hearing loss based on family history or events during pregnancy or birth. These children returned for hearing tests after having initially left the birthing centre or hospital. However, many deemed at birth to be at high risk were then "lost," when parents failed to return for scheduled appointments (Mahoney & Eichwald, 1987). This approach is estimated to have identified at most half the infants with a congenital hearing loss (Mauk, White, Mortensen, & Behrens, 1991). In the UK, hearing screening was usually conducted at an eight-month well-baby check and involved a health visitor watching for the infant's reaction to sounds from an unseen source. A similar system was used in Australia (Ching, Dillon, Day, & Crowe, 2008). This "distraction test" did not prove sufficiently reliable (http://www.ndcs.org.uk/).

By the 21st century, technology for assessing hearing had advanced sufficiently to allow more definitive identification of hearing loss during the neonatal period. In the US, screening now typically occurs before infants leave the birthing hospital (Culpepper, 2003). In England, universal newborn hearing screening was fully implemented in 2006 (Young & Tattersall, 2005; www.ndcs.org.uk). In England, Scotland, Wales and Northern Ireland, hearing screening typically occurs in the birthing hospital before mother and infant leave although it is conducted in the family home or in a health clinic in some areas. Where neonatal hearing screening is conducted, the average age of identification has now dropped to the early months of life (Yoshinaga-Itano, 2006) – two months of age on average in England (Young & Tattersall, 2007). According to the Universal Neonatal

Hearing Screening working group (2004) report, use of the distraction test in Ireland results in a mean age of identification of 30 months, contrasting with the two- to four-month average seen in countries with such screening.

Generally, screening is based on either the evoked otoacoustic emissions test (EOAE) or an auditory evoked response test (AER). Both are quick, non-invasive, painless and carry no risk. Typically, the former is used as the initial screening test with the latter used for follow up if the first test is inconclusive or indicates a hearing loss (Cone-Wesson, 2003). The goal, at least in the US, is for this more detailed testing to have been conducted by the time the infant is three months old, with intervention services provided before six months of age. Despite the effectiveness of hearing assessment during the neonatal period, there remain gaps in identification. There are still children whose parents do not return for follow-up testing. In addition, some proportion of infants born without evidence of hearing loss progressively lose hearing over the first years of life. Testing protocols must allow for identification of these as well as those with hearing losses in the mild range (some of whom are not identified using current methods) and those with unilateral hearing losses (Moeller, Tomblin et al, 2007).

Some practitioners initially questioned whether identification of hearing loss at such an early age might interfere with development of positive parent-infant emotional bonding (eg Gregory, 1999, 2001; Yoshinaga-Itano & de Uzcategui, 2001) or whether potential advantages in development would justify the effort required (Bess & Paradise, 1994). Pipp-Siegel, Sedey, and Yoshinaga-Itano (2002), however, found no evidence in a study involving 86 children with hearing loss identified between birth and six months of age that this increased parental stress and might lead to problems with parent-child attachment. Similarly, Meadow-Orlans et al (2004) failed to find any difference in the distribution of secure versus insecure parent-child attachment when they compared a group of hearing mothers with children identified as deaf or hard-of-hearing before age nine months (most of whom were identified well before six months) and a group of hearing mothers with hearing children. Grandori and Lutman (1999) reported that the European consensus development conference on neonatal hearing screening in 1998 concluded that the risks of anxiety due to early screening were acceptable, given evidence of benefits to developmental outcomes.

Concerns remain about parental anxiety as a result of early screening since during the wait, parents are left wondering if there is a hearing loss (eg Clemens, Davis, & Bailey, 2000; Vohr, Singh, Bansal, Letourneau, & McDermott, 2001). In a carefully designed and conducted qualitative study in England, Young and Tattersall (2005) interviewed 27 families whose infants had received an early diagnosis of hearing loss. The focus was on parents' reactions to and evaluation of processes of infant screening and referral when hearing loss was suspected. About half reported having no strong concerns about further referral, and even after the diagnosis was confirmed they expressed a belief that the screener was right initially to reassure them that false readings were possible and that first tests were often inconclusive. Most parents placed great value on their personal interactions with the screening professional, on positive aspects of the screener's personality and on the reassurance given. In contrast, some parents were not reassured by the screener's explanation that the test was not conclusive. Some of these had other reasons to suspect a hearing loss (for example a family history or birth difficulties). Several failed to understand fully the screener's message and parents in two of these families did not understand the difference between initial screening and a definitive diagnosis. They thought the test showed conclusively that their infant was deaf and that, despite this, no immediate assistance had been provided.

Another carefully-conducted qualitative study involved parents of 17 early-identified children in the Province of Ontario, Canada (Fitzpatrick, Angus, Durieux-Smith, Graham, & Coyle, 2008). Parents were asked to identify their needs following their child's diagnosis and were asked what they would include in the system of diagnosis and intervention if they could redesign it. Age of identification ranged from birth to 42 months, with nine of the children having their hearing losses identified before 12 months. The children, none of whom was identified as having additional disabilities, had hearing losses ranging from mild to profound, and the families had all elected to participate in programmes using an oral communication approach (spoken language without signing), with most enrolled in programmes based on auditory-verbal therapy (see below). All parents agreed neonatal screening was beneficial, with several whose children had diagnoses after one year of age being particularly vehement about the need for earlier diagnosis. Overall, most parents expressed satisfaction with audiology and oral therapy (listening and speech) services, but they felt need, first, for more information specific to their own child's prognosis for spoken language skills and, second, for more opportunities to interact with other parents in their situation. Many recounted a lack of co-ordination of services and information provided across specialists and agencies. Like the parents in the UK studied by Young and Tattersall (2005), the Canadian parents thought that professionals' abilities to communicate and the manner in which information was delivered were important determinants of their overall experience.

In a further analysis of UK participants, Young and Tattersall (2007) explored parents' reactions to and discussion of effects of their knowing about their child's hearing loss so early in life. Although most had positive feelings about this, they related that the timing did not prevent their sense of grief about the ultimate diagnosis. Most, however, thought that being able access appropriate assistance so early was a great benefit to their child and, by extension, to themselves.

A minority (five) of families who perceived that they had not received appropriate and timely help from professionals, failed to share this positive opinion. The researchers emphasised in their interpretation that early interventionists should "… be mindful of the need to create the space for parents to feel their responses to their child's deafness… and not for that psychological process to be disallowed… " (p217). They noted that some parents' response pattern of rushing into activity at the diagnosis and feeling stressed by timetables can be an avoidance mechanism. They also noted that most of these parents expected that early identification and intervention would provide for "normal or near-normal… speech and hearing… " (p217) – in short, they expected their child to become like a hearing child because of the early intervention[6] – although that expectation is not supported by data about early identification and intervention. In fact, average language development in this group tends to fall at the "low average" level compared to hearing children (Yoshinaga-Itano, 2003), an outcome that applies to children learning and using signing as well as those acquiring spoken language skills. McGowan, Nittrouer, and Chenusky (2008), for example, reported that speech development of 10 carefully-selected

[6] ♣Similar reports from parents in Ireland suggest the need for complete and continual parent education services.♣

12-month-olds with hearing loss, despite identification shortly after birth and extensive use of hearing aids, was significantly less mature than that of a comparison group of hearing 12-month-olds. In short, identification and intervention decrease but do not negate effects of hearing loss on development.

One goal of early intervention is to assure that parents have positive expectations for their children's progress, but Young et al (2005) noted that professionals' advice to parents also needs to be realistic. Progress is being made in the effectiveness of support for development of young deaf and hard-of-hearing children, but the many uncertainties about any individual child's development and educational outcomes need to be admitted.

5.2 Enhanced developmental outcomes related to early identification

Although some investigators have pointed out that studies of the efficacy of early identification and intervention have rarely employed appropriate experimental designs (eg Ching et al, 2008), researchers generally have found very significant developmental advantages for children following earlier compared to later diagnosis and intervention services. For example Yoshinaga-Itano and her colleagues (Mayne, Yoshinaga-Itano, & Sedey, 2000a; Mayne, Yoshinaga-Itano, Sedey, & Carey, 2000b; Snyder & Yoshinaga-Itano, 1998; Yoshinaga-Itano, Coulter, & Thomson, 2001; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998) compared the development of samples ranging from 54 to 72 children with early identification of hearing loss to that of 59 to 78 children with later identification. After accounting for variables including degree of hearing loss, gender, socio-economic status of family, age at testing, communication mode (sign or speech-focused programming) and nonverbal play levels (as a measure of cognitive development), multiple regression analysis showed a significant inverse relation with age of identification of hearing loss; that is younger ages at identification resulted in higher levels of functioning. Positive effects on language development were associated, in particular, with identification and the start of intervention by six months of age. The average child with this or earlier age of identification performed on language measures at the "low average" range of the development of children with normal hearing" (p15), a level that far exceeds the level of language skills for same-age children who do not receive early identification and intervention (Leigh et al, in press).

This group of researchers has also found positive effects of early identification and intervention on social-emotional development (Yoshinaga-Itano, 2003) and on the development of play (Yoshinaga-Itano, Snyder, & Day, 1998). Unlike reports of earlier cohorts of children with hearing loss (eg Geers & Moog, 1989; Levitt, McGarr, & Geffner, 1987), children in a programme of studies in Colorado (Yoshinaga-Itano, 2003) who had intervention beginning in the first year of life did not show significant differences between performance on nonverbal cognitive measures and measures of language functioning. Whether early-identified deaf or hard-of-hearing children were in oral (spoken language only) or some form of sign language environment, language and nonverbal cognition appeared to be developing in tandem. Interestingly, Becket et al (2006) also identified six months as a critical age for effects of early deprivation in normally hearing children. Children removed from non-supportive institutions and provided normal environmental supports before that age did not show the negative effects on cognitive and social-emotional development common in children who experienced institutionalisation beyond six months of age.

5.2.1 How early is "early enough"?

Six months of age does not always emerge as critical for positive effects of early intervention (eg Hogan, Stokes, White, Tyszkiewicz, & Woolgar, 2008). Some studies (eg Calderon, 2000; Calderon & Naidu, 1999; Kennedy et al, 2006; Meadow-Orlans et al, 2004; Moeller, 2000) have reported that children with hearing loss identified and intervention provided up to age one year perform, on average, higher than expected compared to later-identified children. Moeller, for example, assessed language development of 112 children with hearing loss and using multiple regression techniques found a significant effect for age at diagnosis and intervention. In her sample, children with intervention beginning before age 11 months acquired language significantly better than those with a later start of intervention services. At age five years, those children were functioning in the low average range compared to norms for hearing children on a number of standardised language tests. In addition to the finding related to age of first intervention, Moeller found that a measure of parental involvement with the child and the educational programme significantly predicted language development levels.

DesJardin (2006) reported that parent involvement had an impact on language development of early-identified children. This is an important result given that Fitzpatrick et al (2008) found parents' satisfaction with post-diagnosis experiences to be related to their continuing degree of involvement in programming and Calderon and Naidu's (1999) finding, in a longitudinal study, that age of first intervention services predicted deaf children's receptive and expressive language and speech scores as well as greater mother-child interaction. Meadow-Orlans and her colleagues (Meadow-Orlans et al, 2004; P Spencer, 1993a, 1993b), conducted a longitudinal study of development from age six or nine months to 18 months, with 20 deaf or hard-of-hearing children with hearing parents, a comparison group with deaf parents, and a group of hearing infants. All children with hearing loss had their losses identified before nine months. Results indicated that about a third of the children with hearing loss who had hearing parents matched the 18-month language levels of the average children in the other two groups. Convergent evidence from various research groups, therefore, has indicated positive effects on child language development from early identification of hearing loss followed immediately or soon after by intervention services, but a specific age has not been definitively identified. Given the heterogeneity of deaf and hard-of-hearing children, this situation is not surprising. At the same time, there has been no indication of overall negative effects on social-emotional functioning from early identification.

5.3 Characteristics of early intervention that support positive developmental outcomes

Yoshinaga-Itano (2003) has pointed out that positive effects of early identification have been found only when accompanied by early intervention. This conclusion was echoed by Hogan et al (2008) who studied early language development of 37 children in England. Unfortunately, data-based comparisons of development across intervention programmes, if conducted, tend not to focus on specific pedagogical or parental support approaches – although it is generally agreed that successful early intervention needs to be aimed at parents and not at individual therapy sessions with the child (Bodner-Johnson & Sass-Lehrer, 2003; Sass-Lehrer & Bodner-Johnson, 2003). Instead, many researchers have focused on identifying effects of the specific approach to communication and language that is used – that is, whether strictly oral (auditory-spoken language) or visual (sign language) or a combination of the two approaches. This issue is addressed at length later.

For guidance about characteristics of successful intervention practices it is instructive to review characteristics of the programmes from which evidence of benefits of early identification have been obtained. Yoshinaga-Itano's team of researches, for example, is in the US state of Colorado, a state that had specific intervention approaches in place even before the beginning of neonatal hearing screening. As described by Yoshinaga-Itano (2003, 2006), the programme has the following characteristics:

1. Providers of early intervention services are trained professionals, usually with graduate degrees in their fields (which include deaf education, early childhood special education, speech/language pathologists, audiologists, counsellors/social workers and psychologists. They receive regular additional in-service training.

2. Services are provided to parents (not directly to the infants) 1 to 1.5 hours weekly and include information on child development, communication strategies etc.

3. First contact is made immediately after the diagnosis and the professionals who work first with parents are specially trained to provide emotional support, as needed, to deal with their responses.

4. Regional co-ordinators provide information and the guidance necessary to assist parents in choosing an initial approach to language use, but this initial decision can be modified when appropriate. Options for various language approaches are available, and decisions may be changed over time.

5. Children's developmental progress is assessed twice yearly and results are used to help parents make or revise decisions on how to support their child's development.

The preceding characteristics are widely accepted as best practice, and their general absence in Ireland should be noted by the Department of Health and Children, the Visiting Teacher Service and the Department of Education, the last of which eventually will pay the literal and metaphorical price for their absence. As for regular assessment of student progress, for example, site visit interviews with educational personnel indicated that most often support services for deaf and hard-of-hearing students in regular schools were provided as available, rather than being specified and provided on the basis of individualised education plans (see *Guidelines for the Individualised Education Plan Process* at http://www.ncse.ie). This was particularly noteworthy regarding audiological services and technological support (classroom frequency modulated – FM – and other assistive listening technologies). Site visit observations of two students in regular classrooms – one hard-of-hearing, the other with a cochlear implant – indicated that they received little if any daily support services. In contrast to evidence reported later in this review, it was stated that school personnel now considered the student with the implant as a hearing student and there seemed little awareness of the continuing support typically needed by implanted and hard-of-hearing children. In most cases, SNAs provide support services and care assistance. They are assigned to the schools for the deaf on the basis of the number of students with special needs and to mainstream schools and special units for the deaf on the basis of individual assessments. A proportion of those SNAs, both hearing and deaf, have backgrounds in deaf education and some serve as sign language interpreters. Several older deaf students reported that since starting to learn sign language, they had far better access to the curriculum and classroom activity than ever before. Most regretted not having learned to sign earlier.

Other US programmes, including the Boys Town National Hospital programme (Moeller, 2000) and SKI*HI (Watkins, Pittman, & Walden, 1998), that have shown positive child developmental effects after early identification of hearing loss also have emphasised a family-centred approach in which professionals and parents are seen as partners and the interventionists work only indirectly with the children (see Brown & Nott, 2003, for similar programming in Australia). In addition, these programmes have strong family counselling and support components. This may be especially important given comments by parents who participated in the Young and Tattersall (2007) study that knowing early in their child's life about the hearing loss did not prevent their grief. Although staff of the Boys Town and SKI*HI programmes present information to parents about communication and technological options perceived as potentially helpful for individual children, programme staff adopt a non-judgmental and supportive approach to family decisions. In addition, the SKI*HI programme uses an in-depth curriculum (Watkins, Taylor, & Pittman, 2004) that shares information with parents about child development in general and specifically for those with hearing loss.

Mohay, Milton, Hindmarsh, and Ganley (1998) reported implementing a similar programme in Australia. The "Deaf Friends" project teamed deaf women with hearing families that had a deaf child. Parents learned a variety of techniques for visual attention-getting and visual communication, regardless of whether their children were acquiring sign or spoken language, through videos, workbooks, and home visits. Mohay and her colleagues reported that such experiences enhanced parent-child interactions and reduced parental anxiety about their children's deafness. Empirical evaluations of language, social or educational outcomes, however, apparently have not been undertaken.

When families decide to use sign language with their children, programmes such as the SKI*HI deaf mentor programme have shown positive effects on parent and child communication. Watkins et al (1998) compared outcomes for a group of 18 families receiving services from a deaf adult (who provided sign language instruction and experience as well as information about hearing loss and the deaf community) and another group of 18 families who received weekly intervention visits but without the deaf mentor. Children whose families worked with the deaf mentor showed faster rates of language growth (including vocabulary and English syntax). In addition, parents who worked with the deaf mentor were more knowledgeable about aspects of deaf culture and became more proficient users of American Sign Language and signed English (see below) than those who did not.

A similar finding was reported by Delk and Weidekamp (2001) who evaluated a programme in which specially-trained deaf adults demonstrated book sharing for hearing parents. In response to a questionnaire, the parents reported increases in use of sign language and in satisfaction with book interactions with their children. In general, experiences that increase parents' confidence and feelings of competence in communicating with their child with a hearing loss have been positive for their interactions and the child's language development. This has been reported for families who have chosen to use only spoken language (DesJardin, 2006) as well as those using signs.

5.4 Summary

A variety of studies, most of which are based on correlational approaches or quasi-experimental group comparisons, indicate that early versus later identification of hearing loss in provision of early intervention services generally provide a host of developmental advantages. The exact age of identification that is critical has not been consistently specified, but six months and one year both have been found to represent boundaries delineating ages that provide significant boosts in development. Further analyses have failed to find an earlier age (two months, four months) that results in another significant boundary related to outcome benefits. Early identification and intervention are not developmental panaceas, however, as research continues to show that language performance of early-identified children overlaps with but does not match typical performance of hearing children. Effectiveness of intervention provided may interact with age at diagnosis in ways not yet fully understood. Several major questions thus remain about early identification of and intervention for hearing loss relevant to educational outcomes as well as personal and social-emotional growth:

1. Is there a "critical age" during the first year of life before which diagnosis needs to occur and intervention needs to begin to optimally support the development of deaf and hard-of-hearing children?

2. Why does average development of deaf and hard-of-hearing children continue to lag behind that of typical hearing children even in the case of early identification and intervention?

3. What are the specific characteristics of intervention procedures that will optimally support the children's development and how might these characteristics interact with those of families and children?

4. What are best approaches to protocols for identifying children whose hearing loss develops during infancy but after the neonatal period and how, if at all, do intervention efforts need to differ from those for families who receive their child's diagnosis during the neonatal period?

None of these questions, however, in any way should be taken to minimise the importance and potential benefits of early identification and intervention.

6. Language Development, Language Systems and Relationships with Literacy

Although age-appropriate language development is often taken as a given when regular education programmes for hearing children are considered (with special attention of course paid to children for whom either organic or environmental differences cause delays), language acquisition has long been recognised as the central difficulty facing most deaf and hard-of-hearing children (Marschark et al, 2002; Moores, 2001). Deaf children born into deaf families who use sign language develop that language at a rate roughly equivalent to hearing children, but this group comprises less than 10 per cent of deaf children (Karchmer & Mitchell, 2003).

Unlike the issues of early identification and intervention, questions about the choice and implementation of methods for supporting the language development of deaf and hard-of-hearing children continue to be hotly, even emotionally, debated. It is generally agreed, however, that if children with hearing loss are not either given visual language models they can process or special programming and assistive devices (hearing aids and/or cochlear implants) that allow effective access to auditory-based language input, they may reach pre-school and even primary years with few if any language skills (Moores, 2001). And, although early identification and intervention can ameliorate those delays, they still do not provide an "even playing field" as most children with hearing loss continue to reach pre-school age with significant language delays (eg Meadow-Orlans, Mertens, & Sass-Lehrer, 2003; Marschark & Wauters, 2008).

Delays and deficits in language affect academic growth and outcomes in at least four ways.

1. Literacy skills necessary for access to academic materials are built on the foundation of general language skills. Deficits in vocabulary, syntax and the ability to use abstract language, all of which have been documented for a large portion of deaf and hard-of-hearing children, directly impede acquisition of literacy (reading, writing) skills and thus limit academic experiences (Marschark et al, 2002).

2. Delays or deficits in the classroom language further limit academic experiences since they complicate the teacher's job as s/he attempts to communicate information to students, and the student's job as s/he expends extra energy and attention to make sense of things the teacher is trying to communicate through language.

3. Access to "incidental learning" – a major source of information for most hearing children – is severely limited when a child cannot overhear (or, in the case of sign language, "oversee") communications among adults and other children in the environment (Carney & Moeller, 1998). To the extent that language delay limits children's experiences to interact with other children and with adults, their exposure to new information and to learn about others is further limited. Thus, lack of language skills limits the amount of social, cultural, and intellectual information typically attained by young children simply from being around people who are conversing.

4. Cognitive and academic learning are limited when a student lacks sufficient language sophistication (metalinguistic or metacognitive skills) to allow "thinking about" learning, re-organising and remembering information observed and learned, making inferences and drawing logical conclusions based on understanding nuance (Marschark & Hauser, 2008). In fact, the frequent observation that median level of reading achievement by US deaf students finishing secondary school is equivalent to that of nine- or 10-year-old (or fourth-grade) hearing children is often explained by the fact that reading activities beyond that level typically require a level of *use* of language understandings that goes beyond literal interpretation of print (Marschark & Hauser, 2008; Martin, Craft, & Sheng, 2001).

Recognising the critical role of language skills in learning as well as socialisation programmes for children with hearing loss have traditionally focused most strongly on this area – sometimes to the exclusion of attention to "content" areas such as social studies, science, and even mathematics (Moores, 2001). Despite the focus on language development and the development of numerous approaches to support it, language remains an area of great concern despite advances accruing from early intervention, the use of more effective amplification devices and greater appreciation for early use of signed languages. Longstanding, if fruitless, arguments on best support for language development of deaf and hard-of-hearing children usually have centred on the degree to which the goal is acquisition of the spoken language used in the surrounding hearing culture or, instead, a fully functional language system (regardless of the sensory modality in which it is received and expressed). Throughout the following, therefore, it will be useful to keep in mind Hauser and Marschark's (2008) warning:

> Our convenient division between individuals who use spoken language and those who use sign language is largely a fiction. Regardless of the hearing status of their parents, their hearing thresholds, and their educational placements, most deaf students are exposed to both language modalities [and] hard-of-hearing students are in a similar situation (p450).

Approaches typically referred to as "oral" or "auditory-oral" focus on promoting production and understanding of *spoken* language and minimise to various degrees visual support for language. Sub-types of oral education (Beattie, 2006) include auditory-verbal methods, which aim to build attention to and understanding of language solely via hearing or audition (eg Eriks-Brophy, 2004; Hogan et al, 2008), as well as traditional oral methods that include an emphasis on using visual information provided by context and lip-/speech-reading along with auditory information. A method called natural auralism stresses learning to use audition in naturally-occurring interactions instead of through a more structured approach for building spoken language skills (Lewis, 1996). The maternal reflective method (Watson, 1998) combines the use of written text with the use of oral methods and stresses a naturally-occurring conversational approach. Cued Speech (Leybaert & Alegria, 2003) is also considered an essentially "oral" method although it uses visual signals presented through specific hand shapes produced in specific locations to represent auditory phonemes (or language sounds) to supplement and disambiguate information available from lip-reading and residual hearing.

'Manual' or sign-based education approaches (Fischer, 1998; Mayer & Akamatsu, 1999) have been prevalent in deaf education settings since their resurgence in the 1970s (Anthony, 1972; Bornstein, Saulnier, & Hamilton, 1980; Gustason, Pfetzing, & Zawolokow, 1980). Subtypes within this general approach include use of (a) natural sign *languages* such as American Sign Language (ASL), British Sign Language (BSL), Australian Sign Language (Auslan), and so on, which are primarily based on production and processing of visual symbols and which developed, in general, without input from the spoken language of the surrounding culture and (b) "artificial" or created sign *systems* such as signed English or signed French. In these systems, in which signs are often produced in conjunction with spoken language, signs are produced to match the word order of the local spoken language; created signs or finger-spelling may be used to represent grammatical meanings in a linear fashion to match the way they occur in the spoken language. Finger-spelling involves production of handshapes that represent the orthography of written language and are used to "spell out" words or meaning units. It is used quite frequently in American Sign Language often to represent English words for which there are no generally-agreed-upon signs, but finger-spelling is used less often by deaf persons in some other countries (Padden & Gunsals, 2003). American deaf mothers have been noted to use finger-spelling occasionally with even very young (pre-literate) children, and some researchers have suggested that it can provide a bridge to understanding print (Padden, 2006; Puente, Alvarado, & Herrera, 2006; but see Mayer & Wells, 1996).

Forms intermediate between the natural sign languages and the created systems have developed in part due to interactions between deaf adults and hearing adults who are late learners of sign language. Such intermediate forms (called "contact signing" by Lucas & Valli, 1992) are often used by hearing parents and professionals, but their efficacy as a basis for literacy skills and learning has been questioned theoretically (eg Johnson, Liddell, & Erting, 1989), because they do not fully represent the lexicon or grammar of either the hearing culture's spoken language or the naturally-developed sign language of the corresponding deaf culture. They typically include some of the non-manual meaning units (such as specialised facial expressions) of natural sign language and omit many of the grammatical morphemes expressed in the spoken language.

The following sections address approaches to language development currently in common use across programming for children with hearing loss. In each case, data available about the rate and course of early development is presented, and implications for literacy and learning in other educational domains are discussed. The primary issue addressed here is the degree to which a child using each of these languages or language systems can be expected to develop language to the extent assumed necessary to support literacy and academic achievement.

6.1 Auditory-oral methods and language development

6.1.1 Traditional oral programmes

Proponents of the various "oral" methods stress the social, linguistic, and academic access provided by ability to comprehend and produce the surrounding culture's language. The primary goal of an oral education approach is to build speech perception, production and general spoken language skills. In addition, spoken language is thought by many (eg Mayer & Wells, 1996; Perfetti & Sandak, 2000) to provide an optimal basis for acquisition of literacy skills in that children are expected to make the transition to reading and writing more easily if they can move directly from spoken to printed forms of the same language. Given that most young hearing children apply phonological knowledge as a major way to decode print, it is also thought that a thorough grounding in the phonology of the spoken language will enhance deaf and hard-of-hearing children's acquisition of literacy skills. To date, however, few reports indicate that participation in traditional oral programming results in deaf and hard-of-hearing children attaining literacy achievements equivalent to those of hearing peers. Reports apparently meant to be positive in tone indicate only a fourth to a third of deaf children achieving average or higher levels (eg Geers & Moog, 1989; Lewis, 1996). Despite many published "how to" articles, both Watson (1998) and Beattie (2006) noted a paucity of databased outcome studies.

Available studies show some children make age-appropriate progress using oral approaches with no one in particular favoured. Even proponents note, however, that many if not most, do not. This is the case even when hearing loss is in the mild to severe range (eg Elfenbein, Hardin-Jones, & Davis, 1994; Goldberg & Richburg, 2004; Moeller, Hoover et al, 2007a, b; Nicholas & Geers, 1997). Children with profound hearing loss, using hearing and participating in oral programmes, have in fact been reported to develop spoken language at only 50 per cent of the rate of hearing children, with average delays of up to five years at high-school age (Blamey et al, 2001; Boothroyd, Geers, & Moog, 1991). Specific deficits have been noted repeatedly for deaf and hard-of-hearing children in vocabulary, syntax and English morphology (eg Griswold & Commings, 1974; Moeller, Osberger, & Eccarius, 1986). Delays have been traced back to the initial stages in language acquisition and are evident in differences in the frequency and age of emergence of vocal babbling (Oller, 2000, 2006) as well as in production of first words. These differences continue to be noticed but are typically less pronounced in young children who have had early access to cochlear implants and also in children who have early-identified hearing loss in the moderate to severe range (Moeller, Tomblin, et al 2007) as compared with children with profound hearing loss.

Differences also have been noted in the emergence of pragmatics, or the functions of children's communication in the pre- and early-linguistic stages. Specifically, Lichtert and Loncke (2006), Nicholas (1994), and Nicholas and Geers (1997) have all reported that pre-school children in oral programming rarely express a heuristic or "information sharing" function in their communications. This is a pattern that differs from that of same-age hearing children. It may simply reflect language level, as opposed to modality of communication, in that a similar pattern was documented for three-year-old children just beginning to use signs ([Spencer] Day, 1986.)

Nicholas and Geers (1997) found that at around three years, when the hearing children in their study were using spoken language consistently, deaf children in oral programming continued to use frequent pre-linguistic vocalisations and gestures. These children, whose hearing loss had been diagnosed on average at 12 months, were said to use speech in only a minority of their expressive communications (about a third of the time). Most speech productions were imitations and not spontaneous communications. The deaf children's use of speech at age three, especially to make comments as opposed to using communication simply to make requests or direct others, predicted their language skills at age five. In contrast, their tendencies to use gesture at age three failed to predict language levels at five years. Although it is not specified by Nicholas and Geers, the development pattern they reported suggests these children would have had continued language delays at age five that would not have provided a base for learning equivalent to that of most hearing children.

Nicholas (1994) noted that the tendency to use speech communicatively seems to be associated with speech perception abilities, so it might be expected that children with earlier diagnoses and use of advanced amplification or cochlear implants would show more rapid development. In a comprehensive review of literature, Geers (2006) reported that this has generally been noted to be the case: Cochlear implants have increased the average rate of language development and that of speech skill development by profoundly deaf children in oral programming compared to that of their peers who use hearing aids. Furthermore, there have been reports that parents have changed from using signs to using only speech after cochlear implantation (Watson, Archbold, & Nikolopoulos, 2006; Watson, Hardie, Archbold, & Wheeler, 2007; Yoshinaga-Itano, 2006) often in response to their children's increased use of speech (eg P Spencer, 2004). Geers and Moog (1994) found advantages for children using cochlear implants compared to those using hearing aids on expressive vocabulary, receptive syntax and measures of speech production. These and associated language and speech benefits have generally been found to increase as the age at which cochlear implants are used decreases, regardless of the type of language programming (oral or signing) in which they are participating (eg Connor, Hieber, Arts, & Zwolen, 2000; Dettman et al, 2007; Fryauf-Bertschy et al, 1997; Holt and Svirsky, 2008; Schorr, Roth, & Fox, 2008; P Spencer, 2004). However, most of these same (and other) investigators report that even with early implantation, language abilities remain on average below those of hearing peers (eg Chin, Tsai, & Gao, 2003; Geers, 2002; Holt & Svirsky, 2008; Schorr et al, 2008; P Spencer, 2004).

In more positive reports, Nicholas and Geers (2007, 2008) presented evidence that children receiving cochlear implants before 24 months and who participate in either traditional oral or auditory-verbal programmes in which reliance on visual input is de-emphasised, can develop language abilities by age 4½ (pre-kindergarten age) at levels within the typical range documented for hearing children. This result was found to be related to degree of aided hearing before receiving the cochlear implant: better hearing before implantation was associated with better language after implantation. It should also be noted that all children studied by Nicholas and Geers had nonverbal cognitive functioning in at least the average range and came from families in which English was the only language spoken. They therefore cautioned that more research was needed to determine whether this positive pattern would be maintained at older ages when language skills and learning demands typically become more varied and complex (Marschark, Sarchet, Rhoten, & Zupan, in press).

It apparently remains the case that the best outcomes of oral education are obtained when emphasis on the oral approach is consistent, when effective amplification is obtained early in life and used consistently, when early intervention and education are provided and when there is strong parent support for the language approach chosen and their children's language development (eg Beattie, 2006; Geers & Moog, 1992; see also Geers, 2002). The preceding studies also indicate that nonverbal cognitive skills, the level of aided hearing available to the child, parents' general resources and the absence of disabilities in addition to hearing loss are important predictors of successful oral language development. Geers (2002) reported that her study of 181 children (aged eight to nine) using cochlear implants showed a small but significant effect of communication mode on spoken language and literacy outcomes, with children in oral (or auditory-verbal) programmes doing better than those in which combined or simultaneous speech and sign were used. Beattie (2006) has noted, however, that the quality of the language and educational programme provided and not only the particular language approach used influences outcomes, while Marschark et al (in press) notes the importance of pre-implant cognitive abilities and language skill.

One well-structured curriculum approach that can provide an example of contemporary oral programming has been described in a qualitative paper by Wilkins and Ertmer (2002). In discussing their private, non-profit oral school in the US, they defined the approach to language development as including "auditory information… supplemented by visual and tactile cues…" (p198) especially during the early stages of language development. The visual information referred to includes lip-/speech-reading, attending to facial expressions, and other visual cues typically part of the language reception process of hearing children and adults. This approach, beginning as multisensory (although never with the use of signed language) with gradually decreasing input from vision and tactile senses as spoken language skills build, has a venerable history and has perhaps been most systematically presented recently in the EPIC (Experimental Project in Instructional Concentration) curriculum (Moog & Geers, 1985). It includes attention to and monitoring of amplification devices (hearing aids or cochlear implants) and individualised but tightly sequenced goals for spoken language skills. Assessment instruments have been developed to track student progress and results are used to define continuing goals. Vocabulary, morphology and syntax are taught through direct instruction with interactive conversational activities used for practice.

A modelling and repetition approach is used in structured sessions. Group sessions typically have a low student-to-teacher ratio (four to six students per teacher in the programme described by Wilkins & Ertmer) and often use ability grouping based on language skills.

Appropriate placement in the programme described by Wilkins and Ertmer (2002) is said to depend upon a careful assessment of potential for success (which skews any outcome assessments, but by design). Variables considered are nonverbal cognitive functioning (and lack of disabilities other than hearing loss), parents' support for and dependence upon spoken language at home as well as at school, aspects of child behavioural functioning such as attention and distractibility and initial results on communication and language measures. In this particular programme, a trial period initiates enrolment and recommendations for continuing, changing communication modality (and thus programme), or moving to a mainstream programme are made after a six-month period. It should be noted that, in addition to the focus on language development, this programme includes activity-based work in early literacy and quantitative concepts. Wilkins and Ertmer report that of their first 60 students, seven later transferred to a different school using a "total communication" approach (sign accompanied by speech and amplification). These transfers indicate that some students were not deemed to be successfully acquiring spoken language, even given apparently optimal oral programming.

Thus it is clear from research comparing groups of children and from qualitative case studies that oral approaches to language development can support adequate language development by some but not all children with hearing loss, even given technological advances and early identification. It has been reported in several studies that compared students in oral versus signing programmes that those in the former, on average, show higher levels of literacy skills, both reading and writing, than students in the latter (Geers & Moog, 1989; Moores & Sweet, 1990; Musselman & Szanto, 1998).

However, a causal relationship has yet to be identified due to choice of language modality being influenced by background factors including family socioeconomic factors, presence or absence of additional disabilities and child's use of amplified hearing, as well as selective bias in programme enrolment. Geers (2006) pointed out that even in these "successful" cases, literacy levels remained low and lagged in language skills persistent at least through the secondary school years.

Because cochlear implants generally increase access to auditory-based language for the children with most severe hearing loss, their use has been expected to increase literacy levels. Findings to date have been difficult to interpret. Geers (2002, 2006) reported that over half of the 181 orally-trained children using cochlear implants she studied scored within the average range (age eight to nine) on reading tests for hearing children. However, when a subsample were re-tested between age 15 and 16, their reading scores averaged about two years behind grade level expectations (Geers, 2005). Increasing lags within the larger sample have been reported by Geers, Tobey, and Brenner (2008) in a longer-term follow-up study. Still, levels achieved by the older students compare well with the average of a fourth grade level frequently cited for the body of deaf and hard-of-hearing children as a whole (eg Traxler, 2000). Given the relative advantages of this group of children using cochlear implants, however, the degree to which orally-focused education can reliably provide adequate support for the emergence and development of literacy and academic skills remains in question.

6.1.2 Auditory-verbal method for language programming

The approach referred to as auditory-verbal therapy (AVT) (eg Estabrooks, 1998; Pollack, Goldberg, & Coleffe-Schenk, 1997) is similar to an earlier method called verbotonal. It differs from traditional oral approaches discussed previously in its decreased attention to visual accompaniments of auditory input (Beattie, 2006; Hogan et al, 2008; Wilkins & Ertmer, 2002). Although this method is subsumed under the "oral education" umbrella, it is addressed separately here due to a resurgence of interest in its use since the advent of enhanced hearing aid technology, cochlear implants and, in some cases, expectations raised by early identification of hearing loss. Proponents note that it is a therapeutic approach typically conducted by highly-trained specialists with children during pre-school years (Eriks-Brophy, 2004). The goal is to have the children acquire spoken language skills appropriate for their chronological age by the time traditional schooling begins at age five or six (Eriks-Brophy, 2004; Rhoades, 2001, 2006).

Much written material is available about conducting the therapy (Estabrooks, 1994, 1998), but only recently have measures of its effects been available. Both Eriks-Brophy (2004) and Rhoades (2006) undertook reviews of available evaluative information and concluded that although case study and descriptive-level evidence supported the approach, no existing studies had employed designs rigorous enough to produce evidence-based judgments of effectiveness.

Responses to surveys distributed to American and Canadian graduates of auditory-verbal therapy programmes (Goldberg & Flexer, 1993) and American and Swiss parents of its students (Robertson & Flexer, 1993) provided qualitative evidence of positive developmental outcomes. Most participants were said to have average to high literacy levels and to interact primarily in mainstream or hearing environments. A survey of Australian students produced similar findings (Roberts & Rickards, 1994a, b). Although these studies may provide an estimate of satisfaction of participants in auditory-verbal therapy, and the reports of a high incidence of mainstreaming and age-appropriate reading skills are consistent with its aims, samples in all cases were self-selected and survey data obtained were retrospective and inherently subjective. Studies by Wray, Flexer, and Vaccaro (1997) and by Lewis (1996), which also indicated that participants tended to achieve higher-level literacy skills than typically reported for deaf or hard-of-hearing students, either provided no normative information with which to compare the auditory-verbal therapy participants or used non-standardised instruments for data collection.

In a descriptive study, Duncan (1999) found that pre-school-age participants could engage in appropriate conversational turn-taking but that their contributions tended to be shorter and had linguistic content less frequently than those of hearing peers. Duncan and

Rochecouste (1999) also found evidence of delay in participants compared to hearing peers on expressive spoken utterance length and use of grammatical morphemes. The deaf and hard-of-hearing children performed at about one year below expectations for their chronological age. They were acquiring English grammatical forms but at a slower rate than is typical for hearing children.

Rhoades (Rhoades, 2001; Rhoades & Chisholm, 2000) administered three standardised language tests (Pre-school Language Scale-3, Sequenced Inventory of Communication Development, Oral-Written Language Scale) to 40 children, aged 50 to 120 months, who participated in the AVT approach for one to four years. The results of repeated testing showed increasing scores with age and with time in programme on all of the measures, and "some" children were reported to have attained a 100 per cent rate of language growth. That is, their scores advanced the equivalent of one-year's language growth with one year of chronological age. It is worth noting that 27 participants used cochlear implants. After several years of participation, some children showed no gap between language-age and chronological age with receptive language generally growing fastest in the first two years of programming, followed by growth in expressive language skills, including use of grammatical morphemes and syntax. Interestingly, about three-fourths of participants in the Rhoades (2001) study were diagnosed to have either or both sensory integration or oral-motor co-ordination problems, and 30 per cent of the children did not continue use of auditory-verbal therapy. Although there was no control or comparison group, these findings indicate that, at least in some cases, spoken language progress is made by deaf and hard-of-hearing children in the programme at rates similar to those of hearing peers. The large drop-out rate, however, suggests that not all children and their families experience success.

Language and literacy progress was also varied in a group of 62 American children studied by Easterbrooks and O'Rourke (2001). The children, who had participated in an auditory-verbal programme for at least one year, showed varied patterns of language and literacy progress. The programme included one-to-one language therapy, parent instruction and expectation of parent follow-through at home. Participating families were generally financially affluent, highly educated and "highly involved" (p313) with their children's education. Children's age at assessment was not clear from the published article, but based on reports from educational testing, language and literacy scores of the boys fell, on average, 3.8 years below what would be predicted from a nonverbal measure of cognition. Girls' language/literacy scores fell 2.7 years below predictions based on the nonverbal measure. Easterbrooks and O'Rourke, who were primarily interested in gender-related differences, noted that language and literacy performance were associated with aspects of child attention behaviours and aided (amplified) hearing levels. Other variables suggested to relate to progress but not controlled in this study included age of identification, entry into and duration of time in the programme.

In a short-term longitudinal study, Hogan et al (2008) documented the rate of change in spoken language skills of 37 children in England who participated in auditory-verbal therapy in addition to programming provided by their local educational agency. Their parents were highly motivated and some travelled considerable distances to attend sessions. Twenty-two of the children had profound hearing losses, 10 had severe losses and five had moderate losses. When data collection began, five were using cochlear implants and, during the course of the study, an additional 18 obtained implants. Children's spoken language skills were repeatedly assessed, at programme entry and then at intervals of at least six months, on the Pre-school Language Scale-3 (UK version) (Zimmerman, Steiner, & Evatt Pond, 1997). Growth over time was plotted and the ratio of language-age (that is age equivalent scores on the language scale) and chronological age was determined at each testing time with that ratio termed the "rate of language development" or RLD.

The rates before intervention were compared to those observed after at least one year of participation. A language development rate equal to 1.0 would show language growth equal to change in age. In fact, 34 of the children scored less than 1.0 at initial testing, and 11 still had an rate of less than 1.0 at the end of the study. This indicates that most children's language growth rates (but not necessarily language levels) accelerated during the programme and were as fast or faster than expected for hearing children. Interestingly, children who switched from using hearing aids to cochlear implants during the study showed two periods of acceleration – one when therapy was initiated and another after implantation. Overall, 23 children showed language development rates greater than their initial language/age ratios predicted they would achieve. Twenty, about half the participants, had language test scores within the 90 per cent confidence band expected for chronological age at the end of the study. Some who did not achieve at this high level had been identified to have additional disabilities. At age five, 30 participants were in mainstreamed educational placements, six were in regular schools but had additional assistance through a resource unit, and one was attending a special oral school.

Hogan et al (2008) pointed out that their study did not compare results from auditory-verbal therapy with those of any other specific type of intervention although the children were receiving other services from local agencies. They also noted that parent involvement and investment in the therapy was strong – a factor that also has been shown (eg Moeller, 2000; P Spencer, 2004) to predict successful language development using other approaches (traditional oral, sign). Some questions also remain about the validity of interpretations of the study's rate of language development since a statistical assumption is made that growth will be linear.

Taken as a whole, the above studies indicate that auditory-verbal therapy is a viable approach for some deaf and hard-of-hearing children whose families choose to focus on spoken language development and do not want to use sign language or signing systems to support their growth. It appears from anecdotal reports from students and parents that literacy skills can be achieved at fairly typical rates when spoken language is attained and that children frequently are able to attend regular schools. Auditory-verbal therapy seems to be most successful with children from fairly highly educated families who remain intensely involved with the training approach and who have high expectations for spoken language development. In addition, children without any learning challenges beyond hearing loss seem to have a greater chance of success using it. Increases in auditory input from use of cochlear implants seem to enhance its positive effects. Despite reports of children who acquire spoken language at near-typical rates, many in auditory-verbal therapy programmes do not. Hogan et al consider the approach to be among the viable choices but certainly not the only one available to families based on their goals for their children.

6.1.3 Cued speech

Cued Speech was developed by Orin Cornett (1967) to provide deaf and hard-of-hearing children access to the phonology of spoken language and thus to promote acquisition of literacy skills. (He assumed that natural sign languages would continue to be used for classroom and social communication.) Recognising that a mere 20-30 per cent of the sounds of English can be reliably determined from watching the lips (called here "speech-reading"), Cornett developed a set of manual signals differing in handshape and in the location of production that would effectively supplement and disambiguate information available from observing lip shape and movement. Unlike sign language or sign systems (see below), Cued Speech signals represent auditory-based phonemes (sounds) and not semantic characteristics or meanings. It is meant to be produced concomitantly with spoken language and results in an integration of information pointing to a single, unambiguous, phonological percept that cannot be obtained from either source alone (Hage & Leybaert, 2006, p195).

Although developed in the US with its original components representing the American English phonological system, Cued Speech has since been used with modifications or additions to accommodate different phonological systems across several western European-based languages. It seems the advent of improved hearing aids, earlier intervention and early use of cochlear implants would (by providing deaf and hard-of-hearing children generally enhanced but imperfect auditory information) increase interest in this method. However, in the US its use has decreased in the past decade, and there is little research or evidence-based evaluation information available for Cued English. Cued Speech is more popular, or at least more peer-reviewed research papers are available, in countries in which French or Spanish is the dominant language (Marschark, 2001).

Researchers in Canada and Belgium have reported gains in speech perception at the syllable, word and simple sentence level for children using Cued English and Cued French (Nicholls & Ling, 1982; Perier, Charlier, Hage, & Alegria, 1988) with larger gains over perception from audition and speech-reading alone when the children had been in environments consistently emphasising cueing from an early age. Kipila (1985) also reported gains from use of Cued Speech in the rate of acquisition of American English morphology, typically an area of special difficulty for deaf and hard-of-hearing children. In a single case study of a child whose family used Cued Speech from age 18 months, Kipila documented 100 per cent correct use by about age five of the grammatical morphemes typically learned earliest by hearing children (present progressive, plural, irregular past tense, possessive, uncontractable copula and prepositions "in" and "on"). Although this child's acquisition process was delayed compared to that of hearing children, it was accelerated compared to that typically reported for deaf children in oral programming in which cueing is not used.

Similarly advanced morphemic knowledge has been reported in a single case study of a child whose parents consistently used Cued French with him from age 11 months (Perier, Bochner-Wuidar, Everarts, Michiels, & Hage, 1986, cited in Hage & Leybaert, 2006) and in a group study in which 27 students (tested at ages ranging from eight to 20 years) from cued French programmes were compared to 41 students who had roughly equivalent levels of parent involvement and programme intensity (Hage, Alegria, & Perier, 1991). The Cued Speech group showed advantaged scores on print measures of vocabulary, prepositions and grammatical gender – although only the preposition contrast reached statistical significance. Increased age was associated with knowledge of grammatical gender in the group from oral programmes, but near ceiling levels were reached by Cued Speech participants by about age 11. Hage and Leybaert concluded that increased phonological knowledge gained from use of Cued Speech led to this advantage.

Use of prepositions in Spanish was studied by Hernandez, Monreal, and Orza (2003), who compared deaf children using Cued Spanish, those in traditional oral programmes, and those using Spanish Sign Language with a group of hearing children. Statements were presented in written form and children were to choose a preposition from among several choices to correctly fill in a blank to make the sentence represent a pictorial representation provided with each item. Average age of the deaf children (total n=35) was 11-12 years and of the hearing children (n=17) eight to nine years. Most children in Cued Speech programmes had been in traditional oral programmes until age three. Despite their late start with Cued Speech, the average percent correct for that group (88 per cent) came close to matching that of the hearing group (93 per cent). Both groups scored significantly higher than children in the sign language and traditional oral groups (who averaged only between 57 per cent and 61 per cent correct and failed to differ significantly from each other).

The authors concluded that the combination of visual cues and speech-reading made these small but important Spanish grammatical morphemes perceptually salient for deaf children and thus allowed them to develop higher levels of competencies. It should be noted, however, that the Cued Speech participants were considerably older than the hearing students (four years on average) and that the performance of the Cued Speech group actually represented delayed development.

Leybaert and Charlier (1996) investigated the degree to which visual information from cueing can promote development of phonological representations that typically emerge primarily from audition, demonstrating rhyming abilities among deaf children using Cued French. Previous work had shown that the ability to make and recognise rhyming words predicts reading abilities in hearing children (LaSasso & Metzger, 1998). Bowey and Francis (1991) have proposed that rhyming allows children to form sound-based categories of words and later make connections between these categories and printed forms. Leybaert and Charlier noted that earlier investigators found deaf children could identify rhymes when lip shapes were the same or when rhyming words had similar spellings (eg Campbell & Wright, 1988; Dodd & Hermelin, 1977). Leybaert and Charlier further specified these findings by comparing groups of school-age deaf children with Cued Speech exposure at home and at school or only at school, with groups with sign language exposure at home and school or only at school, and with hearing children. Among the deaf groups, children with home plus school exposure to Cued Speech showed less reliance on lip shape or on orthography (printed letters) in identifying rhyming words. That is, the children had apparently internalised and generalised phonological knowledge based upon their experience with the combined lip shape/Cued Speech (and perhaps partial audition) of spoken words.

Leybeart and Charlier (1996) also examined rhyming abilities in pre-school-age deaf children who did not yet have reading skills. They found that only pre-schoolers with home and school exposure to Cued Speech could understand the idea of rhyme, and they did so as well as a comparison group of hearing children. The researchers concluded that the deaf children with extensive Cued Speech exposure could develop phonological concepts even before reading skills had been acquired and that such concepts are, therefore, not merely a reflection of reading experience.

The degree to which phonological skills are developed during pre-school years has been found to relate to the emergence of reading skills in children using Cued Speech. Colin, Magnan, Ecalle, and Leybaert (2007) reported a study of 21 hearing children and 21 deaf children in France and Belgium who participated in programmes emphasising spoken French plus Cued French. The time and extent of exposure to Cued Speech varied among the deaf children, with some having parents who used the system consistently at home and some being in a school environment using Cued Speech longer than others. They found the automatic (non-conscious) ability to make phonological comparisons (that is recognise rhymes) at kindergarten age predicted the ability to consciously make phonological comparisons (use meta-phonological skills) at the end of grade one. In addition, the early non-conscious phonological skills and ability for consciously-made phonological decisions predicted deaf children's written word recognition scores at first grade. Age of exposure to Cued Speech related to conscious command of phonology (meta-phonological skills) and first-grade reading. This association was maintained when chronological age and nonverbal IQ were controlled. The researchers noted that children did not overtly use Cued Speech hand movements when performing the tasks in kindergarten, but they did so in first grade. Leybaert and Charlier concluded that the effects of early exposure to Cued Speech may become apparent only when cognitive levels are reached that allow children awareness of and ability to manipulate previously implicit information.

Early and intensive exposure to Cued Speech may be critical for children to obtain significant benefits. In addition to the discussion of rhyming, Leybaert and Charlier (1996) also reported that children with early home plus school exposure to Cued Speech, unlike their peers with lesser experience, made spelling errors based on phonological rules, much as hearing children do. This is additional evidence of an internal phonology that is amodal and of the potential for visual input (albeit accompanied by some auditory input for most children) to support development of auditory phonological rules. As with conclusions about potential viability of traditional oral and auditory-verbal methods for supporting language and literacy development, however, positive outcomes of use of Cued Speech seem to depend upon early experience and a great deal of parent motivation and support. Cued Speech may be easier for parents to acquire than a natural sign language to which they are exposed only as adults (LaSasso & Metzger, 1998; Strong, 1988), and there are numerous case studies that document rich parental Cued Speech input to toddlers and pre-schoolers (eg P Spencer, 2000a; Torres, Moreno-Torres, & Santana, 2006). However, there are no studies directly comparing parents' acquisition and use of the various visually-based systems.

Some reports indicate that Cued Speech, which requires relatively fine motor movements and production of hand shapes in locations that may not be visible to the cuer, is difficult for young children to learn and use expressively. A child's inability to contribute linguistically to a conversation could interfere with language learning and parents' motivation to continue to use the system. Nash (1973), P Spencer (2000a) and Mohay (1983) reported this problem. Nash and Spencer said the children's hearing parents then turned to use of signs which the children learned to use expressively with ease. Although LaSasso and Metzger argued that other case studies have shown expressive cueing from children at 18 months to two years, this is not always so.

Hage and Leybaert (2006) discussed Cued Speech use with children who use cochlear implants and therefore, in general, have more auditory access to spoken language than was typically previously the case. This access often extends to some auditory awareness of grammatical morphemes and finer discrimination of phonemes, or the individual sounds in spoken language words. Despite improved auditory access, a number of researchers have pointed out that the signals received from cochlear implants are not as clear as those received by hearing children (eg Holt & Svirsky, 2008; Pisoni, 2000; see P Spencer & Marschark, 2003). This is even more evident when children are in noisy environments that interfere with signal reception from the implants. Children using both cochlear implants and Cued Speech, however, have been found to have better speech reception skills than those not using Cued Speech (Cochard, 2003, cited in Hage & Leybaert), with children using Cued Speech found to have nearly 100 per cent correct performance on understanding auditorally-presented sentences in an open set condition (repetition of sentences as opposed to recognition in a multiple-choice format) after five years of cochlear implant use. This was not true for those who had not used Cued Speech.

A similar result was reported by Descourtieux (2003, cited in Hage & Leybaert), who found that addition of cued French signals to speech-reading information slightly increased understanding. This trend was evident even in younger children who had a cochlear implant before age three. Cochard, as well as Vieu et al (1998) found benefits for the intelligibility of speech production in children using Cued Speech in combination with cochlear implants. Hage and Leybaert have noted, however, that a potential negative effect of children using implants is that with increased auditory reception they may pay less attention to the Cued Speech hand signals they continue to need to see to obtain information on grammatical words and morphemes that are difficult to hear. Finally, it should be noted that despite its success in supporting literacy skills in children who learn French, Cued Speech has never been shown to provide similar support for literacy skills in English (Marschark, 2007), likely because of the lesser transparency of sound-to-spelling correspondence in English compared to French and Spanish (Alegria & Lechat, 2005).

6.2 Visual-manual approaches and language development

These approaches to language development are all essentially oral methods. Their focus is on developing spoken language skills of deaf and hard-of-hearing children and basing their developing literacy abilities directly on use of spoken language elements, even if those elements are partially expressed manually. One reaction to continuing difficulties in literacy development among deaf and hard-of-hearing children using oral methods was a move to what has been termed “total communication” or “simultaneous communication”, that is a manual code for expression of spoken language.

6.2.1 Manually-coded sign systems

Although the language approach used in many schools since the 1960s has often been referred to as “total communication” (Holcomb, 1970), such an approach has actually rarely been implemented. It assumed that a school would vary communication practices to meet the needs of individual children in individually-occurring contexts (Moores, 2001). This could mean that spoken language, natural sign language, manually-coded sign systems, finger-spelling and other methods could be used at various times with different students. In practice, however, most so-called total communication programmes consist of signs produced in the same order as spoken words and at the same time as words are spoken. This is more accurately described by the label "simultaneous communication" (Moores, 2001) or as "sign supported speech" (Johnson et al, 1989). In the US, the UK and Australia, these systems have generally been referred to as "signed English" or "manually-coded English" even though several different systems have been developed to represent the grammatical morphemes so difficult for deaf and hard-of-hearing children learning spoken language or literacy skills.

It was never claimed that these sign systems were natural languages themselves, but that their use along with spoken language would provide visual support for signed and spoken language skills. Systems such as seeing essential English (SEE1, Anthony, 1971) signing exact English (SEE2, Gustason, Pfetzing, & Zawolkow, 1980), and signed English (SE) (Bornstein, 1990) revisited traditions from France (Stokoe 1960/2005), where such approaches had been promoted by Charles Michel Abbé de l'Epée at the National Institute for Deaf-Mutes in Paris as early as the 18th century. Similar systems were developed in Australia (ASE – Australian Signed English), the Netherlands (signed Dutch), and many other countries. These incorporated either invented signs (in the US) or finger-spelling (in Australia) to represent grammatical morphemes indicating number, verb tense, pronouns, prepositions and adverbials in the spoken language. Early reports showed that, when hearing parents learned and used this form of sign plus spoken language with their young children, patterns of parent-child interaction improved, as did the children's ability to communicate with others (eg [Spencer] Day, 1986; Greenberg, Calderon, & Kusché, 1984; Meadow, 1980).

As use of these systems grew, researchers began to document linguistic and academic (as well as socioemotional) advantages for deaf children as their ability to communicate with their parents and deaf peers increased (eg Meadow, 1980) A number of researchers, including Akamatsu and Stewart (1998), Luetke-Stahlman (1988), Maxwell and Bernstein (1985) provided data showing these systems, even when produced in a "relaxed" form in which not all English grammatical morphemes were represented, were effective communication mediums and also provided effective bases for English language development (Mayer & Akamatsu, 1999). There was evidence by the 1990s from numerous descriptive studies, however, that their use was often limited by slow learning of signs by hearing parents, inaccurate productions by parents and teachers, and difficulties experienced by hearing adults in adjusting to the timing and visual attention needs of young children dependent on visual communication input (Johnson et al, 1989; P Spencer, 1993a, b; P Spencer, Bodner-Johnson, & Gutfreund, 1992; Swisher, 1985; Swisher & Thompson, 1985; Wood et al, 1986). That is, patterns and rate of communicative turn-taking had to be altered to allow children to look back and forth between the signed message and its referent (Swisher, 2000). In addition, some researchers proposed that differences in the basic processes of visual and auditory perception precluded effective matching of manual with spoken language, making it almost impossible to provide an accurate model of the spoken language in accompanying sign (Kluwin, 1981; Strong & Charlson, 1987; Wood, Wood, & Kingsmill, 1991). Thus the signed productions of hearing adults, parents and teachers, have been referred to as ungrammatical – capturing neither the grammatical forms of the spoken language or a natural sign language (Marmor & Pettito, 1979). Perhaps as a result, Luetke-Stahlman (1990) found SEE2 to be associated with better literacy scores than pidgin signed English (PSE), although it led to no better literacy outcomes than did American Sign Language.

Other researchers (eg Hyde, Power, & Leigh, 1996; Maxwell & Bernstein, 1985; Wilbur & Petersen, 1998) have argued that effective models of the syntax and semantics of a spoken language (English) could be provided by signing systems and that the ungrammaticality noted derived from poor training and expectations for teachers' use of such systems. Luetke-Stahlman and Nielsen (2003) reported the sign-to-voice ratios (the proportion of language elements the teachers spoke that were also signed) in several schools participating in a recent study ranged from 76-99 per cent. Clearly there is much variation in the degree to which the spoken grammar is made visually accessible.

Although it is evident that grammatical morphemes in spoken productions are frequently not signed by teachers or parents, Bornstein et al (1980) found deaf children in signed English systems did learn and produce those morphemes, albeit less consistently than hearing children and with a significantly later age of acquisition. Geers, Moog, and Schick (1984) reported similarly delayed acquisition of English articles, prepositions and indications of negation by children in programmes reporting use of simultaneous or total communication. However, a careful descriptive study by Schick and Moeller (1992) gave positive and negative evidence of deaf children's ability to acquire English from manually coded English (sign/speech combined) input. They analysed data on the English language skills of 13 adolescents attending US schools whose teachers provided fluent models of signing exact English (SEE2) (Gustason et al, 1980). Although the study included relatively few participants, language samples were copious and analysed in depth. Schick and Moeller found these students' English skills were comparable to those of similarly aged hearing students in the use of simple and complex sentence structures and use of embedded clauses. Deaf students' productions, however, had much higher error levels on bound grammatical morphemes such as markers for tense and number, use of auxiliaries and copulas. Schick and Moeller proposed that these aspects of spoken English were difficult to acquire from combined sign/speech use but that overall the SEE2 system was providing a useful base for English acquisition.

Power, Hyde, and Leigh (2008) conducted a similar study in Australia with 45 students (aged 10 to 17). All had had extensive exposure to ASE in instructional settings. The students' teachers completed self-rating questionnaires indicating their own skills in using signed English and their attitude toward its use. The test of syntactic abilities (Quigley, Steinkamp, Power, & Jones, 1978), normed on deaf students in the US, was administered to the deaf Australian students. Two potentially interesting findings resulted:

1. Although Australian scores ranged from 52 to 86 per cent correct, they were not associated with age as was expected and no significant difference was found between younger and older students.

2. The Australian students' average score of 62 per cent correct was higher than the mean reported for the US norming group (56 per cent correct).

These findings may be explained by trends toward earlier identification and provision of intervention services for hearing loss in Australia over the three decades between the test's norming and the Australian research. In addition, Power et al suggested that students at the higher grade levels may have received programming more focused on subject matter content than on English language skill development. These differences, as well as a probable increase in emphasis on the use of the signed systems over time (the US norming sample included children in oral programmes as well as those using signs) make findings difficult to interpret.

On the test of syntactic abilities Australian student scores correlated with teacher-provided ratings of students' proficiency in the signed English system, with spoken language ability and written English skills. Analysis of written language samples showed an 18 per cent error rate on common inflectional morphemes, including verb tenses, number and possessives. This was lower than the 28 per cent error rate on these linguistic markers reported earlier by Schick and Moeller (1992). A criterion of sentences in which 80 per cent of the elements were represented correctly was reached by 15 per cent of the children in the Power et al and the Schick and Moeller studies. Unfortunately, the Power et al study did not include a comparison group of hearing students and comparisons with the 1978 norming sample are inherently questionable; therefore, the relative equivalence of the two groups of students cannot be determined. The researchers have noted, however, that there are many points of agreement between their findings and the 1992 report from Schick and Moeller. Concurrence on the relative difficulty of grammatical morphemes indicated that

> … teachers using any form of signed communication to teach English… [should] pay special attention to the more difficult structures, devising special lessons along the lines of those used by teachers of English as a second language… (p45).

They added that there was "…no evidence in the present study that the use of SimCom [simultaneous communication] adversely affects students' spoken language" (p44). Further, results from several studies on classroom learning have indicated that in the hands of a skilled user, SimCom can be as effective as other forms of communication at middle-school through university levels (eg Hyde & Power, 1992; Marschark, Sapere, Convertino, & Pelz, 2008; Newell, 1978). Similar studies have not been conducted with younger students, however.

L Spencer and Tomblin (2006; L Spencer, Tye-Murray, & Tomblin, 1998) concluded that cochlear implant use along with simultaneous or total communication increases children's use of English grammatical morphemes with more use of verb tenses, possessives and plurals used more frequently than by children using hearing aids only. This, in addition to their observation that many children with implants tended to use speech as well as signs in their expressive language, suggests that children can co-ordinate the two modalities and, in fact, synthesise information available across modalities. Tomblin, L Spencer, Flock, Tyler, and Gantz (1999) reported similar findings when analysing linguistic productions using the Index of Productive Syntax (Scarborough, 1990) and the Rhode Island Test Of Language Structure (Engen & Engen, 1983). L Spencer, Barker, and Tomblin (2003) also found that children using simultaneous or total communication as well as cochlear implants performed within one standard deviation of their hearing peers on tests of standardised tests of reading comprehension and writing, as well as language comprehension.

L Spencer and Tomblin (2006) concluded there was much individual variation in language and literacy achievements of children in simultaneous or total communication environments, but that the variation related in part to age of identification of hearing loss, use of advanced hearing technologies and consistency of exposure to a "fully developed language system". Noting that children using simultaneous or total communication tend to continue to do so for at least several years after they receive a cochlear implant, the researchers have suggested the children may become able to code switch between modalities and thus communicate fluently with hearing and deaf and hard-of-hearing peers. Aside from the obvious benefits to quality of life and a child's self-esteem through being comfortable across hearing and deaf cultures (Bat-Chava, 2000), this flexibility can support cognitive and linguistic development as children are exposed to a greater variety of ideas and perspectives. Additionally, Yoshinaga-Itano and Sedey (2000; Yoshinaga-Itano, 2006) reported that expressive use of signs is supportive of and not detrimental to children's use of speech when diagnosis and intervention occur early.

Although the preceding information focuses on children's acquisition of grammar or syntax skills when teachers and parents use combined sign/speech, it is clear from studies of hearing and deaf students that vocabulary development is also a critical element in the growth of language comprehension and, in turn, in the development of literacy skills (LaSasso & Davey,1987; Paul, 1998). In a recent review of studies of lexical development, Anderson (2006) noted that relatively few data are available on children learning language using a "manually coded" system of English. Using a parent diary approach, Griswold and Commings (1974) found the proportions of word types (nouns, verbs, propositions, question words) used by their small sample (n=12) were highly similar to those reported for young hearing children. Anderson compared the first words acquired by the children studied by Griswold and Commings with first words learned by hearing children and found that, although they were learning the words significantly later, the deaf children tended to acquire early-learned words in much the same order as younger hearing children.

Studies of larger groups of deaf children have shown that those learning manually-coded English generally have much smaller lexicons for their ages than do hearing children (eg Bornstein, Selmi, Hayes, Painter, & Marx, 1999; Mayne et al, 1998a, 1998b; Lederberg, Prezbindowski, & P Spencer, 2000). An in-depth analysis of the lexicon and vocabulary-learning processes of about 100 deaf and hard-of-hearing children aged three to six, about half of whom were in programmes using manually-coded English, revealed that the deaf children's vocabulary development was only about half that expected from hearing children's norms (Lederberg & P Spencer, 2001, 2008). This was the case regardless of whether the deaf children were in sign/speech combined programmes or in oral programmes. Further, analyses of these data indicated that the cognitive skills and processes for acquiring new words quickly were achieved by these deaf and hard-of-hearing children, even though the age of acquisition was considerably later than is observed among hearing children. After a still-limited vocabulary was established, it was striking that most could learn new (nonsense) words and signs with only three exposures to them in context. Informal re-checks after a three-month interval showed many not only recognised the newly-learned "words", but could produce them when they were again shown the object with which they were associated. Delays in vocabulary development, then, appeared to be primarily due to a lack of sufficient exposure to language, indicating that the children in total communication programmes were either exposed to relatively limited or inconsistent signed representations of age-appropriate vocabulary. This is consistent with findings from P Spencer (1993a, b; Meadow-Orlans et al, 2004) showing that vocabulary size during the toddler years was significantly associated with the quantity of signs that mothers produced, just as hearing children's vocabulary at the same age is associated with the amount of (informal) language used by their mothers (Hart & Risley, 1994).

It should be noted that in the studies described above, the hearing loss of most participating children was identified after early infancy. With identification of hearing loss by six months and almost immediately-provided intervention services, Yoshinaga-Itano, Sedey, et al (1998) found deaf and hard-of-hearing children achieved significantly higher language skills (regardless of language modality use at home) than otherwise expected. Similar advantages have been reported by Moeller (2000) for 112 children in oral or total communication programming and by Calderon and Naidu (1999) for those in total communication programmes. In the latter two studies, identification and intervention before 12 months provided a significant advantage. Spencer (1993a; 1993b; Meadow-Orlans et al, 2004) found that a group of 18 deaf and hard-of-hearing infants (with intervention provided by 12 months) who had hearing parents were delayed in the onset of linguistic productions. Language samples at 18 months, however, indicated that fully one-third of those children were at the same language level as a middle-performing group of hearing children. The deaf children performing at that level all had mothers producing forms of manually-coded English. This included one child with a moderately-severe hearing loss who, although his mother used signs frequently as she spoke to him, produced only spoken words himself; the other five children had mothers who produced signs fairly frequently, even though with a fairly high rate of inaccuracy. Three of the children produced signs expressively by age 13 months. Despite these positive findings, none of the group's 18 children performed at the level of the highest functioning children in the hearing comparison group. Furthermore, all the children whose hearing parents were using a combination of signs and speech were significantly below their hearing counterparts when parents completed the toddler version of the communicative development inventory for English at age 24-30 months (Fenson et al, 1994). Results of this relatively small-scale study tally with the larger studies summarised previously that indicate that parent and/or school use of manually-coded English provides significant support for lexical development – but that average functioning of deaf and hard-of-hearing children, even when early identification and intervention are provided, remains in the "low average" range, somewhat below that of hearing children of the same age.

It is difficult to distinguish between (a) the effects of children's experiencing a language-poor environment due to parents and other adults having restricted fluency in manually-coded English and (b) effects due to structural problems related to transmission of an originally-auditory language through the manual modality. In a review of studies of children in educational systems using signing, Mayer and Akamatsu (1999) concluded that children with hearing loss required direct instruction in the rules and patterns of English if they were to acquire sufficient abilities in English literacy. They indicated that such instruction was necessary regardless of whether programmes employed manually-coded sign systems, native sign languages such as American Sign Language or British Sign Language, or intermediate "pidgin" systems or "contact" signing that tends to develop when deaf and hearing people interact in sign. Despite these arguments and indications that combining spoken language with artificial or created signing systems may be more effective for children who can process some speech sounds (using hearing aids or cochlear implants) than those who cannot, the general failure to raise reading and literacy skills significantly through use of these systems has been disappointing. This continued lack of progress in literacy outcomes led to reconsiderations of alternative methods to assure access to building linguistic skills assumed prerequisite to literacy.

6.2.2 Sign, sign bilingual, or 'bilingual/bicultural' programming

Studies of infants whose parents are fluent signers of natural sign language (most of whom are deaf themselves) document that early linguistic milestones of native signers are reached, on average, at no later age than by hearing children using spoken language (Bonvillian, Orlansky, & Folven, 1990/1994[7]; Emmorey, 2002; Meier & Newport, 1990; Schick, 2003; P Spencer & Harris, 2006). Native-signing children are typically reported to

[7] The Bonvillian et al studies involved native-signing hearing children of deaf parents and were later shown to overestimate vocabulary growth due to the counting of some gestures as well as signs.

give evidence of comprehension of signs by six to eight months and tend to use single signs expressively by 12 months.

Like hearing children learning spoken language, deaf children learning a natural sign language from fluent parents start combining signs in multi-unit expressions by 15-18 months. At first, these expressions are unmodulated, without grammatical markers/morphemes indicating time (tense), pronominalisation or number. The grammars of natural sign languages differ significantly from those of spoken languages, however, making it difficult to closely match the steps toward full grammaticality. Nevertheless, general grammatical progress occurs at similar ages despite differences in form (for instance, sign languages express many grammatical relations through specific handshapes called classifiers that serve almost like pronouns to represent entities, shapes and how an object is held and handled).

By two years of age, deaf children raised in a rich natural sign language environment have been observed to produce forms of noun-verb agreement, to understand representations of location and to produce the classifiers described above (Lindert, 2001). They also demonstrate different roles when communicating about play (Morgan & Woll, 2002). Increasingly correct use of classifiers and other aspects of grammar is seen by three or 3½ years (Lillo-Martin, 1988), and some children begin to repeat or tell short stories by that age, albeit frequently with "baby grammar" that prevents their being fully understood by communication partners. Use of pronominal reference and cohesion or co-ordination across sentences continue to develop through at least age five years (Lillo-Martin, 1991) and many aspects of complex sign language grammar are not developed until about eight or nine years (Schick, 2006).

In short, development of natural sign language skills, although still being documented, has been shown to follow predictable patterns, to emerge without actively being taught when fluent communicators are part of the child's life, and to provide a rich and complete language for interaction and learning through conversation and observation.

In one of the largest studies of language development in deaf children of deaf parents, vocabulary development was tracked for 69 young deaf children of signing deaf parents using a modification of the communicative development inventory (CDI; Fenson et al, 1993) created to represent American Sign Language (CDI-ASL; Anderson & Reilly, 2002). Results indicated that, up to 18 months, average vocabulary size was somewhat larger for the deaf children than for hearing children on the inventory for spoken American English (often known as the *sign language advantage*; Abrahamsen, Cavallo, & McCluer, 1985). By age two, vocabulary sizes of deaf children were quite similar to those of hearing children, a finding consistent with previous studies indicating that the sign language advantage is short lived (Abrahamsen et al, 1985; Meier and Newport, 1990). The lexicon's content was also similar between the two groups, although differences were observed. First, after the first few signs, the deaf children tended to use more verbs than hearing children. A similar phenomenon was reported by Hoiting (2006) for children acquiring the sign language of the Netherlands. Second, although the spoken English version of the inventory (Fenson et al, 1993) includes animal sounds ("woof") as well as animal names, the former were for obvious reasons not learned early by the deaf children. In addition, because body parts are typically referred to by pointing in American Sign Language, there was no equivalent for those spoken words on this version of the test. Perhaps of more interest, the trajectory of vocabulary development Anderson and Reilly (2002) documented was essentially linear and failed to indicate the presence of a "burst" or period of rapid acceleration in vocabulary acquisition that has been reported to occur for hearing children (eg Dromi, 1987; Goldfield & Reznick, 1990).

It should be noted that there is no universal agreement on the vocabulary burst occurring for hearing children and its explanation remains to be understood fully (Lederberg & P Spencer, 2001, 2005). Nevertheless, Marschark and Waters (2008) argued that the failure to observe the phenomenon in the Anderson and Reilly study is consistent with a variety of other results in the literature concerning the development of deaf children. In particular, to the extent that the vocabulary burst indicates the use of *cognitively-mediated word learning*, its absence is in line with other findings indicating that deaf children frequently fail to spontaneously utilise relational processing strategies in learning, problem solving and memory tasks (Marschark et al, 2006; Ottem, 1980). Still to be determined is whether, at least in the case of the Anderson and Reilly study, the lack of evidence for relationally-based learning is a likely outcome of early childhood hearing loss (because of the reduced availability of incidental learning) or the result of learning language from parents most of whom themselves would have acquired their early vocabulary from parents who did not share a common mode of effective communication (hearing parents).

6.2.2.1 Sign/bilingual approach as an educational model

Similarities in developmental progressions of spoken and natural sign languages, as well as continuing reports of below-expected performance on literacy and academics by children exposed to total or simultaneous communication[8] led to the establishment of programmes in which natural sign languages are expected to be a deaf child's first language (eg Simms & Thumann, 2007). These provide rich language environments in expectation that children's language skills will develop through natural interactions with fluent signers. This approach, often called "bilingual/bicultural" or, more recently "sign/bilingual", is predicated at least in part on Cummins's (1989) linguistic interdependence theory which posits that all languages share core proficiencies and that skills developed in a first language will transfer to skills in a second language. When applied to education of deaf and hard-of-hearing children, acceptance of this theory suggests it is most important for them to learn a natural, complete language in the early years.

Most programmes provide some training in spoken language, usually in pull-out or special sessions, but learning of written forms of spoken language is assumed to be facilitated primarily by productive knowledge of a natural sign language. In addition, age-appropriate development of a natural sign language will ideally allow children access to information through interactions with adults and other children in classroom and at home. Such a result, of course, relies on the availability of adults and other children fluent in sign language (Johnson et al, 1989).

Most available research on the bilingual approach focuses on relationships between children's skills in a native sign language (British or American Sign Language) and their reading and, occasionally their writing skills. Despite the lack of emphasis on speech, Wilbur (2000) has concluded from a comprehensive review of research that there is no evidence that focusing on native sign language actually decreases speech skills attained by deaf students. In fact, Yoshinaga-Itano (2006), has argued that fluency in sign will support spoken language development when the ability to perceive auditory information – through use of a cochlear implant for example – is attained.

The applicability of Cummins's (1989) theory to education of deaf and hard-of-hearing children is not universally accepted. Mayer and Wells (1996), for example, claimed in a widely-read theoretical paper that Cummins's work was not directly relevant in the context of an American Sign Language to English transfer due to structural differences between the languages at multiple levels (morphological, modality of perception) and to the fact that there is no written form of the former from which transfer to another written language can be made. Mayer and Wells's view was consistent with results from a study by Moores and Sweet (1990) that found no relationship between ratings of adolescents' ASL conversational fluency and scores on the test of (English) syntactic ability, the Peabody individual achievement test, nor other measures of English functioning. Hoffmeister (2000) argued that the ASL assessment used by Moores and Sweet was general and more detailed and sophisticated measures might allow better identification of relationships. In addition, the ability to identify relationships between the Moores and Sweet ASL measure was inherently limited by the ceiling effect on the measure, with a relatively large number of children performing at the top level (Strong & Prinz, 1997, 2000). Nevertheless, Convertino, Marschark, et al (2008) found no relationship between deaf college students' ASL skills and their learning from print. Performance was significantly predicted, however, by their signed English and SimCom skills.

Other research related to effectiveness of sign/bilingual programmes also has suffered from design and statistical difficulties. For example, DeLana, Gentry, and Andrews (2007) summarised a study of 25 students participating in a public school programme they labelled ASL/English bilingual. The study involved six teachers in a single school district where considerable effort was made to provide fluent American Sign Language models.

[8] Importantly, the quality of language and support for cognitive development/academic achievement in such programmes has not been documented, and conclusions have been based on general findings such as norming studies of the Stanford Achievement Test (Allen, 1986; Traxler, 2000).

The reading comprehension subtests of the Stanford achievement test, ninth edition (SAT-9) (Harcourt Educational Management, 1996) was the sole reading measure examined in the context of demographic and experiential descriptor variables. Of the nine variables on which correlations with reading outcome were calculated (including presence of deaf family members, English versus ASL home language, quality of parent sign skills and degree of parent involvement), no statistically significant relations were identified. The lack of significance may have been a result of the small number of participants and resulting lack of statistical power, but no power analysis was provided. A moderate and statistically significant correlation was found between years of ASL usage and reading comprehension. It is not apparent, however, that child age was controlled when this was calculated. Their relation was not significant in the Convertino et al study (2008) when other factors were controlled.

Additional analyses in the DeLana et al study related the set of background variables (plus an IQ measure) with average annual reading score increases and average annual deviation from age-group means. Only one test was statistically significant, with low versus high levels of parent involvement (as rated by teachers) relating to average deviation from age-group means. Because 10 statistical tests (*t*-tests) were conducted for each of the independent variables without making any correction for multiple tests, even the one significant result must be questioned. It is consistent, however, with other studies showing an impact from parent involvement on development of various language-related skills (eg Moeller, 2000; P Spencer, 2004). Similarly, the several students DeLana et al (2007) identified by inspection of data as especially "low" or "high" achievers also showed characteristics that predict such status for all deaf and hard-of-hearing students and not just those in bilingual sign/English programming. When other variables were controlled, achievement was not related to whether children had deaf or hearing parents (Convertino et al, 2008).

Strong and Prinz (1997, 2000) utilised a more detailed test of ASL skills (Prinz & Strong, 1994) and analysed the relationships between it and several tests of English skills (test of written language, Woodcock Johnson psychoeducational test battery-revised) for a sample of 155 eight- to 15-year-olds at a residential school for deaf children. Results showed that students with higher ASL skills also scored higher on English literacy measures even after age and nonverbal IQ were controlled. Although for the sample as a whole, students with deaf mothers outperformed those with hearing mothers on the literacy measures, this difference disappeared for students with medium to high levels of ASL skills when those levels were controlled. These results show convincingly that ASL skill does not interfere with development of English skills. However, because Strong and Prinz failed to assess or account for communicative use of manually-coded English common spoken language, or benefits of residual hearing, it is not possible to attribute a causal effect between ASL skills and English development based on their analyses.

Hoffmeister and his colleagues (Hoffmeister, 2000; Hoffmeister, Philip, Costello, & Grass, 1997) also found that ASL skill was related to and did not interfere with development of English literacy skills[9]. They investigated the ASL skills (knowledge of synonyms, antonyms, plural forms) of 78 students, aged eight to 15 in four US schools (two day and two residential schools) and related those skills to manually-coded English skills and English reading comprehension (from the SAT-HI). They used a recognition format for the American Sign Language tests (which included no printed English) to minimise memory constraints. Students with deaf parents scored significantly higher on the first two tasks than those with hearing parents and limited exposure to ASL. The difference did not reach statistical significance for the plurals/quantifiers test.

In the same study, SAT-HI reading comprehension scores were compared for a subsample of 50 students, divided into those with extensive ASL exposure and those with limited exposure. Knowledge of manually-coded English was also assessed using the Rhode Island Test of Language Structure (Engen & Engen, 1983) for which a score on complex sentence structure was created. Again, the group with extensive sign language exposure scored significantly higher on knowledge of ASL than the group with less exposure. More surprisingly, the higher-exposure group also scored significantly higher on the task of manually-coded English suggesting that the effects of greater language exposure were not specific to ASL. The students with more sign language experience also scored higher on the reading comprehension measure, even when age was controlled.

Hoffmeister (2000) concluded that even children exposed more often to manually-coded English than to ASL learn its rules, and that deaf children exposed to it also perform well on measures of manually-coded English (MCE). Thus, he argued "deaf students can and do transfer skills from one language to another" (p160). Hoffmeister (2000) also concluded that "intensive language exposure in the form of ASL enhanced language functioning, as reflected in the MCE and reading measures" (p158). He has pointed out, however, that there is an inherent confound in the study – the students with more ASL exposure usually had more (and earlier) exposure to language overall than those whose experiences with fluent manual language were limited to the school context. The relations found between ASL knowledge, knowledge of manually-coded English and reading thus may have resulted at least in part from early, consistent exposure to language rather than from exposure to any particular language. There was no way to test whether these advantages would have accrued had that language been fluently-signed, manually-coded English or spoken language based on effective use of amplification or cochlear implants. DeVilliers, Bibeau, Ramos and Getty (1993), however, provided evidence of high literacy skills among oral deaf children of oral deaf parents, and the studies cited earlier by Leybaert and colleagues obtained similar results for children who received consistent exposure to Cued Speech (and spoken language) at home and at school.

6.2.2.2 Sign and/bilingual approach and vocabulary development

Numerous studies of deaf as well as hearing students have shown a strong relationship between vocabulary knowledge and literacy skills, making vocabulary development an area of particular interest for those concerned about deaf children's reading achievement. In an extensive study, Singleton, Morgan, DeGello Wiles, and Rivers (2004) investigated vocabulary knowledge of 72 children in grades one to six who had in-school exposure to American Sign Language, comparing their written language productions with those of 66 same-age hearing students who were monolingual speakers of English and 60 hearing English-as-a-second-language (ESL). Students were divided into three groups based on their competency in ASL as assessed on the American Sign Language proficiency

[9] Neither these nor related studies by the same team have been published in peer-reviewed journals and their rigour is thus unclear.

assessment (Maller, Singleton, Supalla, & Wix, 1999). Proficiency scores (low, moderate and high) here have been found to be independent of age and grade level. All participants watched a video of the *Tortoise and Hare* story and prepared a written retelling of it in English. Consistent with earlier studies, the deaf children used fewer words overall than hearing students for whom English was a first language or those for whom it was a second language.

Comparison of the proportion of words used that were listed as "most frequent words" (Luckner & Isaacson, 1990) indicated that deaf children with low ASL skills used a greater proportion of "most frequent words" than any other group and had more redundant word usage than children in other groups, although they were not statistically significantly different from the English-as-second-language students on this measure. The high American Sign Language group used more non-frequent words than either the ESL or the low-ASL group, a finding that implies they had more creative use of English vocabulary. When English grammatical or "function" words were compared, however, both typical and English-as-second-language hearing children used more than did any of the deaf groups. Among the deaf groups, those with high ASL skills were more likely to use grammatical function words (pronouns, prepositions) when there was an ASL sign equivalent. However, overall, the low-ASL group (recruited primarily from a school that used total or simultaneous communication) actually used more function words than the moderate and high ASL groups.

The overall picture is that children with moderate or high ASL skills were as creative and had as broad a use of vocabulary in their stories as did the hearing students, while the low ASL students were the least productive. However, apparent transfer from ASL to English appeared limited to semantic or conceptual vocabulary, not the function or grammatical words not represented by discrete signs in ASL. The transfer that Cummins (1989) hypothesised was, at least at these age levels, occurring at a conceptual and perhaps cognitive levels but not at the level of mechanics of grammar. In conclusion, Singleton et al (2004) posited that using an English-as-a-second-language model for instruction of deaf children was probably not helpful and they claimed that hearing gave an "…advantage in terms of exposure to the probabilistic patterns of vocabulary in English" (p100), a reference to the difficulties deaf children face in learning the highly frequent function words and grammatical morphemes. These data also suggest that the children in the study were still in the process of learning their first language and that perhaps attaining fluency in a second language required time beyond the sixth year in school.

The following portion of an example of the written production of a child with high ASL skills shows conceptual strengths and enduring English grammatical weaknesses (p101):

> *Turtle and rabbit race try*
>
> *Who win turtle*
>
> *Rabbit sleep tiptoe turtle and wake rabbit…*

In contrast, the following portion is an example provided from a hearing, monolingual English-speaking child:

> *The rabbit and the turtle were at the starting line.*
>
> *After that they were running.*
>
> *Rabbit was far away from the turtle.*
>
> *So the rabbit went to sleep next to a tree…*

And, finally, an example from a hearing child learning English as a second language shows that the grammatical system is far from perfected, but the placement of and necessity for function words seems to have been grasped:

> *One day rabbit and turtle was race.*
>
> *The rabbit can run fast then turtle.*
>
> *The rabbit think that turtle is far away from rabbit.*
>
> *So rabbit sleepy…*

These excerpts exemplify the point made by Hermans, Knoors, Ormel, and Verhoeven (2008a) that setting up and attaining a fluent bilingual system is more difficult for deaf than for hearing children. They attributed this partly to variation in the input models provided (in the sign language skill of teachers and parents) and in part to most deaf children having to face learning yet a third representation system, written language, before fluency in either a first (sign language) or a second (spoken language) conversational language is fully developed. They noted that studies showing that better reading skills accompanied better native sign language skills (American, British and Netherlands Sign Languages) give evidence of the transfer of "conceptual knowledge, metacognitive and metalinguistic knowledge/strategies" (p157) between a first and a second-learned language. However, Hermans et al (2008a) have asked why, after two decades of sign/bilingual programming across many countries, deaf children still have not matched the literacy achievement of their same-age hearing peers. They suggested it was important to keep in mind that the original language (in this case, a sign language) and that represented in print interact as the children acquire literacy skills. As an example, Hermans et al reported a reading error in which the signed form of a concept actually seemed to interfere with the child's reading of a sentence (p158) and commented (along with Paul, 1998) that "the role of spoken language in the acquisition of written language" (p157) skills may have been underestimated by proponents of sign/bilingual education approaches.

According to the model that Hermans et al (2008a) proposed for deaf children's acquisition of print vocabulary, it is important for them first to have extensive vocabulary repertoires in sign language, so that signs can provide the basis for the association between meaning and printed word. In the early stages of learning of second-language vocabulary, children have information about the semantics and the grammatical role of a newly-learned print word. The richer the understanding of the sign, the richer will be appreciation of the meaning of the written word to which it is associated (McEvoy, Marschark, & Nelson, 1999).

In a recent analysis of the language and literacy performance of 87 deaf children in special schools in the Netherlands, Hermans, Knoors, Ormel, and Verhoeven (2008b) found that, as they predicted, sign vocabulary size predicted knowledge of vocabulary in written form, even after age, nonverbal cognitive skills and short-term memory skills were statistically controlled. Also as predicted, they found that children whose preferred language was

Netherlands Sign Language (NGT) had larger sign vocabularies than those who showed no such preference. Also as predicted, Hermans et al (2008b) found children with deaf parents, and thus with early and consistent exposure to signing, had larger sign vocabularies. Sign vocabulary scores were also associated with story comprehension performance in sign and in written Dutch. Comprehension of stories in NGT and in written Dutch were also significantly associated; however, this association was not significant when vocabulary differences were controlled. The researchers pointed out that earlier studies showing associations between reading and natural sign language skills had not accounted for vocabulary differences. They concluded: "…high scores on the sign language tasks are not *necessarily* [emphasis in original] associated with high scores on the written language tests" (p527). They further noted that the children studied who scored above the ninetieth percentile on the test of written vocabulary also tended to have the highest ratings on their spoken Dutch skills, as reported by teachers, as shown in their comprehension of stories presented in spoken Dutch. The researchers cautioned, therefore, that researchers needed to ascertain whether and to what extent spoken language abilities might confound and complicate identification of apparent relationships between sign language skills and literacy measures.

Although it is apparent that exposure to rich sign language models can build vocabulary skills, it is also the case that knowledge of it does not assure that understanding of the written word will include information about its morphological structure. Morphological knowledge, found to associate with hearing children's reading achievement, may take much longer to consolidate than is generally recognised and certainly does not automatically transfer from the first to a structurally different second language. Poor understanding of language morphology represented in print makes it difficult to figure out the meaning of new words read in passages and makes a new learner heavily dependent upon learning word meanings through context, a process that does not work effectively until a reader knows about 98 per cent of the words in a given text (Hu & Nation, 2000). Knowing the word's spoken form adds the potential of multiple sources of information about its meaning, although this may of necessity happen late in deaf children's stages of reading acquisition. Hermans et al (2008a) therefore suggested that teachers may use methods like Visual Phonics (Woolsey, Scatterfield, & Robertson, 2006) or finger-spelling to "increase children's knowledge of the sublexical structures (letters, graphemes/phonemes, and syllables" (p169) or Cued Speech to transmit information about the spoken language to combine with that based on sign knowledge.

One difficulty in interpreting research on education in general is that published papers providing outcome data often fail to detail classroom activities. Andrews, Ferguson, Roberts, and Hodges (1997) provided a detailed view of what happens in a programme that utilises a bilingual sign and spoken language approach. They acknowledged that the quantitative and qualitative data they presented on a small group of children failed to identify the bilingual programme's activities as responsible for the children's progress. Nevertheless, their situation is particularly interesting in that the programme is not located in an area with a large deaf adult population (such as was envisioned by Johnson et al, 1989) or even a large number of deaf students in an age cohort. In addition, the children in the Andrews et al study did not begin bilingual programming until after age two (most children not until after age four), more than half were from non-white ethnic groups, and almost half were identified as having multiple disabilities. In these ways, the programme setting was similar to that encountered in most parts of Ireland.

Over the years spanning pre-kindergarten to first grade, the programme had one deaf teacher and several hearing professionals fluent in the native sign language. Home visits were provided during the first two years by the latter, who were knowledgeable about the abilities and culture of deaf people. They provided sign language demonstrations and other support to parents and, importantly, demonstrated and encouraged the reading of books using sign language. Parents received information on the accomplishments of deaf people and assistive devices that would be helpful at home (closed-caption decoders, door-bell flashers etc). The curriculum followed the state-mandated curriculum with an additional supplement designed specifically for deaf and hard-of-hearing children. During pre-kindergarten, the teachers focused on children's acquiring basic concepts and language through play activities, group discussions and daily storybook reading using sign language – assuring that the children saw English print in meaningful situations. Additional reading and writing were emphasised during kindergarten and first grade, with stories and other information presented in spoken language by one teacher and in sign by another.

This whole-language approach to story-reading was continued during the first grade (when most children were aged six but several were older) with activities including keeping a daily journal, "computer literacy, mathematics, science and social studies organised around thematic units" (p19). Aspects of English grammar (pronouns, grammatical morphemes) were also directly taught as examples occurred in story reading and in poems written by class and teacher. The researchers reported on each child's progress over a school year as measured by a set of standardised tests of basic concepts, receptive sign vocabulary, Stanford achievement test and the Woodcock-Johnson psycho-educational battery. Most children for whom scores were available raised their scores by at least a grade-level equivalent, a noteworthy achievement for deaf children.

In a well-designed and carefully analysed qualitative study of methods used and outcomes attained in a bilingual programme in Canada, Evans (2004) employed induction and grounded theory (Bogdan & Biklen, 2003) to provide a holistic understanding of family, school, community and society systems. Three teachers and three students, each from a classroom in grades four to six (aged nine to 11 years) were purposely selected to participate. The teachers, all hearing, were judged to be fluent in sign language (ASL) and had at least five years' teaching experience. Two students had deaf and one had hearing parents. The family of the third child used a mixture of ASL (mother) and spoken English (father and sibling); ASL was the home language for the other two families. The students' first language was ASL and they were learning English as a second language in written or print form. Data collection included interviews with parents and teachers, repeated observations at school focused on the way ASL and acquisition of English skills were linked and repeated observations of literacy-related activities at home. The 611 pages of field notes and interview transcripts were reviewed and five overarching themes were identified, with subthemes then delineated and relationships among the two explored.

Evans found the teachers were consistent in their classroom use of ASL, even responding to spoken messages from the more "oral" students by using ASL The two languages, ASL and spoken English, were kept separate except in one-to-one communications when whispering or mouthing while signing was more appropriate or, occasionally, when the languages were closely linked (when discussing a specific written sentence or passage).

Evans also noted that the teachers tended to provide conceptual rather than literal translations when working with written English passages and frequently pointed out when an English word or phrase might be misconstrued ("dirt floor" implies made of dirt, not "dirty" floor). Multiple translations of words or phrases, explanations of context and multimodal explanations (using pictures along with print or speech) were common. Evans indicated that these methods were all consistent with a sign bilingual approach or philosophy.

She also highlighted aspects of the educational environment she considered inconsistent with bilingual programming. These included frequent explicit teaching of grammatical morpheme meanings, sentence structures, spelling and vocabulary which, she argued, was less effective than "guided" or more naturally-occurring instruction. She pointed out that one class was repeatedly instructed in the parts of sentences (subject, verbs) but the students never seemed to remember the information when it was brought up again. She noted that parents were more likely than teachers to engage children in naturally-occurring and meaningful literacy experiences. Evans further noted that the small class size was inconsistent with a bilingual approach based on a model developed and used in Sweden and Denmark (Mahshie, 1995) where larger class sizes are deemed important to allow for ability grouping and peer learning. Finally, Evans lamented that the school's deaf studies curriculum was not implemented fully because teachers "felt that academic subjects took precedence in the classroom" (p24).

The inconsistencies Evans identified probably do interfere with a bicultural or deaf studies approach, as culturally conceived. However, she seems to identify bilingual approaches with "whole language" approaches, a link which may not be obligatory. It appears that these experienced teachers were responding to what they saw as a further need to make direct links between the students' ASL and English in an attempt to improve English skills. The observation about class size is quite interesting and should be further explored. Small class sizes have traditionally been deemed necessary for working with deaf students so that individualisation can occur and visual lines of sight are clear, but models such as suggested by Johnson et al (1989) where classes are combined with co-teachers may provide viable alternatives when teachers are skilled at sign language and are sensitive to students' visual needs.

As with all language approaches discussed here, however, use of modern technology to increase children's reception of auditory information seems to interact with existing language knowledge and support learning. Advances in hearing aid technology and cochlear implant use have increased the amount of auditory information available to most children with hearing loss, and researchers have looked at the literacy performance of children using implants in sign/bilingual programmes.

Early exposure to native sign language is mandated in Sweden, although it is not certain to what degree most home language experiences represent natural sign language versus a synthesis of spoken and signed-language structures. Further, despite the mandating of bilingual education for more than 25 years, there appear to no published data indicating academic benefits for Swedish deaf children. Preisler, Tvingstedt, and Ahlstrom (2002) studied 22 pre-school children who received cochlear implants between two and five years and who also were exposed to sign language at home. Overall, those who developed the best sign language skills also had the highest level skills in spoken Swedish. Furthermore, increases in the two abilities tended to occur in parallel although the researchers noted that achieving higher levels of sign language skills did not assure spoken language skills. These findings of a positive relationship between skills in a native sign and a spoken language replicate a similar earlier finding for hard-of-hearing children (Preisler & Ahlstrom, 1997). They are also consistent with a report by Yoshinaga-Itano and Sedey (2000) of US children (aged 14 to 60 months) with higher levels of language skills (regardless of modality) who were found to develop better speech (articulation, prosody) skills later. Yoshinaga-Itano (2006) provided detailed case study information of three deaf children (one who also had visual impairment) who showed the same kind of sign-to-spoken language relationship over time. These three children used sign for communication before obtaining implants and continued to use signs while reportedly developing fully intelligible speech by age five.

Swanwick and Tsverik (2007) reported on a qualitative study of the social-emotional, language and learning environment provided for children using cochlear implants in six sign/bilingual schools in the UK. When the paper was prepared, half the profoundly deaf students in the UK had cochlear implants and the authors suggested the proportion would increase due to implementation of the newborn hearing screening programme in 2006. Swanwick and Tsverik noted that to that date there was:

> no consensus in the research about how to define and measure the quality of life of children following cochlear implantation but there is an agreement that success should be seen in social and educational as well as linguistic terms (p218).

The participating schools included four special schools for the deaf and two local authority mainstream schools. In all, they served 158 students of whom 37 had implants.

Observations and reports from parents and teachers indicated that the schools made flexible use of British Sign Language and spoken English – always in parallel, not combined as in signed English (SSE) or simultaneous communication systems. Other visual supports, for example interactive white boards, were used extensively to support learning. In the literacy classes on which the researchers focused, spoken English was used often in small group sessions that included those children for whom it was deemed to be individually useful. Flexibility and individualisation of language and support services were key components. In addition, the schools were characterised by co-operation between deaf and hearing professionals in the school and an emphasis on Deaf culture and deaf awareness. The authors indicated that such practices, along with careful assessment and monitoring of individual progress and a focus on individual needs, were good practice in educational services for deaf children. Although this study is clearly well conducted and fulfils most requirements for high quality research using a qualitative paradigm, the authors did not provide measures of child participation or achievement which limits the helpfulness of results. They noted that parents and professionals held high expectations for the children's development of English skills; however, they also noted that "few of their pupils with implants could be described as straightforward or successful users" of spoken English (p226). They suggest that this might reflect placement decisions rather than being an outcome of the bilingual programming provided and that further research should focus on this model of service delivery.

A programme at Clerc Centre at Gallaudet University in the US uses a similar approach and provides special programming for children using cochlear implants and also learning

ASL. The students interact with other deaf children, many of whom use sign exclusively but also have opportunities for small group and individual work focusing on spoken language development. No peer-reviewed progress publications are available, but a conference presentation (Seal et al, 2005) provided profiles of development of individual children that indicated correlations of .67 to .97 between growth in sign and spoken language. Seal et al noted that children entering the pre-school programme with little or no formal language in either mode begin to communicate with sign before beginning to use speech. The researchers noted that decisions about encouraging an individual child's transition from sign to spoken language should take into account any discrepancy between modes of functioning and that children should not be put in a position of suddenly depending on their weaker communication mode. They noted that most children transitioned to at least partial dependence upon spoken language but that the transition might be extended in time.

It is apparent that full implementation of a sign/bilingual model of education will require specialised training and skills in teaching staff. In general, teachers need to have a combination of knowledge about child development, educational practice and strong skills in production and understanding of natural sign language skills. Winn (2007) has noted that sign language skills are considered by pre-service teacher training students in Australia to be a critical training element. He concluded that continuing courses in Auslan were needed if teachers were to meet the needs of increasingly diverse students in increasingly diverse educational environments.

The lack of such training for teachers in Ireland is particularly noteworthy, regardless of whether or not they work in sign language-oriented settings. With few same-aged peers (an issue raised by both students and parents) and teachers who are not skilled signers or visual communicators, deaf students appear to have to rely heavily on untrained, if enthusiastic and well-meaning special needs assistants. During the site visit, they, their principals and teachers indicated that in many cases involving deaf and hard-of-hearing students, SNA duties went beyond what was officially recognised as "care needs assistance". Because they frequently have greater expertise in deafness and Irish Sign Language, they may provide support services (sign language interpreting), tutoring and "co-teaching" to help a child access the curriculum. Further, some certified teachers have taken it upon themselves to self-educate in deaf education and the needs of deaf students and a few individuals have obtained training outside Ireland. It is essential, however, that appropriate standards be established for the ISL skills necessary for teachers and other educational personnel.

A related concern is the paucity of deaf teachers. Interviews with educators during the site visit revealed there were no college programmes in Ireland for obtaining a degree in deaf education and only a single programme for training sign language interpreters. Although the establishment of such programmes may appear daunting, there are people in Ireland involved in deaf education (primarily SNAs), some with knowledge of Irish Sign Language, who would require relatively modest academic and practicum training to become teachers. Interviews with teachers and educational administrators, however, highlighted that there is an Irish language requirement for teacher certification and that deaf students do not take Irish in school. Over the course of the site visit, visitors received conflicting views from parents, teachers and administrative personnel on whether written Irish was an appropriate subject matter for deaf students, but it appeared few have had the opportunity to study it. In any case, because of the oral language fluency requirement, deaf individuals who utilise ISL essentially are excluded from the opportunity to become teachers. According to the NCSE (June, 2009), deaf students can "gain restricted recognition allowing them to teach in special classes and schools", but they thus are explicitly limited in their opportunities.

Simms and Thumann (2007) reported on the components of an undergraduate and graduate programme at Gallaudet University in the US which aims specifically to train teachers to work within sign/bilingual programmes. It stresses fluent use of natural sign language and understanding its role in a sign/bilingual approach, appreciation of the culture and history of deaf persons, high expectations for the achievements they can attain and the ability for collaboration between deaf and hearing education professionals. Simms and Thumann have posited that deaf learners typically have strengths in visual processing and that a deaf-centred approach to teaching may stress different aspects of development and skill development than programmes based on models of hearing students' learning styles. Although intuitively appealing, it appears to remain without empirical support (see Marschark, Convertino, & LaRock; 2006; Marschark & Wauters, 2008).

Perhaps the best known programme of this sort for younger children is the CAEBER (Center for ASL/English Bilingual Education and Research) now at Gallaudet University. According to its website, CAEBER "envisions high academic achievement for deaf and hard-of-hearing students by facilitating proficiency in both American Sign Language and English…" Apparently the only outcome information available on it is its 2002 five-year report to the US Department of Education, which is its funder (http://caeber.gallaudet.edu/assets/PDFs/resources/year5.pdf; retrieved 20 November 2008). According to the data presented in that report (for children in the state of New Mexico), reading comprehension scores on the Stanford achievement test, ninth edition for eight- to 18-year-olds were no higher than those reported by Traxler (2000) for all deaf and hard-of-hearing children in the SAT9 normative sample. This finding is particularly noteworthy given that 33 per cent of the CAEBER student sample had deaf parents and thus represented a group that frequently are claimed to have higher literacy skills than deaf children with hearing parents. This is not to say that signed/bilingual educational programming has been shown not to be effective, but that positive evidence is lacking despite the appeal of the theoretical perspective.

6.3 Summary

Although there has been much research and there remain strong opinions about the relation between specific methods for language development of deaf and hard-of-hearing students and their acquisition of language and literacy skills, no method has been identified that promises success for all children. Traditional oral methods that combine speech-reading with aided residual hearing to process spoken language, on average, do not support age-appropriate language development, although the number of children who can learn spoken language through this method is clearly increased by use of cochlear implants and advanced hearing aids as well as early intervention.

Auditory-verbal methods, with decreased emphasis on visual information such as speech-reading also have been found to be increasingly effective for children benefiting from earlier access to auditory information through use of technology, It appears, however, that auditory-verbal methods are most appropriately used in a therapeutic situation as opposed to general daily communication. Traditional oral and auditory-verbal approaches, as well as other orally-based methods, have the advantage of children's acquiring the language they will confront in print. However, acquisition of literacy skills continues to be complicated by typical delays in acquisition of vocabulary and grammatical/ morphological knowledge using these approaches.

Development of morphological (as well as phonological) knowledge, appears to be enhanced by consistent and early use of Cued Speech in a child's environment, giving visually-accessible experience with the grammatical elements of the spoken language. Use of this approach is relatively uncommon in English-speaking countries, however, and difficulties are noted in that children's expressive use of the system is quite delayed compared to receptive skills. This makes natural participation in conversations, universally thought to be an important engine for language growth, difficult to achieve. Further, Cued Speech does not appear to support literacy skills in English as it does for languages with more regular sound-spelling correspondence.

Although there are emerging reports of early spoken language development by children receiving cochlear implants during their first year, generally age-appropriate emergence of language is most effectively supported by sign language or signing systems which are more readily perceptually accessible. Use of signs allows early communication between parent and child and helps to build conversational skills while providing access to information. Complications occur when parents are not experienced with signing use themselves and this may be compounded if they are expected to learn a natural sign language whose grammatical structure differs from that of their spoken language. To the extent that parents do not use signs or use them only inconsistently, children's acquisition will be limited.

Parents' learning and use of sign systems or natural sign languages seems to be promoted by opportunities to interact with fluent adult signers – especially deaf adults – opportunities that are not always available. When ungrammatical models of sign systems or languages are presented, it is not surprising that a child's acquisition of a productive grammar is limited. In addition, those exposed to a natural sign language will face literacy acquisition as learners of a second language and questions remain about the degree to which fluency in a signed language provides a bridge to literacy in one typically spoken. Signed/bilingual approaches to language and literacy remain intuitively appealing, but evidence of their effectiveness is limited, at best.

Several general conclusions can be drawn from the evidence base about available communication and language options for young deaf children:

1. The acquisition of communication and language skills at age-appropriate or close to age-appropriate times is a necessary requisite for continued development and preventing delays is more important than the specific method or modality used.
2. Parent involvement and support of an approach is a critical factor in the child's success, as is the quality of educational support provided to family and child.
3. Advances in technology, including early identification and intervention, use of improved hearing aids based on more specific testing and use of cochlear implants by children with the most severe hearing loss have increased the amount and quality of auditory information available to them and, as a consequence, their potential for use of spoken language. Specific predictors of language development and literacy achievements for individual children with implants continue to be unreliable, however, and much more research is needed that focuses on effects of specific methods related to specific child and family factors.
4. Acquiring many of the component skills for literacy development requires direct instruction and focused training to help deaf and hard-of-hearing students to move from their language skills (regardless of modality) to skills dealing with print.

7. Beyond Language Methods: Educational Strategies to Promote Literacy Skills

The preceding discussion has focused primarily on the roles of language mode and development in supporting communication and literacy skills of deaf and hard-of-hearing children. Although each method addressed places a strong focus on its facilitation of skills necessary for acquisition and development of reading and writing skills, the evidence shows no method is consistently or reliably associated with literacy success. Earlier diagnosis and intervention, as well as use of advanced technologies, promise that gains can be made although deaf children utilising these innovations still generally lag behind hearing age-mates.

This section considers methods for supporting literacy development that cross over the boundaries of language methods and modalities. It provides an overview of factors influencing literacy and addresses teaching approaches for which there is some evidence of successful promotion of reading and writing skills. Topics addressed include early shared reading experiences as well as the role of phonology, syntax and cognitive processes in reading and writing.

7.1 Emergent literacy and shared reading

There is a clear literacy-learning advantage for children who arrive at school with age-appropriate language skills (Musselman, 2000). It should not be and is typically no longer assumed, however, that language development must precede the emergence of literacy skills (eg Roberts, Jurgens, & Burchinal, 2005; Valdez-Maenchaco & Whitehurst, 1992; Yaden, Rowe, & MacGillivray, 1999). A case also can be made that, for hearing and deaf and hard-of-hearing children, literacy activities themselves promote language development (Teale & Sulzby, 1986; Williams, 2004) and the two can be mutually supportive. This recognition has led to a focus on early parent-child and teacher-child reading experiences as a context for building language and print awareness skills.

The primary activity studied as a basis of support for emerging literacy skills has been referred to as “shared reading”. Some studies of hearing children have been assessed by the Institute of Education Sciences, US Department of Education (www.whatworks.ed.gov), which uses guidelines requiring the highest level of causal evidence.

These investigations have demonstrated positive effects of early shared storybook reading on emerging literacy of hearing children at risk for literacy difficulties (eg Crain-Thoreson & Dale, 1999; Justice & Ezell, 2002; Whitehurst et al,1994).

Shared reading is just what the name implies – books or other written material (although at the youngest ages the material may include pictures only) become the focus of an interaction between an adult (typically parent or caregiver) and a young child. At the earliest stages, this may consist of merely looking at pictures together and allowing the shared attention to be the topic of communication. At later stages, stories, as reflected by the pictures, may be "told" without regard for the actual text leading to associations between print and either spoken or signed words (Roberts et al, 2005; Senechal, LeFebre, Hudson, & Lawson, 1996). The initial purpose of such activities is to introduce children to the idea of books and print. Shared reading progresses more smoothly when parents follow the children's lead on focus of attention and duration of time spent on the activity (Bus, 2003; Bus, van Ijzendoorn, & Pelligrini, 1995; Whitehurst et al, 1988).

Although shared reading is common among many parents and children, it does not occur often in other families. Hearing parents of deaf children have often commented to researchers and educators that their children do not enjoy books and that they themselves do not know how to create and sustain interest and attention in the activity (Delk & Weidekamp, 2001; Swanwick & Watson, 2007)[10] . Although some studies of deaf children (for whom literacy typically emerges at a somewhat later age) have reported positive findings, these studies have tended to have few participants, be qualitative or case-study in design, or to have no comparison groups (Ewoldt & Saulnier, 1992; Gioia, 2001; Williams, 2004). One experimental comparison was conducted of three groups (n=28) of deaf and hard-of-hearing children (Fung, Chow, & McBride-Chang, 2005) testing the effects of one shared reading curriculum, the dialogic reading intervention developed by Whitehurst et al (1988). All the children, who lived in Hong Kong, were in oral

[10] Research involving the large number of deaf parents who themselves lack fluent print literacy skills apparently has not been undertaken.

programming, had hearing parents, and were aged five to nine years. Dialogic reading emphasises the parent's role as listener and responder rather than teacher during shared reading activities and has been shown to have positive effects with hearing children (eg Jimenez, Filippini, & Gerber, 2006; Hargrave & Senechal, 2000; Zevenbergen & Whitehurst, 2003). The programme is fairly structured as parents are taught to use a specific sequence of prompts, feedback methods, expansions and repetitions to increase children's contributions to the interaction. Children are prompted to complete a sentence or idea, remember something from the story or relate it to an experienced event and then to ask both wh- ("who", "what", "when", "where", and "why") and open-ended questions.

In the Fung et al (2005) study, children and their parents were randomly assigned to one of three treatment groups. The first group received the dialogic reading intervention. A specific set of books was given to the parents to read along with guidebooks that explained programme procedures, rationale and goals. Small notes were attached to specific pages to remind them of opportunities to use particular prompts and questions. The researchers had prepared picture cards for the parents to let the children use when discussing or responding to questions and for use in prompting the retelling of stories. They also were given a calendar indicating when the reading activities should be done and they were called by programme staff twice in the first two weeks to answer questions. Intervention activities continued for eight weeks.

A second group of parents was given the same books to read with their children along with the calendar indicating when books should be read. They received no other materials or training. The third group received no materials or training, although the set of books was given to them after the eight weeks had passed.

Pre-intervention testing showed no significant differences among the groups of children in average age, hearing levels, or performance on the Raven's coloured progressive matrices test (Court, & Raven, 1995; Raven, 1959), a test of nonverbal cognition. The Peabody picture vocabulary test (PPVT, Dunn & Dunn, 1997), Cantonese version, was also administered before the intervention. Although differences failed to reach statistical difference, the group that was to receive the dialogic reading intervention had a higher average score on the Raven test (91) than that of the other two groups (70 and 68 respectively). The small number of participants, and resulting lack of statistical power, is a potential confound in the study. Post-intervention testing showed that the Raven's scores of the dialogic reading group, however, had increased to even higher levels, with an average of 114 (100 is average), while the other two groups' scores stayed essentially the same (66 and 65 respectively). Change scores on the Peabody picture vocabulary text also were greater for the dialogic reading group with effect size in the "large" range. Parent responses to questionnaires post-intervention expressed the belief that the dialogic reading programme had benefited them and their children. Although it is unclear to what extent this study's findings can be generalised, it appears to be an approach worthy of further examination with deaf and hard-of-hearing children and their families.

The generally more structured approach of dialogic reading may be of special benefit in building parent confidence in the shared reading process.

A major difficulty faced in shared reading with children with hearing loss, and not specifically addressed in the dialogic reading programme, is the children's need to divide attention between communication and the display in the book (P Spencer, 2000b). This difficulty is shared across dyads using any language approach that requires visual attention, whether through speech-reading, Cued Speech or signing. Management of this difficulty can be assisted by appropriate seating so that the child is easily able to look at the mother, by pacing communicative input to match the child's natural attention changes from the book to the mother, and by use of manual or gaze attention getting signals by the mother when speech-based signals are ineffective. Researchers have indicated, however, that making such adjustments is not intuitive for hearing parents (eg P Spencer & Harris, 2006; Swanwick & Watson, 2005, 2007).

Specific strategies used by deaf, signing parents have been described by several researchers (Lartz & Lestina, 1995; Schleper, 1997). Schleper described 15 principles of effective early shared reading based on his observations of deaf parents and created the shared reading programme (SRP) to facilitate their use. Most are the same as those identified for early shared reading regardless of child hearing status or the language modality used. These include promoting positive interactions by following the child's interests and reinforcing attention to books, making print meaningful by elaborating on the text and providing related language input, as well as adjusting the level and amount of input to child language levels and connecting story concepts to events in the child's life. However, Schleper identified other strategies specific to use of sign language in shared reading. These include the adult's placing his or her hands to produce signs near pictures or print in the text so that the child can see them simultaneously, using tapping and other physical signals to redirect child attention to communication or back to the book and using sign language translations for the text in the book – only later relating the story to the actual text. The shared reading programme has been implemented in US states. It lasts for 20 weeks for each family, with a tutor (usually deaf but always a fluent signer) making home visits to demonstrate the strategies and signs appropriate for a given book in person and on a videotape for parents. Delk and Weidekamp (2001) surveyed parents of 116 deaf and hard-of-hearing children aged one to 11 years (average age 4½ years) who had participated in the programme. They found that parents reported increased quality and enjoyment of shared reading, with 97 per cent reporting that their use of sign language had increased. Unfortunately, no observational or direct assessment data were collected nor do other studies appear to have provided such evidence.

Shared reading activities also have been incorporated into some early intervention programs in the US, England and the Netherlands and there is additional descriptive evidence of parent satisfaction with the process. Similar findings of increased enjoyment of shared parent-child reading as well as more productive communication was reported by hearing parents of three deaf children in the Netherlands who participated in an intervention stressing visual attention, expansion of text and accommodating child interests (Van der Lem & Timmerman, 1990). Evidence that repeated book sharing provides one avenue for the relating of signed language to print was reported in two case studies (Maxwell, 1984; Rottenberg, 2001) in which children using the signed English series of books (Bornstein, Saulnier, & Hamilton, 1980) began to "read" the illustrations of signs given on the page and then moved on to reading (by signing) the printed words themselves. Positive reports of gains from adult-child shared reading are supported by qualitative studies of shared reading activities in the early school years between teachers and individual or small groups of students (eg Andrews & Mason, 1986a, b; Gioio, 2001; Rottenberg & Searfoss, 1992; Williams, 2004).

In addition to reports of increases in linguistic and emergent literacy skills, researchers have reported that deaf and hard-of-hearing children who participate in these activities show high motivation for reading as well as emerging writing activities, sometimes using these skills spontaneously to assist when "through-the-air" communication fails.

Aram, Most, and Mayafit (2006) studied the shared reading and mediated early writing activities of 30 mothers and kindergarten-age deaf and hard-of-hearing children in Israel. The families participated in the MICHA afterschool programme which provides information and guidance to parents about managing their children's hearing losses, but they had not been provided specific guidance on early reading or writing activities. All children went to mainstreamed school classes during the day where early literacy experiences were provided. It appears the children used spoken language because the paper makes no mention of signs or signed language.

The families were videotaped at home sharing a wordless storybook and engaging in a mediated writing activity in which mothers assisted in writing words they knew the children could not write on their own. A variety of background information was obtained, and existing scales were used to measure the interactive reading activity (*Adult/Child Interactive Reading Inventory* [DeBruin-Parecki, 1999], back-translated to Hebrew; *Dialogic Reading Cycles* [Whitehurst et al, 1988, 1994]). A measure of mothers' use of wh-questions during the activity was also obtained. These measures were combined to represent a "storybook telling" variable. A six-point scale (Aram & Levin, 2001, 2002) was used to rate the mothers' scaffolding of the writing activity and also the amount of autonomy they allowed the child, the degree of precision the mother demanded in the child's production of the alphabetic letters and the degree to which mothers gave evidence of perceiving the activity as mutual or shared as opposed to adult directed. These were collapsed to comprise a "writing mediation" variable. Six measures of early literacy were obtained from the children:

1. Assessing the ability to write spoken or pictured words
2. Word recognition
3. Letter knowledge

4. Phonological awareness
5. Receptive vocabulary
6. General knowledge.

The first set of three measures was considered to represent alphabetic skills and the second, measures to represent linguistic skills.

A series of hierarchical multiple regression analyses showed that when child age, degree of hearing loss and the maternal storybook telling measures were controlled, mothers' writing mediation ratings contributed significantly to variance in child alphabetic skills (word writing, word recognition, letter knowledge). Similarly, after controlling child age, degree of hearing loss and mothers' writing mediation ratings, the mothers' storybook telling ratings contributed significantly and uniquely to explaining variance in child linguistic measures (phonological awareness, receptive vocabulary and general knowledge.) Thus the quality of mothers' mediation of writing and of storybook telling had independent effects on developing print versus linguistic skills. No comparison data were obtained from children who did not participate in the intervention, however, so causal conclusions cannot be drawn.

Overall, there is a convergence of data that support shared reading as fruitful in early at-home intervention and early school years for supporting development of hearing children. Effects have been reported on developing vocabulary, building phonological knowledge, increasing motivation for attention to books and (for hearing children) reading comprehension advantages extending into the elementary school years (Zevenbergen & Whitehurst, 2003). There are at least strong albeit generally qualitative reports suggesting similar effects for deaf and hard-of-hearing children. Reports of specific linguistic or reading comprehension effects of shared reading for this population are not readily available, however.

7.2 The role of phonology in early reading

Strong arguments claim that knowledge of phonology is an important support for acquiring literacy skills. Perfetti and Sandak (2000) have pointed out, for example, that reading is not a parallel system to a spoken language. It is, instead, a system of visually representing that language and as such directly relates to it structurally. They have noted that students learn to read a writing system that encodes a spoken language, and they describe how even logographic written systems such as Chinese are highly abstract and have phonetic as well as semantic components. Better deaf and hard-of-hearing readers frequently are found to have and apply considerable phonological knowledge – knowledge about the way that sounds represented by print letters can be used to decode or unlock word meaning. Leybaert (1993) concludes that many deaf children can utilise mental representations that are functionally equivalent to phonological codes by integrating information obtained through sign, finger-spelling, orthography, articulation and speech-reading.

Paul (2003) acknowledged the view that phonological knowledge was important for skilled reading, pointing out that a preponderance of studies showed the best deaf and hard-of-hearing readers had phonological abilities normally thought of as being auditorally based (but see Leybaert, 1993). Paul cited evidence that phonological knowledge could not only be an aid in word identification, but could also support syntactic knowledge, especially the ability to understand grammatical morphemes of tense, number in English (the spoken language on which his work is focused). Furthermore, deaf and hard-of-hearing students typically are found not to use context effectively for determining word meanings (Andrews & Mason, 1986b; deVilliers & Pomerantz, 1992).

Questions remain about the degree to which pre-existing phonological knowledge is a necessary, as opposed to merely a particularly effective, method of entry into reading given that learning whole words ("sight" words), understanding morphology and deriving meaning from context are alternative paths to understanding. Some researchers (Andrews & Mason, 1986) have argued that signing can give access to word knowledge through association between meaning and orthography, and others (Padden & Ramsey, 1998) have presented evidence that finger-spelling can aid decoding of words. Harris and Moreno

(2006) noted that pre-existing phonological skills were not always necessary for developing reading skills and they referred to examples from Harris and Beech (1998) of two children with good reading skills who were skilled signers but had no evident auditory phonological awareness. Izzo (2002) conducted a correlational study of 29 deaf students, aged four to 13½, and also failed to find a significant association between phonological and reading skills. Overall, the children in Izzo's study, who used either Signed English or American Sign Language, obtained low scores on a picture-based test of phonemic awareness. Their reading scores ranged from low to moderately high and these, based on retelling a story read independently, associated significantly with age and sign(ed) language ability. Regression analyses indicated that when language scores were controlled, age no longer predicted significant variance in reading scores. It should be noted, however, that a total of only 40 per cent of reading variance was accounted for by the three variables of language, age and phonological awareness. Similarly, Goldin-Meadow and Mayberry (2001) noted that associations found between reading skills and phonological skills failed to show causality. They proposed that the experience of learning to read actually led to recognition of phonological patterns suggesting a causal relation the opposite of that typically assumed. Musselman (2000) also raised this possibility.

Much research on children with cochlear implants has focused on the degree to which they developed speech perception and production skills (Boothroyd & Eran, 1994; Kirk, 2000; P Spencer & Marschark, 2003), both suggesting the presence of phonological knowledge. L Spencer and Oleson (2008) hypothesised that improved listening and speaking skills build increased phonological knowledge and led to increased reading skills. Based on retrospective analysis of records of 72 children, they found evidence to support that logical chain. Speech perception and production after 48 months of cochlear implant use related significantly to later reading skills. It appears there is individual variation in the degree to which phonological knowledge is attained by children with hearing loss, in the degree to which it supports their literacy development, and in the path through which a phonology-literacy association develops. Easterbrooks and Stephenson (2006) concurred, indicating that findings related to the critical nature of phonological skills in the emergence of these children's literacy skills remains mixed.

7.2.1 Acquisition of a phonological system

To the extent that phonological knowledge supports literacy development, questions remain about the manner in which it can be acquired by children with at best partial access to the sounds of the spoken language represented in print. Each language system addressed in the previous section is assumed to provide paths to phonological knowledge, although some are more direct than others. Traditional oral and auditory-verbal programmes stress the learning of speech sounds and expressly aim for that knowledge to be transferred directly to reading and writing skills. Cued Speech was, in fact, developed to make that process more visually available, still toward the goal of representing and appreciating the sounds or phonemes of the spoken language.

The path is less direct in systems using signs. Total communication or manually-coded versions of a spoken language tend to co-produce signs and speech, assuming that both signals will be perceived to some extent by most users. Of course, this is not always the case and it is necessary for specific instruction in phonology to occur if it is to effectively support literacy in the spoken language (Luetke-Stahlman & Nielsen, 2003). Sign/bilingual programmes typically use the initial sign language as a medium of instruction in reading of the surrounding culture's spoken language, and often provide pull-out small group or individual classes in spoken language that stress phonology (Seal et al, 2005); however, it is also not uncommon for sign/bilingual programmes to assume a reverse learning procedure for phonology. That is, as Musselman (2000) and Goldin-Meadow and Mayberry (2001) suggested, learning to read enough words through context and sight-word approaches will help the child begin to learn grapheme-based phonological regularities that can then be applied to new words.

A more direct approach consists of using technology such as digital hearing aids and cochlear implants to give more access to information from sound, decreasing the need for compensatory visual approaches. In fact, children with early cochlear implant use have been found to produce phonemes more accurately (about 70 per cent correct) after three years of experience than has been reported for previous cohorts of children with the same hearing loss using hearing aids (Peng, L Spencer, & Tomblin, 2004; L Spencer & Bass-Ringdahl, 2004). Earlier implantation has been shown to result in greater phonological awareness (James, Rajput, Brinton, & Goswami, 2008). Palmer (2000), however, has noted that phonological awareness does not assure use of this knowledge in decoding written words. She stresses the importance of recognising that written English is a coded or representational system for expressing and understanding spoken English. She reported that a 12-week programme (Phonographix) based on reading of books plus explicit teaching of phonics (the association between phonology and the orthographic or written form of words), was successful for two nine-year-old deaf children with initially very delayed reading skills. Despite having only two participants, her conclusion of programme success was supported by findings that significant gains were made in phonological and word decoding skills but not in other skills (including memory span and mathematics) that were not the programme's focus.

Regardless of approach, it remains evident that most deaf and many hard-of-hearing readers have only tenuous knowledge of phonology during early school years – and sometimes fail to apply that knowledge when it is available and used in limited practice contexts. Compared to hearing children, deaf and hard-of-hearing students place a higher dependence upon visual similarities, shown by their tending to rely on orthographic similarities when asked to write words that rhyme even in such cases (cave, have) in which orthography misleads about phonology.

Researchers (eg Harris and Beech, 1998; Harris & Moreno, 2006; Schorr, Fox, van Wassenhove, & Knudsen, 2005; Trezek & Wang, 2006) have shown that deaf and hard-of-hearing children can co-ordinate visual information with the partial auditory information they receive and utilise speech-reading to obtain information about the sounds of spoken language. Therefore, increases in speech-reading ability may support reading as well as understanding of spoken language. It is well known, however, that speech-reading fails to disambiguate among most sounds produced in English, and associated information may need to be provided. Use of Cued Speech to do this has already been discussed and, although it may be more helpful in languages such as French and Spanish, in which pronunciation rules are more regular (Harris & Beech), it may also be helpful for children needing to learn English. Alternatively, a system called Visual Phonics (International Communication Learning Institute, 1996) also has been developed and several reports suggest it can be a helpful aid in phonological development regardless of the language modality typically used for communication purposes.

Visual Phonics is based on the concept that it is more critical to understand phonemes as building blocks of language and to develop the ability to use and manipulate them than to actually hear or produce the sounds (Trezek & Wang, 2006). It is thus a system of hand signals produced with spoken language to disambiguate those that either cannot be seen or cannot be differentiated through speech-reading. Visual Phonics can be used in speech therapy sessions in sign/bilingual school settings (Waddy-Smith & Wilson, 2003) as well as with children using other language approaches during the rest of the school day. It differs from Cued Speech in three ways:

1. Cued Speech is typically (although not always) used as a routine communication system and is most beneficial when produced at home and school as a regular means of communication (along with spoken language). Visual Phonics is used in the school setting and for specific purposes of teaching phonics (the relation between phonemes and orthography, or their written representation). It is therefore used selectively and intentionally.

2. Cued Speech provides information about the sounds themselves but not their production; Visual Phonics handshapes incorporate iconic elements that remind students of articulatory movements necessary to produce the sounds orally.

3. Cued Speech represents sounds at the syllable level. Visual Phonics represents individual phonemes.

Trezek and Wang (2006) reported on a study of a small number of deaf children in kindergarten and first grade in a total or simultaneous communication based programme. The school had adopted the direct instruction corrective reading-decoding curriculum used successfully with hearing readers with and without reading problems (eg Campbell & Wright, 1988; Gregory, Hackney, & Gregory, 1982). In the Trezek and Wang study, teachers were trained in Visual Phonics which was used to implement the curriculum. Although interpretation of this study is limited by the low number of participants (n=9) and the lack of a comparison group, testing indicated that during the eight months, students increased skills in word reading, pseudo-word decoding and reading comprehension. A strong effect size was shown for the word reading increase. Gains were not associated with level of hearing loss and students with profound hearing loss seemed to benefit as well as those with losses in the severe range. Further, teachers gave anecdotal reports of children's spontaneously using the Visual Phonics handshapes when working to decode words on their own.

A follow-up study of the system's effects was conducted in a different school district in the US by Trezek, Wang, Woods, Gampp and Paul (2007). The approach again was used together with a structured curriculum designed to teach general literacy skills in kindergarten and first grade. This study included 20 children in two classes using manually-coded English (total or simultaneous communication) and one oral class. Ten students had cochlear implants. Professionals in the local school district had developed the district-wide reading curriculum and daily lessons included 90 minutes of literacy instruction with explicit instruction in phonemic awareness and phonics, a "read aloud" session in which teachers read to the children, vocabulary instruction, and general guided reading activities. Teachers had initial and follow-up training in the Visual Phonics method and researchers' observations documented that the programme was implemented as planned.

Teachers expressed initial difficulties presenting the phonics portion of the county's reading programme to students with hearing loss but reported that Visual Phonics use had removed that difficulty.

Testing before and after the two-semester programme showed children had in all cases made gains in the curriculum's targeted abilities. Significant differences with strong effect sizes were reported for gains in *sentence writing phoneme* and *sentence writing spelling* subtests of the Dominie reading and writing assessment portfolio (DeFord, 2001). For both these subtests, a story is read (first in total, then word by word) to a student who is to write each word on a standardised form. Written representation of sounds (phonemes) and spelling accuracy are computed. Gains were also reported for a subtest of phonemic awareness segmentation, in which the student must indicate the number of syllables in words presented orally, and in subtests for phoneme deletion (indicating what word remains after a particular sound is deleted), phonics onsets and phonic rimes. In the latter two subtests, students say aloud sounds represented by written letters or clusters of letters.

Despite the observed gains, Trezek et al found that students' stanine scores, which can be translated roughly into percentile scores for comparison with a norming sample (in this case using hearing children), decreased on some subtests. That is, although the deaf and hard-of-hearing participants had improved in their emerging phonics and reading skills, they had not kept up in all areas with progress expected based on their initial levels. The researchers suggested that this result might have reflected initially high levels of performance due to previous programme participation. However, they could not specifically connect the children's gains with use of the Visual Phonics method because the study did not include a comparison group and half the participants used cochlear implants which also increase access to phonology. An additional limitation the researchers faced is common to much US educational research in that the district had mandated use of its reading curriculum throughout the district and therefore it was not possible to set up groups receiving different interventions for comparison.

Other methods have been devised to make the phonology of spoken language more perceptible by students with hearing loss, notably computer-assisted systems among them a computer "vocabulary tutor" called Baldi that displays images of articulatory gestures along with lessons on speaking and reading the word (Barker, 2003; Massaro, 2006). These methods have promise in that data based trials, including multiple baseline single subject studies, have shown increases in recognition and production of spoken words.

An advantage is that individual students can use the programmes at various times and in various settings during the day. The degree to which such an approach will be accepted and used in educational settings for deaf and hard-of-hearing students has yet to be fully explored, however, and more evidence of successful outcomes is needed.

7.3 Vocabulary

One reason for interest in developing phonology is its use in decoding and identifying printed words represented in a child's lexicon or vocabulary. Vocabulary size of deaf and hard-of-hearing children, however, has consistently been found to be smaller on average than that of hearing children, reflecting their language delay and providing a barrier to reading and writing that could otherwise enhance further language development. The lexical or vocabulary delay is due in part to their lack of experiences overhearing conversations and also probably due to parents and other adults using restricted vocabularies with them because of lowered expectations or the adults' own lack of vocabulary in sign (Calderon & Greenberg, 2003; Easterbrooks & Baker, 2002). As with other aspects of development, their vocabulary development also reflects their parents' degree of involvement with them and their learning experiences and, in many cases, limited opportunities to interact with peers, siblings and older children (Marschark et al, 2002). Lederberg (2003) concluded that vocabulary growth of children with hearing loss was related to frequency with which they are exposed to a word, visual accessibility of the word's representation, and the degree to which the word's use is contingent upon or related to the child's interest and focus of attention.

Reading abilities of children with hearing loss have been found to associate especially strongly with their vocabulary skills (LaSasso & Davey, 1987; Marschark et al, 2002; Paul & Gustafson, 1991). They typically have limited entries in word classes, reflected in overuse of familiar verbs and concrete nouns in their writing (de Villiers, 1991; Paul, 2003). Since their vocabulary knowledge tends to be less rich or complete than that of hearing children due to having seen or heard the words in fewer contexts, they have particular weakness in comprehending multiple meanings for the same word. To overcome this, Paul (1996) suggested that vocabulary instruction must deviate from the traditional practice of learning definitions in relative isolation before use in assignments and should instead involve encounters with new words in multiple situations. He argued that discussion and schematic representations of aspects of a word's meaning (semantic feature analysis) and repeated experiences with a word in meaningful contexts is a better way to support vocabulary development.

Vocabulary levels predict deaf and hard-of-hearing children's reading skills (eg Hermans et al, 2008b; Kyle & Harris, 2006) and, more often than is the case with hearing children, those with hearing loss must learn a word's print representation without having had a label for that meaning in conversational language (Hermans et al, 2008a). Hermans et al (2008b), however, indicated that learning of written vocabulary is easier when children know a sign for the concept or entity represented. They have posited that the initial stage of a printed word's recognition occurs when it is paired in memory with a sign. After repeated encounters with the word, understanding of its meaning is strengthened as it is used in varied syntactic and pragmatic contexts. This step is consistent with L Kelly's (1996) assertion that syntax and semantics work reciprocally in the building of reading comprehension. The third stage of word understanding described by Hermann et al involves arousal of its meaning becoming automatic upon being encountered, so that excessive cognitive resources are not required to identify it and its meaning when it is found in a new context (Bebko, 1998). When opportunities for generalisation and deepening of understanding of a word's meaning are not provided, Herman et al (2008a) suggest that meaning can "fossilise" and fail to include all the features which it typically would include.

Automaticity in word recognition and comprehension is enhanced when children also have multiple ways to represent a word's meaning, that is when they know its printed, spoken and signed expression. In addition, Wauters, Tellings, van Bon, and Mak (2008) found that increasing the number of senses through which a child experiences the meaning of acquired words (hearing, seeing, smelling, touching) increases the strength of acquisition and subsequently makes comprehension quicker and more automatic. Interestingly, although this approach was generally found more effective than acquiring word meaning through purely linguistic means, hearing children profited more than deaf children.

'Chaining', a method thought to provide opportunities to teach multiple representational forms, has been noted to occur frequently in classes taught by teachers who are deaf or fluent signers (Padden & Ramsey, 1998; 2000). This involves the teacher directly and sequentially demonstrating a word using print, sign and finger-spelling. Thus the word's letters, or orthography, appear twice with the signed form typically being its most easily-accessed meaning. An extension of this approach can be used in programmes that also hope to build the word's spoken representation by adding its spoken form to the chain (Seal et al, 2005). Although there is little or no indication that deaf and hard-of-hearing children directly decode printed words via finger-spelling (Musselman, 2000), its use in these chains indicates that some teachers think it may be of direct assistance in initial learning of the printed form.

Vocabulary development has been extensively studied in young children with cochlear implants although the purpose is usually to identify developmental predictors instead of establishing expectations for vocabulary growth. Typically studies find that children using cochlear implants understand and produce more spoken words than those with similar hearing levels with hearing aids. Connor et al (2000) investigating language modality and age of implantation effects on vocabulary, reported that at the beginning of their study the 66 participating children who were in simultaneous or total communication programming had an average expressive vocabulary size slightly larger than the 81 children in oral education programmes. The children in total communication programmes were exposed daily to manually-coded English and were also received intensive auditory training and training in spoken language. Both groups (oral and total communication) showed less rapid growth in receptive vocabulary (tested using only speech) than is typical for hearing children, and their scores increasingly lagged over time. Similarly, the growth over time in expressive vocabulary was less than that expected for hearing children during the same period (even though responses were allowed in each child's preferred language modality). However, growth was higher for children using total communication compared to those in oral-only programmes if they received their implants early – before five years. Connor et al concluded that age of implantation and characteristics of cochlear implant technology affected growth in vocabulary and speech skills. Although the former was accelerated compared to that of children with similar hearing levels who did not use cochlear implants, those with implants still showed delayed vocabulary development for their age. Other researchers have reported similar results (eg Schorr et al, 2008).

Signing use as a support for spoken vocabulary development has shown benefits for children who are deaf and hard-of-hearing. Mollink, Hermans, and Knoors (2008) studied 14 hard-of-hearing children, aged about 4½ years to a little over eight who used hearing aids and were in educational placements with deaf children. Sign supported Dutch was the school's mode of communication. Pre-testing showed the deaf children's average nonverbal cognitive functioning to be slightly below the average established for hearing children, along with a similar result for visual short-term memory. Vocabulary training occurred under four conditions:

1. A control condition which included no specific training
2. A spoken Dutch-only condition
3. A combined sign and spoken Dutch condition
4. And a condition in which definitions using spoken Dutch were combined with mention of a specific colour name associated with the vocabulary item.

Children were tested in spoken Dutch only before, one week after and five weeks after the training sessions. In all except the control condition, the number of words correctly named by the children (in spoken language) had increased significantly one week after training. The most efficacious condition was that in which sign and spoken word were used. Although test scores at one week post-training were statistically significantly higher than those five weeks later, the actual difference was relatively small (means of 39.5 per cent and 36.5 per cent correct respectively); significant benefits of training endured even after the longer period.

Mollink et al also analysed learning and retention of word meanings based on the iconicity of the sign representing each word. They found it had no significant effect overall on learning although there was an interaction between degree of iconicity and scores between one and five weeks post-training, with lower scores obtained at the five week post-test only on words with lower versus higher sign iconicity. Thus, higher iconicity had a positive effect on longer-term word memory, but researchers could not give a satisfying explanation for their findings. It is possible that adding the signs served to focus attention on the words' meanings or that use of multiple modes facilitated learning and memory. More research with larger numbers of children is needed to further investigate this phenomenon. At the least, however, it again demonstrates that presenting words in more than one modality fails to interfere with learning their spoken representations.

A convergence of research findings shows that vocabulary development continues to be limited for deaf and hard-of-hearing children and agrees it is an area in which special efforts need to be made. Although it is consistently pointed out that vocabulary instruction needs to occur in meaningful contexts as opposed to simple drill and practice or definition memorisation, it is also agreed it should be specifically addressed and cannot be expected to develop sufficiently without direct instruction (eg Davey & King, 1990; deVilliers & Pomerantz, 1992; Easterbrooks & Stephenson, 2006; Musselman, 2000; Paul, 1998). Easterbrooks and Stephenson (2006) further recommended instruction in the use of context for identifying word meanings and provision of specific activities that build understanding about root and base words, prefixes and suffixes by identifying the print forms of English grammatical morphemes (see also Gaustad & Kelly, 2004). This level of understanding words in print requires knowledge of phonology, semantics, vocabulary and syntax.

7.4 Syntactic knowledge and reading

Syntax refers to sentence word order and also to use of grammatical morphemes that represent and qualify aspects of number, verb tense and, in some languages, the gender of nouns, pronouns, prepositions and articles. When syntax and reading are discussed regarding deaf children, this usually refers to the syntax of spoken language not a natural signed language. In fact, a major challenge for students who sign is that the syntax of natural sign languages does not match that of spoken languages. Clearly, in English some syntactic constructions are more difficult than others, but the difficulties with syntax noted in reading and writing by deaf and hard-of-hearing students are myriad. For example, Paul (2003) summarised work by Quigley and his colleagues (King & Quigley, 1985) by reporting that deaf and hard-of hearing students had difficulties at sentence level with negation, conjunction, question forms, pronominalisation, verbs and verb tenses, complement structures, relative clauses, disjunction and alternation (p100). Gaustad and R Kelly (2004) showed that hearing middle-school students had better use and understanding of grammatical morphemes and word segmentation than deaf college students, even when those students received similar scores on standardised reading tests. The fact that the deaf students scored so well on the reading tests suggests that although poor morphological skills may limit deaf students' literacy abilities (by decreasing automaticity of processing, Bebko, 1998; L Kelly, 2003), other abilities can be used to assist comprehension.

Some researchers suggest the ability to apply background knowledge and use context beyond the sentence level can help students compensate for their lack of understanding of syntactic rules (Ewoldt, 1981; McGill-Franzen & Gormley, 1980; Nolen & Wilbur, 1985). Although there have been arguments against these interpretations (Paul, 1998), deaf and hard-of-hearing students' often-mentioned lack of background knowledge (Marschark, Sapere, Convertino, Seewagen, & Maltzen, 2004) will limit usefulness of such strategies unless much pre-teaching is done before reading activities.

Another such ability may be that of obtaining information from word order in sentences. Schick and Moeller (1992) reported that English word order was relatively intact for deaf and hard-of-hearing adolescents with extensive exposure to a manually-coded English system, although their use of grammatical morphemes was deficient. In fact, syntactic abilities may depend upon the quality and consistency of the models provided along with the extent to which sentences parallel the order of events mentioned and follow a subject-verb-object word order.

Findings of strengths in deaf students' understanding of word order are not universal, however. For example, Miller (2000) compared the word and sentence reading performance of 19 hard-of-hearing students in Israel (most of whom used signed and spoken Hebrew), 206 deaf students (most of whom used Israeli sign language, a natural sign language), and 35 hearing students. He found that only about half the students with hearing loss had sufficient competence to respond appropriately to a test requiring knowledge of syntax as reflected in word order. The other students tended to identify key content words in the sentences and use those in an attempt to understand the sentences. This strategy was successful when information in the sentences was consistent with students' prior knowledge and experience but not when it was new or anomalous.

Although lack of phonological knowledge has been blamed for the syntactic problems evidenced in reading and writing by students with hearing loss, it was notable that some of the worst performers in Miller's study were hard-of-hearing students, suggesting that more than the degree of auditory sensitivity (and presumably phonological awareness) determines the application of syntactic knowledge in reading comprehension. Results consistent with this suggestion come from a study by Nikolopoulos, Dyar, Archbold, and O'Donoghue (2004). They assessed the performance of 82 children, all of whom had cochlear implants before age seven, on a test of comprehension of grammatical contrasts in spoken language. The test tapped understanding of nouns, verbs, negative constructions, singular/plural forms, passive sentences and relative clauses. Nikolopoulos et al found that before getting their cochlear implants, only one child obtained a score as high as the lowest percentile group of hearing children in the test norming sample. After three years of implant use, 40 per cent attained at least this level and 67 per cent scored at that level or higher after three to five years of use. Further, of the children who received implants by age four, 86 per cent scored at the first percentile compared to their hearing peers after five years of implant use, with 36 per cent of them scoring in the 25th percentile or higher. Because percentile scores offer a way to compare with same-age hearing peers, this shows a gain in relative standing over years of use (longer experience with an implant leads to better literacy skills). Looking at the Nikolopoulos et al data from another perspective, 18 children (47 per cent of those available to be tested) who had implants before age four scored in percentiles 1-25, two children (5 per cent) scored between the 25th and 75th percentiles, three (8 per cent) between the 75th and 100th percentiles. In comparison, of the children implanted after age four, only nine (21 per cent) scored between the first and 25th percentiles after three years of use and one child (2 per cent) scored between the 25th and 75th, none higher than that.

In short, in addition to benefits from implant experience, the age at which auditory information becomes available also affects development (see Marschark et al, in press, for discussion on the role of cognitive development in such findings).

Nicholas and Geers (2007) examined language growth in a group of children with implants by age three. They found that those who had implants earlier (12 months) developed use of bound grammatical morphemes (meaning units attached to words, such as those indicating tense and number) at a faster rate than those implanted later. Regression analysis predicted that children receiving implants by age 16 months would achieve within one standard deviation of the average for the hearing normative sample on the pre-school language scale (which includes sections on syntax) by the time they reached 4½ years of age. The analysis showed that age of implantation was negatively related (younger age at implantation = faster growth) to both grammatical morpheme production and sentence complexity by school age. It is not clear whether this prediction will be borne out because the analysis remains theoretical at this point and relies on an assumption of linear growth that may or may not prove to be valid.

Some researchers have indicated that an initial burst of growth in language skills has not been maintained at the same rate as time beyond implantation lengthens (El-Hakim et al, 2001; Geers, 2005; see Marschark, Sarchet, Rhoten, & Zupan, in press, for review and discussion). Furthermore, children in the Nicholas and Geers study implanted at even slightly older ages (>24 months) did not show the same rate of growth. Nevertheless, these findings suggest that more children with severe and profound hearing loss may be able to acquire early stages of syntactic development at typical or typical rates with early implantation and intensive intervention.

There is also indication that deaf children can co-ordinate input from a cochlear implant with that from signing to create a more complete syntactic system. L Spencer et al (1998) compared 25 children using cochlear implants and 13 using hearing aids. All were in simultaneous or total communication programmes (sign + speech). Researchers found the group with cochlear implants exceeded those using hearing aids on use of grammatical morphemes as well as measures of speech perception and production. Of particular interest is the finding that the children with cochlear implants frequently used voice-only to produce grammatical morphemes (91 per cent of the time) but used either predominantly signs or sign plus speech to express the content words in a phrase or sentence. The researchers give an example of a child signing "my dad work on a farm" but speaking "dad works on a farm (p312)". Although the group of children using hearing aids sometimes produced the manually-coded English sign for an inflectional or bound grammatical morpheme (and several children used devices in American Sign Language to note the semantics of such morphemes), the group using implants produced the grammatical morphemes significantly more frequently, more accurately and more often through the speech mode. This group first used the devices when they were older than 31 months, with a mean of five years and seven months – relatively late compared to current practice. The degree to which visual-manual and implant-facilitated auditory input can be integrated and accessed with automaticity in perception and production of language needs to be further investigated, especially given indications that syntactic skills facilitate literacy skills (L Kelly, 2003).

7.5 Instructional approaches and reading comprehension

Comprehension is the central purpose of reading and the active process of constructing meaning from text (Luckner & Handley, 2008, p6). Understanding messages carried by print requires skill in all the preceding abilities. In addition, application of vocabulary, syntactic and phonological/morphological knowledge must proceed at a fairly rapid or automatic rate to allow memory and cognitive processing of the material decoded. Having background information and experiences that make the reading material familiar also assist in text interpretation.

Luckner and Handley (2008) reviewed research published in English (with a focus on publications in journals readily available in the US) between 1963 and 2003 on reading comprehension of deaf and hard-of-hearing students. They included studies at all levels of evidence, experimental or randomised clinical trials, case study or qualitative, correlational or descriptive, and single subject. About half the studies identified tested an intervention procedure and converging findings across multiple studies indicated that the following approaches produced positive outcomes (Luckner & Handley, p9):

1. Explicit instruction in strategies for comprehension.
2. Teaching narrative structure or story grammar.
3. Using modified directed-reading thinking activities (DRTAs – reading for specific purposes, guided by questions).
4. Using approaches to activate and build background information before reading activities.
5. Using high-interest well-written reading materials that have ***not*** been simplified grammatically or in vocabulary choice.

6. Providing specific activities to build vocabulary knowledge.

7. Using connected text instead of sentences in isolation to provide instruction in syntax or grammar.

8. Encouraging use of mental imagery while reading.

9. Teaching students to look for key words to assist in comprehension of text (Sartawi, Al-Hilawani & Easterbrooks, 1998).

Easterbrooks and Stephenson (2006) also surveyed existing research but used more rigorous criteria for evaluating the degree of certainty in the evidence produced by the studies. Their analysis used state websites, education administrators at state agencies, and web-based indices of peer-reviewed publications to identify the set of top 10 activities considered "best practices" for supporting general literacy skills. They then evaluated the quality and quantity of research evaluating outcomes of those practices. They found little to no research investigating outcomes related to the amount of time provided for independent reading, a still-developing supportive research base indicating that web-based instructional programmes can provide useful visual support for reading (Barman & Stockton, 2002). There was only mixed evidence across studies for the effectiveness for reading comprehension and teaching of phonemic awareness and phonics as a method of word decoding (Izzo, 2002; Luetke-Stahlman & Nielsen, 2003). Like Luckner and Handley (2008), Easterbrooks and Stephenson found evidence that supported the practice of directed reading. Reading in a content area, such as science or social studies, was found to have a mutually supportive relationship with general reading comprehension, and Easterbrooks and Stephenson decided it fit the definition of "best practice". Shared reading activities were found to meet the criteria for best practice at younger ages but not necessarily for older and better readers. Approaching vocabulary and morphological knowledge through meaningful activities was also shown to effectively support reading comprehension (deVilliers & Pomerantz, 1992; Paul, 1996) and thus was also labelled a best practice.

7.5.1 Metacognition and reading comprehension

Practices that prompt application of cognitive processes and promote reading as a problem-solving activity, appeared in the foregoing surveys of research literature to increase literacy skills. Schirmer and Williams (2003) have pointed out that metacognition, or awareness of one's own comprehension and intentionally using strategies to support it, is an important and positive component of effective reading. Some researchers have found that metacognition is often not spontaneously activated by deaf and hard-of-hearing readers (Walker, Munro & Rickards, 1998).

For example, deaf students have been reported to be less aware than hearing peers when they do not comprehend what they are reading, to rely more on pictures and less on their relevant background knowledge than hearing children do to help them predict and comprehend text, and generally to be "passive" readers instead of actively engaging comprehension strategies unless prompted by the teacher (Marschark, Sapere, et al, 2004; Schirmer, 2003; Schirmer, Bailey & Lockman, 2004, pp 6-7).

Schirmer et al (2004) posited that responsibility for this lack of use of metacognitive strategies is largely due to teaching methods that have fostered dependence. They summarised existing research which showed that teacher questioning that encourages application of background knowledge and uses salient details from the reading as a basis for drawing inferences increases students' abilities to analyse, synthesise and evaluate what they have read and can increase independence in applying metacognitive processes. Walker et al (1998) reported that a 30-lesson curriculum to encourage deaf and hard-of-hearing students to make simple and complex inferences resulted in increased reading comprehension.

Schirmer et al (2004) employed a "thinking aloud" approach like Schirmer's (2003) to assess deaf students' use of metacognitive strategies while reading. Sixteen deaf students were assessed over the two studies. Content analysis was performed on transcripts of the children's verbalisations (mostly in sign because they were in programmes using a form of manually-coded English) to identify the strategies they used. The students were found to use paraphrasing, visualising, interpreting and looking for main ideas to construct meaning. On the other hand, they did not monitor their comprehension carefully and, consistent with other reports, were often not aware when their comprehension failed. They therefore failed to modify and use alternative strategies when that might have been appropriate. The deaf students, like hearing students, gave evidence of evaluating their reading material, but their evaluations were primarily affective and they did not spontaneously comment on the story's writing quality. They also did not give evidence of deciding when to skim a section quickly or when to slow down and re-read to enhance comprehension. Although these deaf students often failed to recognise when their lack of comprehension was the result of a lack of background knowledge, they used such knowledge when it was available.

Schirmer et al (2004) recognised that the limited number of participants in the two studies prohibited firm conclusions. Based on their own and others' research, however, they recommended that deaf students be given "systematic and explicit instruction" (p13) on strategies for comprehending text. These would include monitoring text characteristics, being aware of their reading purpose, recognising their own problems, keeping attention on the text, monitoring the pace of their reading and deciding when they should re-read or read more slowly and carefully, and evaluating the quality of the text and the ideas it was expressing. The researchers concluded that use of verbal protocols, or thinking aloud, during reading was a useful method for identifying the strategies used by individual readers and, therefore, designing individualised instruction.

7.6 Writing

Development of reading and of writing skills are intimately intertwined and it is generally agreed that writing places even greater demands than reading on linguistic and cognitive processing (Moores, 2001; Mayer, 1999). It therefore is not unexpected that deaf and hard-of-hearing students show delays and difficulties in producing written work. Typical deaf students age 17 to 18 have been reported to write at levels of skill like those of hearing students age eight to 10 (Marschark et al, 2002; Paul, 1998, 2001). Written productions have been described as having shorter and simpler sentences than expected for age along with use of fewer adjectives, adverbs, prepositions and conjunctions (Marschark, Mouradian, & Halas, 1994). Problems with aspects of morphology and grammatical structure are especially prevalent (Yoshinaga-Itano, Snyder, & Mayberry, 1996). Despite these problems of form, deaf and hearing students have been found to produce similar numbers of t-units (propositions or ideas) in writing samples (Musselman & Szanto, 1998; Yoshinaga-Itano et al, 1996) and, to an extent, expression of meaning is relatively unimpaired compared to difficulties in form (Marschark et al, 1994; Svartholm, 2008; Yoshinaga-Itano et al, 1996).

The above difficulties have been reported for children across programmes using spoken language, manually-coded systems for signing and natural sign languages. Burman, Nunes, and Evans (2006), for example, reported on their development and trial of an approach to assessing the written language skills of children whose first language is British Sign Language (BSL). The need for a unique assessment instrument was based on many of these children failing to produce writing that could be scored as falling even at the earliest or lowest level proposed by the Qualifications and Curriculum Authority for English students. Burman et al have noted that children who use a natural sign language face an extra translation step when writing a spoken language. In addition to syntactic differences, they note there is not a one-to-one correspondence between many signs and spoken words. (They give an example of "up until now" – expressed by a single sign in BSL).

Despite differences in the writing products of deaf and hard-of-hearing and hearing students, some processes have been found to be similar. As with reading, writing skills begin to emerge during the early years and the stages of development progress in the same order as for hearing children, if somewhat delayed, gradually taking on more conventional form (Ruiz, 1995; Schirmer & Williams, 2003). Young deaf and hard-of-hearing children are reported to make connections between finger-spelling, signs and print and are motivated to use writing in notes and as informal communication means (Conway, 1985; Williams, 1999).

The quality of older deaf and hearing students' writing relates to the purpose and genre in which it is produced. In a study by Musselman and Szanto (1998), letters written in response to specific prompts showed more elaboration and more complex expression of ideas than writing in response to, for example, a standardised, shorter sample written in response to a picture. The profile of strengths and weaknesses was similar in both situations, however. The students made relatively few errors on punctuation and spelling;

multiple meanings were expressed (showing a command of semantics), but grammatical expressions were problematic.

There are also reports that deaf and hard-of-hearing students' writing lacks sufficient use of cohesive devices (also called discourse rules) to provide coherent messages (deVilliers, 1991; Maxwell & Falick, 1992; Yoshinaga-Itano et al, 1996). Marschark et al (1994) found deaf children were just as capable of appropriate use of cohesion and discourse rules as hearing age-mates, but that their difficulties in vocabulary and syntax interfered with fluid writing. In fact, problems with syntax are thought to interfere significantly with organisation of written content (Mayer, in press), although other sources of difficulty have been identified. Among these are general cognitive and problem-solving skills (Marschark & Hauser, 2008). Deaf and hard-of-hearing children, for example, have repeatedly been described as having shorter memories for sequence as well as difficulties connecting disparate bits of information (Marschark et al, 2006; Pisoni et al, 2008). These cognitive differences could affect overall structure and cohesion of written productions and, in fact, are not dissimilar to difficulties reported for many hearing children with learning disabilities (Singer & Bashir, 2004).

Antia, Reed, and Kreimeyer (2005) suggest some researchers have concluded that teaching writing in classes for deaf and hard-of-hearing children may militate against learning to build cohesive and coherent meaning across levels of text because producing basic sentence structures is strongly emphasised. That is, the pedagogical approaches applied to supporting writing development have interfered with optimal development (Wilbur, 1977; Ewoldt, 1985). Disappointment with results of highly structured drill approaches to teaching writing contributed to the turn to "whole language" or more naturalistic pedagogical approaches in the 1980s. Those methods involved approaching writing activities as inherently social and communicative, focusing on expressing and sharing meaning (McAnally, Rose, & Quigley, 1987). Mayer (in press) summed up the result of this pedagogical change as improving student attitudes toward writing, building abilities to express ideas and content, but resulting in no real improvements in grammatical structure and form.

Although students with hearing loss generally lag behind hearing children in their abilities to produce clearly interpretable written material, researchers have documented great variability in this regard. Antia et al (2008), in a study of 110 students between third and 12th grade (ages eight to 18 years) in public school classrooms found they performed on average at the "low average" level compared to norms for hearing students. However, deaf students' scores ranged from above average compared to hearing students to being unscoreable due to the low quality of writing. Consistent with earlier research, the lowest scores of the students with hearing loss were on subtests tapping vocabulary and syntax. As in the Musselman and Szanto (1998) study, girls obtained higher writing scores than boys and socio-economic status related positively to writing scores – a common association across educational measures in general.

Antia et al (2008) identified an interesting developmental pattern, with deaf and hard-of-hearing students in the upper grades (years seven to 12 of school) scoring higher compared to hearing norms than those in grades three to six. Thus, unlike earlier reports, they found the gap between students with and without hearing loss narrowed with age and years in school. Degree of hearing loss explained only about 4 per cent of the variance in writing scores but, overall, writing scores decreased as hearing loss increased in severity. Average scores for students with mild or unilateral hearing losses matched those for hearing peers, and deaf and hard-of-hearing students tended to increase rather than decrease their relative standing with increasing age and years in school. Interestingly, students with moderate to moderately-severe hearing losses (46-85dB) tended to score higher than those with lesser losses but lower than those with more severe losses.

Keeping in mind that all these students were being educated in public schools and not special classrooms or schools for deaf students, the researchers posited that students having a moderate to moderately-severe hearing loss may have been placed in the general education classrooms based on their tested hearing levels instead of their achievement levels, while those with severe-to-profound loss were more selectively placed in that environment based upon assessments of actual functioning. Some but not all students with severe-to-profound hearing loss used interpreters but this did not associate with higher writing skills. Researchers suggested the quality of interpreting varied across situations and, as Marschark and his colleagues (Marschark, Sapere, Convertino, &

Seewagen, 2005) have noted, student understanding of interpreted lessons is often limited even when interpreter quality is assured.

Musselman and Szanto (1998) found adolescents in oral programmes produced better grammatical forms in their written work than students from total communication backgrounds. This result is consistent with earlier findings from Geers and Moog (1989) and Moores and Sweet (1990), but it is not clear whether it reflects background variables associated with choice of language placements or effects of the language training itself. Because the students in oral programming were, at least in theory, exposed to more complete models of the (spoken) language which they were to represent in writing, the connection may have been easier to make.

To the extent that access to spoken language may relate to the quality of written language productions, use of cochlear implants could provide benefits. L Spencer, Barker, and Tomblin (2003) studied the writing skills of children using cochlear implants who were in programmes using a combination of spoken language and a manually-coded sign system (signed English). They administered the clinical evaluation of language fundamentals-III (Semel, Wiig, & Secord, 1995) to assess expressive and receptive language skills of 16 children, average age about nine, who had used cochlear implants for an average of 71 months. The language scores were compared to performance on a written language sample. Scores on the language measure, which lagged behind those of a comparison group of hearing children, were found to correlate highly (r=.70) with the score for written productivity. Although the average number of t-units (meaning units) expressed was not significantly different between deaf children with implants and hearing children, the former produced fewer pronouns, verbs, determiners, adverbs, conjunctions and prepositions. Therefore, use of cochlear implants, which typically result in a child being able to receive increased auditory language input, did not resolve the language or the written difficulties of deaf participants.

Antia et al (2005) concluded that:

> …even students who have access to oral English through audition have difficulties in various aspects of writing and probably need instructional support from both the

> general educator and the teacher of D/HH [deaf and hard-of-hearing]….writing instruction should be a focus for most students with hearing loss (p254).

As with reading, there is a consensus that writing instruction needs to be meaning based with more practice in producing work at a less formal level when structural rules are being addressed. However, again as with reading, there appears to be need for a balanced approach in which direct instruction and pragmatic, freely-produced opportunities for writing are provided (Marschark et al, 2002).

7.7 Summary

There has been a greater tendency to use research to define specific weaknesses and needs of readers with hearing loss than to identify methods to improve those areas. More information is available than might at first be evident, however.

Based primarily on qualitative reports, shared reading experience appears to be helpful as a basis for emerging literacy skills in deaf and hard-of-hearing readers. It requires adults' use of specialised strategies for visual turn-taking and support for joint visual attention and thus appears to have potential for additional benefits to learning in social, cognitive and academic domains. At present, however, quantitative evidence is lacking for this intervention having a long-term impact on reading achievement or other abilities.

Phonology, and specifically knowledge of the phonological structure of the spoken language on which literacy is to be based, has been shown in numerous studies to associate with deaf and hard-of-hearing students' literacy skills, although arguments persist about the degree to which this association shows causality and, if so, in what direction. There is considerable evidence that phonological knowledge can be increased with the addition of visual information to the limited auditory information available to many deaf and hard-of-hearing students through Cued Speech, Visual Phonics and speech-reading. Use of cochlear implants has been shown to increase speech perception and production abilities as well as phonological knowledge, but not to the levels generally attained by hearing children. Importantly, there is a convergence of evidence that reading abilities are not necessarily dependent upon the acquisition of phonological knowledge.

Vocabulary continues to be an area of need for most deaf and hard-of-hearing students and its lack contributes to difficulties comprehending text to the degree that it slows and complicates decoding and comprehension. Vocabulary development requires exposure to a rich language environment and, especially in the case of children with hearing loss, direct instruction to build word knowledge. Direct instruction must be meaningful and engaging and it appears most helpful when based on multiple experiences of words in varied contexts and with varying nuances of meaning. Implant use has been shown to promote vocabulary development and studies have shown that sign vocabulary acquired before obtaining and using the implant supports rather than impedes acquisition of spoken vocabulary. Introduction of new words in sign as well as speech supports their acquisition in spoken form.

Despite multiple studies indicating weaknesses for deaf and hard-of-hearing students in spoken (as well as written) language syntax, there are few data available on methods to directly increase syntactic abilities. Fewer difficulties have been noted in the area of word order than in use of prepositions, pronouns and bound grammatical morphemes such as those indicating tense and number. Learning such elements is complicated in that they are difficult to hear, are represented by very different mechanisms in natural sign language than in spoken language and are often omitted in manually-coded forms of spoken language. Again, increasing auditory input through use of cochlear implants appears to increase understanding of these morphological units, but the addition of visual information also appears to be helpful. As with vocabulary, strong suggestions have been made that direct instruction of syntax is required but must occur in meaningful situations with segments larger than individual, short phrases. Evidence is lacking on various methods for promoting development in this area.

Reading comprehension requires a level of automaticity in vocabulary and syntax understanding that is often not reached by deaf and hard-of-hearing students although they benefit from direct instruction in using metacognitive strategies. These strategies include checking their own understanding, setting purposes for reading and generating questions and predictions as they read. Use of writing during reading activities also has been found to be useful in helping students organise their ideas.

7. Beyond Language Methods: Educational Strategies to Promote Literacy Skills

Acquisition of writing skills by deaf or hard-of-hearing students continues to be challenging. For those writing in English, word order is more often intact than use of grammatical words and morphemes such as pronouns, prepositions and indicators of tense and number. Although it has been posited that English conversational skills in one modality or another would promote writing skills, serious challenges remain regardless of language modality or use of cochlear implants.

Research comparing progress made by students using one language method or modality to those using another needs to be supplanted by a focus on methods of literacy enhancement that encompasses various language methods.

8. Achievement in Mathematics and Science

A major purpose of literacy skills is to allow students access to information beyond that of their own direct experience and to acquire information on varied topics that will affect their educational and employment potentials. Mathematics and science are topics of special importance in this regard, and there has recently been considerable research into processes and accomplishments in these areas. The following questions have been addressed:

- What gains are being made in deaf and hard-of-hearing students' acquisition of skills in STEM (science, technology, engineering and mathematics)?
- How does the performance of these students in these topics compare with that of hearing students?
- What factors, especially factors that can be manipulated by modifications in educational approaches and environments, are found to influence deaf and hard-of-hearing students' performance in STEM subjects?
- Can curriculum modifications support improved performance by this population?

8.1 Mathematics

A relationship between language development and literacy skills is to be expected. One between language and mathematics skills may be less so. It is important to keep in mind, however, that language comprehension is critical for general learning processes and that many if not most practical mathematics problems require understanding meaning in a linguistic context (Akamatsu, Mayer & Hardy-Braz, 2008; Bull, 2008; Hyde, Zevenbergen & Power, 2003; Mousley & R Kelly, 1998). Although most studies of skills related to mathematics operations and number concepts suggest that deaf and hard-of-hearing students are delayed, as opposed to showing different pattern of development compared to hearing students (Hyde et al, 2003), Marschark et al (Marschark, 2003, 2006; Marschark & Hauser, 2008; Marschark & Wauters, 2008) have proposed that cognitive or learning style differences between students with and without hearing loss require modified pedagogical approaches to support academic achievement of those who are deaf or hard-of-hearing. Finally, indications are widespread that the mathematical and problem-solving experiences provided to most students with hearing loss are insufficient in frequency and structure to achieve the desired outcomes (Hyde et al, 2003; Kluwin & Moores, 1989; Pagliaro & Kritzer, 2005).

It is evident that approaches to date have failed to optimise mathematics learning in these students. Data collected over at least 40 years show they face obstacles to age-appropriate development of mathematical skills (R Kelly, Lang, Mousley, & Davis, 2003; Serrano Pau, 1995). Traxler (2000) has shown in the detailed analysis of a US national sample that students with hearing loss (aged eight to 18) achieved below hearing students on standardised maths and problem-solving tests, functioning only at the 80th percentile of the average scores of hearing students. According to Traxler, and to an analysis by Mitchell and Qi (2007), students aged 17 to 18 achieve about fifth or sixth grade-level (age 11 to 12) skills in mathematics on average, even on computation skills tests. Although this is relatively higher than their achievement in reading, it is still significantly below what would be expected for their age and years of education. Blatto-Valle, R Kelly, Gaustad, Porter, and Fonzi (2007) documented a lack of significant growth in maths skills from middle school to college age in deaf and hard-of-hearing students, showing that achievement levels begin and remain below those of hearing students. Mitchell and Qi note that this gap between performance of hearing and of deaf and hard-of-hearing students has stabilised over the past 30 years.

A variety of reasons has been proposed for this, including deficits in early experiences with quantitative concepts, delays in language development, teaching qualifications and practices in mathematics, as well as sensory- and language-based differences in how persons with and without hearing loss process information (Marschark & Hauser, 2008). It should be noted, however, that just as with literacy, there are deaf and hard-of-hearing students who excel in mathematical achievement, with Wood et al (1983) reporting that about 15 per cent of deaf students performed at or above the average for hearing students. It is of particular interest, therefore, to explore factors that can support such development.

Bull (2008) has noted that, as a group, deaf students have delays in developing measurement concepts and fraction concepts and operations. In addition, she referred to a review by Butterworth (2005) that concluded that even pre-verbal infants had some recognition of differences in number of quantity, and Bull concluded that "…aspects of numerical processing are not reliant on verbal or language skills" (p171). Bull suggests that to be effective for mathematics problem solving, basic number concepts and skills need to be practised to the extent that they become automatic. She adds that deaf and hard-of-hearing children may have fewer opportunities to practise these skills and thus their transition to automaticity may be hampered. She cited work by Bandurski and Galkowski (2004), indicating that deaf children of deaf parents, for whom language training and development typically is a topic of lesser focus than for deaf children with hearing parents, exceed the latter group on "relational processing tasks" (p174). Bull proposed that this was due to deaf children of hearing parents having less incidental experience with mathematic as well as linguistic symbols early in life.

Kritzer (2008) provided evidence for this proposal in a detailed, home-based qualitative study of two deaf children (aged four and five) judged to have "high" math skills and three (aged five) judged to have "low" math skills. Although the children were selected randomly from a small group of 13, it happened that both high performers had deaf parents and the low performers had hearing parents. The deaf parents used ASL and hearing parents used spoken English with sign support. Kritzer was interested in how the children's parents referenced, or mediated, quantitative concepts during interactions that required categorisation in a problem-solving activity. The analysis showed that parents of the two highest functioning children referred to maths concepts more frequently. In addition, these parents were exposed to more problem-solving situations requiring critical thinking while quantity was discussed. Kritzer pointed out that they also used abstract terms describing quantities ("everything", "all") more often. Although the three children whose mathematics functioning was lower were exposed to maths concepts during the intervention activity, their parents did not produce math-related vocabulary. The researcher noted that their parents were more likely to use the categorisation activity as a labelling exercise than to prompt the children to use a problem-solving approach focused on identifying categories.

Kritzer's results indicated that patterns of communication (that is reciprocity) and language use differed between the groups identified as higher and lower functioning in maths skills. This was perhaps inevitable since the groups also differed on parent hearing status and thus parent (and child) communication skills. Given that Kritzer did not report child language levels, it appears she simply described another aspect of the differences in parents' ability to support learning – regardless of the topic – when they and their children share a functional language system. Her report is important, however, in highlighting the role that shared communication skills play in developing abilities such as maths that are not always considered "verbal" and in pointing out that differences in opportunities to learn mathematical concepts occur very early in life.

Recommendations for deaf education (Dietz, 1995) as well as for general education in the US (National Council of Teachers of Mathematics, 2000) have called for frequent use of problem-solving activities in the form of story problems in the earliest grades of school. Pagliaro and Ansell (2002) found this was rarely the case in classes for deaf and hard-of-hearing children, however. Thus their experiences with mathematical problem-solving may continue to be limited during early school years. Less than one-fifth of the 36 first- to third-grade teachers Pagliaro and Ansell surveyed (representing five schools all of which used signing to some extent) reported presenting story problems daily. Teachers apparently believed that story problems, whether presented in sign, voice and sign, or written form, were too difficult for children until basic maths and reading skills were achieved. In contrast, Pagliaro and Ansell suggested story problems be used from the earliest grades to engage children in mathematical thinking and problem-solving processes: "Teachers should not wait for students to 'get the basics down' before introducing story problems to them; rather they should employ the story problems as tools to help build those 'basics' " (p 116). Because their survey data showed that teachers who had at least one mathematics methods course in pre-service training presented story problems more frequently than those with only in-service training session, Pagliaro and Ansell recommend that all deaf education teacher candidates have a required course to assure they know mathematics content, how students learn mathematical concepts and how to teach maths effectively.

Students with hearing loss may continue to suffer from lack of equal opportunity to acquire mathematical concepts as they go through school. Opportunities for those in grades six to 12 (age 12 to 18) in the US have been shown by R Kelly, Lang, and Pagliaro (2003) to relate to the type of school and classroom placement in which students are enrolled. They obtained survey data about the teaching of mathematics word problems from 132 maths teachers to deaf and hard-of-hearing children: 68 taught in centre or special schools, 29 taught in mainstream classes integrated with hearing students, 35 taught special classes for deaf and hard-of-hearing students in the context of a mainstream school. There were no significant differences among them in the overall time spent on problem-solving activities, nor in the degree of emphasis reported for various types of problem-solving strategies. These included identifying goals and key information, planning, identifying separate operations required to solve a problem, estimating, evaluating the plan and obtained result, using a trial and error approach, generating and testing hypotheses. In addition, teachers in all three environments emphasised concrete visualisation strategies for problem-solving (diagrams, illustrations, hands-on activities, signing) over more analytically-oriented strategies[11]. The groups did not differ in the degree to which teachers assigned practice exercises (for which the procedures had already been taught) as compared to "true" problems (which focus more on problem solving). There were, however, differences in the levels of maths texts used, with grade-level texts more often used in integrated mainstreamed classes. There also were differences in teachers' preparation to teach the subject, with those in integrated mainstream classes more likely to have specific maths background.

They were more likely than the others to use analytically-oriented problem-solving strategies, including use of analogies to understand word problems and relate them to currently-known information. Thus, students in integrated mainstream classrooms were more likely to experience challenging and nuanced problem-solving approaches. Finally, these teachers had higher perceptions of their students' problem-solving abilities. They were less likely to declare that students' English skills were the primary barrier to successful solving of word problems.

[11] Note that in many ways, these eight processes also correspond to the "problem solving task" of reading comprehension and related metacognitive monitoring.

Pagliaro and Kritzer (2005) similarly noted that US elementary- and high-school teachers of students with hearing loss tended to make infrequent use of currently recommended or "reform-based" activities during class time. Based on a survey with 290 respondents identified as the "most effective mathematics teacher" by school administrators, Pagliaro and Kritzer noted little time spent on "discrete" or real-life-based problem solving. They attributed this, at least in part, to the teachers' limited mathematics training (Kluwin & Moores, 1989; Pagliaro, 1998).

These differences are unsurprising given that teachers in the higher grades in regular (mainstream) schools are required to have content-specific degrees and those in special classrooms or centre schools for students with hearing loss must have specialisation in deaf education. However, as R Kelly et al (2003) pointed out:

> …in two of the three school settings deaf students are receiving mathematics instruction from teachers who are not qualified by education or certification to teach mathematics… In the [other] setting, students are being taught by teachers who have not been educated in the specific needs of deaf learners (p115).

The researchers also noted that differences in teachers' perceptions of students' skills, as well as higher use of verbally-mediated analytical approaches such as analogical reasoning, may reflect reality-based differences in students that led to placement decisions. Those in integrated mainstream classes, if placement is appropriate, can be expected to have higher language skills and at-grade or close to at-grade abilities in other areas such as mathematics. However, as R Kelly et al conclude: 'Teachers cannot expect deaf students to perform well at problem-solving tasks if they do not give them opportunities to be engaged in cognitively challenging word-problem situations' (p117).

In addition to having an effect on teacher expectations and strategies, language skills of deaf and hard-of-hearing students may associate with the mathematical concepts and skills at a more basic level, with language delays limiting the appreciation of technical vocabulary and ability to understand in-person as well as written problem presentation and problem-solving approaches. Hyde et al (2003) reported that deaf and hard-of-hearing students in Australia had difficulty understanding English syntax as well as vocabulary in word problems, failing to understand phrases like "at the start" and being unable to relate two sentences in which the second referred back to information in the first. Sentence constructions that did not represent the exact order in which events referred to would have happened were especially difficult, as were problems asking students to compare two quantities and determine the difference. Hyde et al (2003) concluded that the results of their study were essentially in agreement with performance of deaf students in the UK as described earlier by Wood, Wood, Griffith and Howarth (1986).

R Kelly and Gaustad (2006) compared scores of deaf college students on maths achievement tests with their scores on tests of reading and, specifically, on tests of knowledge about morphological units (or meaning units) in English words. They found morphological knowledge and general reading skill significantly predicted performance on one of the maths tests, the ACT (2000), and associated positively with scores on the other (NTID mathematics placement test). R Kelly and Gaustad proposed that the specialised vocabulary required for maths could be acquired and manipulated more readily when morphological skills could be applied consistently and automatically. They noted that sign language interpreters often used a simpler word/sign to substitute for a more technical one, like those encountered often in discussions of maths theory and practice, and they called for use of finger-spelling or more specific signs. R Kelly and Gaustad noted, however, that their study failed to include a measure of general nonverbal cognitive functioning – a variable that might have predicted variance in language and maths achievement (Convertino, Marschark, Sapere, Sarchet & Zupan, 2009).

As suggested in the R Kelly and Gaustad study (2006), deaf and hard-of-hearing students have difficulties with mathematics even in college. Dowaliby, Caccamise, Marschark, Albertini, and Lang (2000) reported that of 248 deaf college freshman entering two-year associate degree programmes, 79 per cent scored below the 50th percentile on the standardised ACT test. Blatto-Vallee et al (2007) compared performance of deaf students and hearing students in middle school (n=18 and 43 respectively), high school (n=28 deaf, 51 hearing), and college programmes (n=39 deaf, 62 hearing) on a test of mathematical problems. A group of 64 deaf students at the associate degree level was also included, but without a comparable hearing group.

The mathematics test was slightly modified (to represent American instead of British English terms) from one developed by Hegarty and Kozhevnikov (1999) and included 15 short word problems that emphasised logical problem-solving. Student visual-spatial abilities also were assessed using a test of visual form completion and another test requiring students to envision the shape of a complete form when component parts were illustrated. In addition, students' "notes" or "shown work" while problem-solving were collected and analysed according to the types of representations they had created. When the work illustrated "relationships between objects and/or parts of an object described in the problem" (p438) it was coded as being "schematic". "Pictorial" visual representations showed the objects mentioned in the problem but did not indicate any relationship or discerned pattern among them. Only schematic representations were assumed to illustrate actual reasoning or problem-solving.

The groups of participating hearing students, regardless of year in school, obtained higher scores than the deaf students on the maths and both visual-spatial tests. Developmental trends on the mathematics test differed for deaf and hearing students, with the latter's scores increasing at a faster rate than those of the former. Thus the advantage for hearing students at college level was even greater than at middle school level.

Except for the college bachelor's degree group, hearing students also obtained higher schematic representation scores than deaf students on the drawings or visual aids they produced while solving the problems. Schematic scores were determined in regression analyses to be the best predictor of scores on the mathematics tests for students at all levels, and production of pictorial representations negatively correlated with maths scores.

For deaf students, the visual-spatial measures added to the prediction of maths test scores at middle school, associate degree and bachelor's degree levels. The visual-spatial scores were significant predictors of hearing students' maths scores only at the middle-school level, and even the schematic scores lost predictive power in regression analyses at the high school and bachelor's degree programme levels. Blatto-Vallee et al (2007) concluded that use of pictorial representations during problem-solving indicated only a surface understanding of the problem, and that schematic representations of relations between entities in the problems was a developmental phenomenon, disappearing when mathematics procedures became automatic for hearing students beyond the middle school level. The continued relative lack of use of this approach, along with the relative lack of increase in maths scores with age, indicated that deaf students tended to stabilise in their general problem-solving strategies and skills.

Blatto-Vallee et al (2007) related their findings to Marschark's proposal that cognitive processes and learning differ between deaf and hard-of-hearing and hearing people (Marschark, 2003, 2006). The former appear to be merely delayed on some mathematics skill development, such as representation of number, estimation, general computational skills (Bull, 2008; Hitch, Arnold, & Phillips, 1983; Nunes & Moreno, 1997). No delay has been shown for representation and discrimination of number when quantities are represented spatially and simultaneously (Zarfaty, Nunes, & Bryant, 2004). However, hearing children have generally been found to be advantaged when sequential memory is needed for problem solving, as when one piece of information has to be kept in mind while another operation or calculation is accomplished (see also Ottem, 1980). In fact, processing of temporal information is an area in which most deaf and hard-of-hearing children are usually reported to perform less well than hearing children (Bull, 2008; Todman & Seedhouse, 1994), and there are indications that they tend not to spontaneously relate or co-ordinate bits of information or steps in a process (Marschark et al, 2006). In addition, they are less likely than hearing children to bring previous knowledge and experience to the task of acquiring mathematical skills (Marschark et al, 2008).

R Kelly and Mousley (2001), in a study of 33 deaf and 11 hearing college students, argued that reading skills provided only a partial explanation for the difficulty that students with hearing loss demonstrate on word problems in mathematics. The researchers reported that the students in their sample made many computational errors even when they applied correct procedures. They attributed this to a lack of sustained focus on the problems. R Kelly and Mousley also reported motivational problems, with deaf students often making comments that showed a lack of confidence in their ability to solve word problems – followed by lack of completion of those problems.

Bull (2008) recommended that mathematics instruction for students with hearing loss recognise their visual-spatial orientation and their relative lack of confidence in their solving abilities. Nunes and Moreno (2002) developed a programme based on the ideas of providing visual representation of the relations between elements in maths problems and of giving deaf students the opportunity to use their visual-spatial strengths to learn basic or core mathematical concepts typically understood by hearing children. The programme was designed for school years two to five (age seven to 11) and included visually-based (nonverbal) representations for problems focused on additive composition (number and measurement concepts), additive reasoning (addition and subtraction as inverse operations), multiplicative reasoning (reasoning about multiplication/division operations and graphic displays) and fractions based on understanding of ratio. (Teachers later reported that the ratio concept was difficult for them and for the students.) Concepts were explained to the teachers who were encouraged to use their school's language system/modality and their own ways of explaining them to the children. About one hour a week was expected to be devoted to the programme.

The evaluation project used a quasi-experimental design. A "baseline" group of 65 students with hearing loss were tested on the NFER-Nelson mathematics test (Hagues, Courtenay, & Patilla, 1994), as were the 23 children in the experimental group. At the outset, scaled scores of the experimental and baseline groups did not differ significantly. After a year, the experimental group was reassessed and again compared with the baseline group's original scores. The former group's scores now significantly exceeded that of the baseline group. Although it is not known if or how much the baseline group's scores would have improved without the intervention, additional support was provided for its efficacy by comparing the experimental group's progress with that predicted (in the test manual) from their original scores. Most (68.2 per cent) had scores at the end of the project that exceeded the prediction. This is especially impressive in that the prediction was based upon expectations for hearing, not deaf or hard-of-hearing, students.

Anecdotally, teachers reported that students greatly enjoyed the booklets and activities provided in the curriculum and that they spontaneously began to generate diagrams and illustrations during problem-solving when it was not formally in use. Nunes and Moreno (2002) concluded that the programme was successful, although they could not determine exactly which aspects led to its success. They stated that cognitive and motivational factors were probably involved: use of drawings and visual representations to support children's intuitions about mathematical and number concepts, and increasing their interest in and enjoyment of mathematics. It is possible that these advantages also accrued to the teachers through their training in the programme and their reinforcement from children's interest. It is important that the maths problems on which the children worked were all conceptual and required reasoning and problem-solving, thus reflecting observations by Blatto-Vallee et al (2007) that visual-spatial displays of maths problems that represent schematic (relational or problem-solving) aspects of the problem are more helpful and more predictive of success than simple pictorial displays. This programme thus built on the potential for visual-spatial strengths but emphasised the development of relational problem-solving approaches.

After conducting an extensive literature review, Easterbrooks and Stephenson (2006) summarised evidence on 10 maths (and science) practices in deaf education frequently referred to in research literature or considered important by teachers and others in the field. One they mentioned, and an approach they concluded had a sparse but positive research base, is that of using visual/graphic organisers such as graphs, charts and concept maps. They concluded that teachers' ability to communicate well in the language or language system used by their students also represented "best practice" in deaf (as well as general) education settings. Taking an active problem-solving approach in which students analyse multiple methods and explain potential solutions has strong research support when older students with hearing loss are considered, but Easterbrooks and Stephenson concluded that more evidence was needed for young children. They described the research base as "developing" for use of case-based, collaborative problem-solving situations and activities emphasising critical thinking skills. They concluded that more research was needed on the usefulness of technology-based approaches to learning and about focusing on specialised vocabulary or terminology. Evidence, they said, was "limited" on the efficacy of modifying the reading level of texts used in content areas such as mathematics.

8.1.1 Summary

Delays in language development, a relative lack of exposure (incidentally and in classrooms) to life-based problem-solving activitie, and frequently inadequate pre-service teacher preparation in mathematics are believed to lead to the overall delay in development of maths concepts and skills by students with hearing loss. Below-age language skills limit access to teacher-provided as well as text-based explanations and most deaf and hard-of-hearing students lack age-appropriate command of technical vocabulary in mathematics.

Surveys of teachers as well as classroom observations show relatively little class time devoted to problem-solving activities, although teachers certified in mathematics use more analytically-oriented approaches. Although deaf and hard-of-hearing students show special difficulties dealing with word or story problems, testing also indicates lower-than-expected performance on calculations.

Deaf and hard-of-hearing students show relative strength in visual-spatial abilities although they do not necessarily apply these skills when presented with maths problems and face special difficulties when needing to relate multiple bits of information and to identify relationships. Specific training has been recommended in approaching problems through producing schematic illustrations. An elementary-level curriculum emphasising visual-spatial over verbal activities has been found to increase problem-solving skills. Evaluators noted that the curriculum motivated student interest in maths and identified that as at least partially responsible for its success.

Others have found that older deaf and hard-of-hearing students approach word problems in maths by expressing lack of confidence in their ability to perform them and subsequently failing to seriously attempt their solution. In addition, it has been suggested that they tended to lose attentional focus, especially when problems required relating multiple operations or logical steps. Although it is not clear to what extent these characteristics represent differences in learning style or cognitive processing between students with and without hearing loss, it is clear that modifications in curricula and in teaching strategies are required if deaf and hard-of-hearing students are to develop to their potential in the important areas of maths skills and concepts.

8.2 Science education and achievement

Curriculum reforms during the 1970s in science teaching in US schools were never fully implemented in classes or schools for deaf and hard-of-hearing students (Marschark et al, 2002). This is despite reports of successful outcomes for such students who participated in process-oriented, activity-based programmes with low verbal demands (Boyd & George, 1973; Grant, Rosenstein & Knight, 1975). Marschark and Hauser (2008) suggested that gaps in knowledge and experience between deaf and hard-of-hearing students and those without a hearing loss may not be obvious in the early years. In fact, Roald and Mikalsen (2000) showed that young children held similar concepts related to scientific phenomena regardless of hearing status. However, significant differences in levels of knowledge and achievement were noted by high school. This is undoubtedly the case at least in part:

1. Because literacy difficulties limit deaf and hard-of-hearing students' exposure to information in the sciences.

2. Because of their decreased opportunities to learn incidentally from conversations occurring around them.

3. Due to a lack of understanding of vocabulary used in science.

4. Because of difficulties inherent in using vision for watching communication (whether signed or spoken) in addition to attending to activities and other visual learning material (Marschark & Hauser, 2008). Also, interpreters for signing deaf students have been noted to simplify scientific terms and explanations. Lang et al (2006) pointed out that of the words deemed important from a science curriculum review, about 60 per cent had no sign representation. The researchers indicated a need to identify signs in use, and pointed out difficulties in attempting to create signs for these ideas and in students' experiencing different signs for similar concepts across classes.

Despite continuing difficulties with literacy skills, researchers have recently suggested that writing can be a supportive component of a strong science curriculum. For example, Yore (2000) proposed that embedding structured writing activities within the science curriculum could provide a way to guide students' thinking and encourage active evaluation of their own knowledge. Although he recommended “do first and read and write later”, with concrete, hands-on activities being the core of instruction, he proposed that writing activities could support the integration of ideas and help students address relationships they have discovered. According to his approach, which has had some success with hearing students at various levels in school, teachers should react to the content and structure of brief written work and not focus on issues such as spelling and grammar when meaning is not disrupted. The approach includes occasional use of templates or provided structures and initial group work to identify sources, as well as peer-review of written products to help students ascertain and improve the degree to which their written work communicates to others. Yore suggested that this kind of approach could be of use to deaf students as well, but his proposals clearly assume effective teacher-student and student-student communication. His approach also points out the importance of cognitive and metacognitive skills for science learning and undoubtedly for learning in general. He explained that effective reading and writing in science required “conceptual background; knowledge about science text and science reading; declarations, procedures and conditions of reading strategies; and executive control to set purpose, monitor progress, and adjust actions” (p110).

Lang and Albertini (2001) employed a qualitative approach to analyse teacher reports on classroom and student activity in grades six to 11 (age 12-17) after a workshop on development of science and English literacy for deaf and hard-of-hearing students. The workshops stressed acquisition of knowledge and concepts in a social construction context, in which communication with others was seen to be a critical influence on learning.

After the training, the researchers collected and analysed 228 writing samples elicited from students in one of four contexts:

1. Creative pieces, often asking students to imagine themselves as being an entity or phenomenon, such as a biscuit passing through the digestive system, a simple machine, or a chemical element

2. Guided free writing, in which students were to record predictions, observations and conclusions related to a hands-on, “authentic” science activity

3. End-of-class reflection, in which they were asked to write down important points or concepts they had learned
4. Double entry, which asked students to summarise and react to text selections provided by the teacher.

Teachers and researchers judged creative pieces and guided free writing to be effective for learning and assessment. Creative pieces routinely resulted in the longest and most detailed writing. Guided free writing gave teachers useful information about students' ability to think logically and construct meaning from an activity, that is about science process skills. End-of-class reflections were of lesser usefulness and double entry effectiveness required much attention from teachers to identification of the text excerpt to be used and to preparation of effective prompts. Despite these difficulties, teachers and researchers considered double entry writing to be especially productive. Overall, teachers thought the writing activities, although lengthening time required for each lesson, provided important insights about individual students' grasp of science information and processes.

Usefulness of all four types of embedded writing activities relied on a teacher's ability to provide explicit guiding prompts and questions to focus the student. This capacity to identify and emphasise appropriate content appeared to relate to a teacher's training in science. In fact, training and background in the field is positively related to student achievement in science and mathematics (Kluwin & Moores, 1985, 1989) and to student opinions on teacher effectiveness (Lang, McKee, & Conner, 1993). In addition, familiarity with patterns of written English usage allowed teachers to identify and understand students' thinking processes and concepts learned.

Lang and Albertini (2001) found that follow-up activities were judged especially important in consolidating learning, for example following up on development of definitions and understanding of science vocabulary or, in other cases, clarifying conceptual misunderstandings. They called for more research into the effectiveness of various methods for follow-up, setting up initial context and posing prompts or guides. Investigation of effects of or interaction with initial student characteristics and skills is especially needed to make productive use of the embedded writing approach in developing science as well as literacy and cognitive skills.

In an interesting and creative qualitative study, Roald (2002) conducted conversation-based interviews with five deaf teachers in Norway who had majored in physics at university level and who had also been students in the secondary science classes that he had taught. They reflected on their own education as well as that they were providing and concluded that a teacher's knowledge of subject matter was critical for successful teaching, but so was the teacher's ability to communicate fluently with students. In this case, the teacher-informants were referring to fluency in Norwegian sign language. They made other comments that can provide some guidance for programming in the sciences. First, they believed that collaborative learning, in which students communicated among themselves and participated fully in discussions with the teacher about science problems and topics, was especially helpful. They suggested that class sizes smaller than five to nine students overly limited collaboration potential. They strongly favoured structured (although activity- and discussion-based) lessons in which discussion of problems and concepts preceded laboratory activities and reading. As students, most of the teachers had found textbook content and language very difficult. They noted, however, that having to write laboratory reports and other notes helped them to organise and remember what they had learned. Finally, they now favoured the use of drawings to illustrate "objects and relations" (p65) and assist science learning and problem solving, even though they remembered having resisted this approach when they were students and now reported receiving a similar initial reaction from their own students. The teachers had apparently felt that this approach reflected their own teachers' expectations that their language skills were too weak to provide sufficient support for problem-solving – so their reluctance may have been defensive. As noted earlier, however, many deaf students reported during the November 2008 site visit that teachers underestimated their abilities and thus they were not challenged to do better academically.

Barman and Stockton (2002) presented a qualitative evaluation of the science, observing and reporting-high school curriculum (SOAR-High) implemented in three US schools for deaf students. This is accessed online and information presented is accurate and of high quality given that experts in each scientific area have developed the lessons (http://csc.gallaudet.edu/soarhigh). Structured lessons address earth science and energy topics. Written material, guide questions, illustrations and hands-on activity suggestions are included. Materials guide students in science processes: observation, inference, prediction, communication, measurement, classification, interpreting data, forming hypotheses and designing experiments. The programme emphasises use of technology in that, along with being accessed online, it involves many opportunities for students to gain experience working with internet searches, videoconferencing and developing web pages. Students keep an electronic portfolio of work that allows them to share their ideas with others in group work and also provides a means for evaluating their progress. The technology aspects were enjoyed most, even though a few complained there was too much work on the computer and too little interaction with the teacher.

Some thought the reading level of the text-based materials too difficult and evaluators noted that students continued to have problems generating hypotheses. The teachers were positive about the programme's effects, however, and believed its online nature and technology emphasis helped students develop independence.

Fulfilling the potential for use of computer technology in classrooms serving deaf and hard-of-hearing students depends on teachers feeling competent to use the software and thus encouraging its use. Kluwin and Noretsky (2005) cited work in Australia (Morton, 1996) with teachers in regular education classrooms that identified issues of anxiety, self-confidence and perceived relevance of technology that influenced their use of it. Peer support, mentoring and formal collaborative work as part of teacher training also has been identified as influencing their use of technology (Gray & McNaught, 2001; Sherman, 1998).

Kluwin and Noretsky also reported on process and outcomes of an online training programme developed for teachers of deaf and hard-of-hearing students. Forty-seven teachers from 42 US schools participated, most from programmes in urban areas. Participants got one online course a semester for a possible three courses. Coursework included modules on integrating computers into the classroom (basic skills related to use of software programs, review and evaluation of computer-assisted instruction software, educational application issues), accessing and using internet resources and contributing resources to internet sites. Course participation was managed using a commercially-available online course management system (Eduprise). Textbooks and additional readings were also provided. E-mail was used for communication between participants and instructors. Project money was available for each school district to provide a local support person but not all participating districts did so.

Using a mixed methods approach (questionnaires, content analysis of communications in discussion forums, direct observations), Kluwin and Noretsky (2005) found no significant effects on teachers' persistence in the programme based on their initial anxiety, expertise or general access to technology in the classroom. Availability and quality of local support, however, were significantly related to teachers' tendency to complete the available coursework. The researchers noted non-significant trends in the data for teachers initially anxious and non-expert in use of technology to report greater challenges and lesser classroom use. In contrast, there also was a trend for initially-more expert users to be more positive and to report greater classroom use by the end of the project. The researchers, who noted the limitations of their analyses due to the relatively small number of participants, concluded that teachers' skills in classroom technology use could be improved through a combination of online coursework and local, in-person support. Therefore, as in the study of student technology use reported by Barman and Stockton (2002), effective teacher technology use depended strongly on in-person communication and support.

8.2.1 Summary

Only limited research is available addressing science and mathematics programming for students with hearing loss, but available findings are consistent across the two topics.

1. Delays in literacy development and deficits in vocabulary negatively affect achievement in these areas, limiting opportunities for incidental learning and usefulness of text-based material. These effects are amplified by the fact that signs do not exist for some of the important concepts and ideas that need to be efficiently expressed.

2. The gap between average performance of students with and without hearing loss is minor at early ages but increases as years in school increase.

3. Student participation in and development of problem-solving abilities in realistic scenarios are limited. This seems to result, in part, from the relative absence of true problem-solving activities provided in the classroom, but there may be other factors at work. Teachers report that even with specific interventions, most upper-level deaf and hard-of-hearing students are unable to generate effective scientific hypotheses.

4. Successful teachers tend to have training in the subject matter being taught and to be knowledgeable about the learning styles and patterns of students who are deaf or hard-of-hearing. Limited numbers of teachers have this combination of abilities, however.

Embedding writing within science projects appears to promote and consolidate benefits from activities, even though students' writing skills are typically delayed. Creative writing focused on science concepts and ideas appears to be helpful, with the focus on effective communication instead of the mechanics of grammar. Group discussion and direct communication with the teacher are especially valued as methods for acquiring science knowledge by deaf and hard-of-hearing students. When technology is used to transmit scientific information (and thereby to provide science expertise that many teachers' pre-service training has not given them) the addition of person-to-person communication seems to be an important support for successful learning. Whether online or in printed text, the language of science explanations and material can easily overwhelm students' reading skills and limit benefits. As with students, significant amounts of in-person support to teachers are required for online-based programmes to be effective.

9. Educational Placement Decisions and Outcomes

Two general philosophies of educational placement are held across and often within countries. The first is that placement in the "mainstream" or within schools and classes where most students are hearing and non-disabled offers the best opportunities for deaf or hard-of-hearing children to acquire age-level academic and social skills. Some researchers and practitioners distinguish between "mainstreaming", in which it is generally assumed the student with hearing loss will adapt to the general education system, and "inclusion" in which teacher and class are expected to adapt to that student's needs (Antia, Stinson, & Gaustad, 2002; Hyde, Ohna, & Hjulstadt, 2005; Power & Hyde, 2002; Stinson & Antia, 1999). The difference is one of semantics and attitude, if not always practice. In both situations the reality is typically one or a few deaf and hard-of-hearing students participating in a class of mostly hearing students, although "mainstreaming" is also used to refer to a context in which deaf and sometimes hard-of-hearing children are educated in special classrooms within a general education school.

The second major philosophy is based on claims that due to deaf and many hard-of-hearing students' special communication needs and because such a large proportion of the population has delays in academic areas, specialised schools where all resources are focused on serving children with hearing loss can best meet and promote their developmental and academic needs. Looking ahead, however, there is little empirical evidence that either of these approaches is better for deaf and hard-of-hearing students, in general.

Over the past several centuries, as education has become available for deaf or hard-of-hearing students, the most prevalent types of placement have changed. During the 1800s and early 1900s, special separate schools, based on either oral or signed communication were the norm in the UK and US (Lang, 2003). Such programmes traced their histories at least in part to the schools established in the 1700s by Heinicke in Germany (spoken communication) and L'Epée in France (signed communication). Regardless of the choice of primary communication modality in these schools, there was a shared assumption that deaf students required specialised instruction methods and approaches to language development that differed significantly from those of hearing students. As the 20th century progressed and the 21st century began, however, the prevailing educational and legal philosophies changed to emphasise the importance of interactions between deaf and hard-of-hearing students and hearing students in schools and classrooms where learning opportunities were similar and, at least in theory, equivalent.

Currently, several models of educational placement are available. The first remains special schools. In the US, by the mid-1970s, over a third of all deaf children attended residential schools and another third attended special school programmes. Beginning in 1975, legislation emphasising placement of children with disabilities in local schools and parents' preferences for keeping their children at home to led to significant changes (Marschark, 2007). In 1999 (National Centre for Education Statistics, cited in Stinson & Kluwin, 2003), about 20 per cent of deaf students in the US were attending special schools and that proportion has since dropped to about 15 per cent (Mitchell & Karchmer, 2006). This trend is not limited to the US.

Some special schools (the Clark School and Central Institute for the Deaf in the US, the Mary Hare Schools in the UK) continue to emphasise spoken communication to the exclusion of use of signs. This is also the case for some private schools in Australia (the Cora Barclay Centre for the Deaf and Hearing Impaired), as programmes stressing auditory-verbal approaches have increased since early cochlear implantation has become more prevalent (Power & Hyde, 1997, 2003; Hyde et al, 2005). Other separate or special schools, including those that are publicly funded such as the Clerc Centre at Gallaudet University in Washington DC and the Indiana School for the Deaf, emphasise use of natural sign language while making varied levels of accommodation for support of spoken language development, especially for children with hearing loss or who use cochlear implants (Seal et al, 2005). Similarly, in Australia, some schools emphasise use of sign language in a sign/bilingual educational approach (Hyde et al, 2005). The lack of availability of such programmes in Ireland is problematic, limiting placement alternatives that match student needs. Primary schools for the deaf are small in size, creating both teaching and learning challenges. Further, during the site visit, both students and parents indicated that the lack of sufficient numbers of deaf and hard-of-hearing students in the various schools and programmes created difficulties for establishing peer groups to support both social and academic growth. The fact that special primary programmes for the deaf also educate secondary school deaf students, despite the lack of appropriate staff and resources, only makes the situation worse. That is, observations and staff reports during the site visit indicated that secondary school students were included in classes with younger, primary school students. Beyond the inappropriate social-emotional situation created, teachers of primary students have neither the training nor the materiel (for example science equipment, textbooks) necessary for educating secondary school students, thus seriously jeopardising normal academic progress. Resource units for deaf students in mainstream schools would help to alleviate some of this difficulty, but collectively, the seven units in Ireland served fewer than 50 students in 2006-07, according to unpublished 2007 and 2009 reports. Together, these obstacles are likely to reduce student success and cost the country more in education services, social services, and utilisation of human potential.

The larger proportion of students with hearing loss in England (Powers, 1996), Australia (Power & Hyde, 2002, 2003), Israel (Zandberg, 2005), and the US (Karchmer & Mitchell, 2003) now attend local schools in which they are grouped in special classrooms or, if primarily in classrooms for the general (or hearing) population, typically receive part-time special services from a resource room teacher. The latter arrangement was observed in one school during the site visit, seemingly with excellent results and certainly with high satisfaction on the part of students and parents. Resource room teachers often travel among several schools and provide a range of services from consultation with the general education teacher to direct, individualised academic support to deaf and hard-of-hearing students. Much of the direct teaching they provide is remedial in nature (Kluwin, Stewart, & Sammons, 1994; Stinson & Kluwin, 2003), and this model seems to be especially prevalent in the US (cf Power & Hyde, 2002). Importantly, itinerant (or peripatetic or visiting) teachers in those countries receive the same training as other teachers of the deaf. During the November 2008 site visit, school administrators, a visiting teacher, and two SENOs reported that visiting teachers had little or no specialisation in deaf education, although there are several well-recognised exceptions. While the site visitors were unable to assess the generality of those claims, more than a dozen parents reported that visiting teachers provided them with little or no support in educational decision-making. Within schools, visiting teachers were reported to have advisory roles, but in most cases their relative lack of knowledge about deaf education severely limited the potential impact of their input.

Demographic differences between students in special versus local schools and, within local schools, between those in special classes versus those primarily in classes with hearing peers, are striking. In special classrooms and special schools in the US more than half the students are from minority ethnic groups; the opposite is true for children in general education classrooms (Karchmer & Mitchell, 2003). This may be because ethnic status is generally a proxy for general socio-economic status in the US and unfortunately continues to influence learning opportunities (Kluwin, 1993). Students who attend their local schools are also less likely to have any identified disabilities to complicate the effects of their hearing loss than those in special schools (Allen, 1992). Practically, separate schools may be better equipped to handle the needs of children with multiple disabilities but theoretically comparisons of academic outcomes in the two settings are inherently invalid because the children who attend them will be different a priori.

Another general difference between students in local versus special schools is level of hearing loss. In the US (Antia et al, 2004; Karchmer & Mitchell, 2003) and Australia (Power & Hyde, 2002), students in general education classrooms tend to have lesser degrees of hearing loss and are therefore considered hard-of-hearing instead of deaf. This also means that more of the students in general classrooms use spoken language as their primary means of communication, although some require and receive sign language interpreters (Antia, Kreimeyer, & Reed, in press).

Some researchers have concluded that academic achievement is higher on average for students attending general education classrooms in local schools compared to those in special classrooms or special, separate schools (Holt, 1994; Kluwin, 1993; Kluwin & Stinson, 1993). An earlier study showed that students in general education made more progress in mathematics than those in special classes (Kluwin & Moores, 1985, 1989). However, what may at first seem to be an effect of placement has since been recognised as reflecting other variables, primary among them student characteristics that led to the placement choice. That is, more academically successful students were more likely to be placed in general education classrooms and, as is true for hearing students, those who begin with higher skill levels tend also to make faster progress over a given amount of time. An example of a study reaching this conclusion was reported by Powers (1999). He related the performance of deaf and hard-of-hearing students (hearing losses from moderate, or about 40dB levels, to profound) results on the General Certificate of Secondary Education (GCSE) examination administered in England and Wales to a number of background variables. Although Powers acknowledged gaps in the information he could collect, he found students in special schools for deaf students tended to perform less well than those in mainstreamed programmes. After further investigation, however, Powers pointed out that this was probably a result of placement decisions being made on initial skill levels and could not be attributed to characteristics of the educational placement itself. Regression equations accounted for only 20 per cent of the differences in outcome, but those predictors included age of hearing loss onset (with later onset predicting better academic performance), family socio-economic status, presence or absence of additional disabilities and presence of a deaf parent. This set of background variables has been found to associate with academic performance of deaf and hard-of-hearing students regardless of their type of placement (Marschark et al, 2002; Moores, 2001). Thus, in contrast with findings for students with cognitive or emotional disabilities (but without hearing loss) for whom achievement has been found to be supported more in mainstreamed or general education classes than in special classes (Carlberg & Kavalle, 1980), no functionally significant effect has been found for students with hearing loss.

Over a series of studies of deaf and hard-of-hearing students, after accounting for initial student and family characteristics, type of school placement has been found to account for only about 1-5 per cent of the variance in academic outcome (Allen & Osbourne, 1984; Kluwin & Moores, 1985, 1989; Powers, 1999). A stronger and more significant predictor has been the presence of additional disabilities, but overall an average of 75 per cent of the variance in academic outcome has remained unexplained. Stinson and Kluwin (2003), noting that Kluwin and Moores (1989) were able to attribute some of the previously unexplained variance in their study of maths achievement to differences in teacher preparation and quality of teaching, commented that future research should focus more on this aspect of the educational experience than on class make-up itself.

Clearly the shift to educating more deaf and hard-of-hearing students in general educational classrooms requires changes in teacher preparation (general education teachers and those specialising in deaf education). Even if, overall, deaf and hard-of-hearing students in such settings show academic achievement somewhat higher than that of their peers in special classrooms or special schools (Antia et al, 2008), those who are in general education classes continue to lag behind that of hearing student peers, on average falling at the "low-average" or somewhat below average level (Antia et al, 2008; Blair, Peterson, & Viehweg, 1985; Most, 2006). This consistent finding indicates that continuing assistance and resource teaching will be needed, especially if early identification and intervention as well as use of advanced hearing technology leads to an even greater proportion of the population with hearing loss being placed in general education classes.

As Antia et al (in press) caution, deaf or hard-of-hearing students who use spoken language are often assumed to understand and to be processing more information than is actually the case. In addition, Marschark and his colleagues have found that even college-age students, those who use spoken language and those who are skilled signers gain less information from peer-to-peer communication and classroom lectures (via an interpreter or direct communication) than they or others tend to recognise (Marschark, Convertino, et al, 2007; Marschark, Sapere, et al 2005; Marschark, Sapere, et al, 2004). Even when text-based support (real-time written transcriptions provided during class lectures) has been provided, deaf and hard-of-hearing students at secondary and university level have been found to understand significantly less of the information than hearing students listening to the same presentation but no more than they do through sign language (Marschark, Leigh, et al, 2006). Thus, simply providing sign language interpreters, print-based real-time transcriptions, or even preferential seating and amplification do not "level the playing field" for students with and without hearing loss in the same classroom. Because differences continue to be found among secondary and university students in this regard, it may be expected that even more accommodations are needed to enhance communication access for younger students with hearing loss given their frequently delayed acquisition of vocabulary and related language skills.

To provide necessary support, teachers must be prepared to work closely with general education teachers, and this may well require that they be knowledgeable about curriculum approaches used in general education classrooms. Effective skills at consultation and collaboration are critical in addition to skills in supporting use of varied technologies. Of course, knowledge about the special learning needs and styles of students with hearing loss (Hauser, Lukomski, & Hillman, 2008; Marschark & Hauser, 2008) as well as communication methods will continue to be required. Finally, such teachers need to be able to serve as advocates for their students and to facilitate them becoming advocates for themselves, as well as supporting their developing positive self-esteem and social-emotional characteristics (Antia et al, in press; Bullard, 2003; Smith, 1998). This is clearly not the situation in Ireland (and most other countries), where most class teachers in mainstream schools have little training in or familiarity with the issues confronted by deaf students (communication, socialisation, academic expectations). Interestingly, however, in essentially all of the settings observed during the November 2008 site visit, deaf students expressed the belief that they were able to learn much more than was being expected of them, and they wanted academic expectations raised.

9.1 Fostering social-emotional functioning in support of academic achievement

Social-emotional aspects of deaf and hard-of-hearing students' participation in general education classrooms have been an area of special concern and much research. The literature is replete with reports of negative self-esteem, lack of friendships and loneliness among students being educated in mainstream or general education settings (Stinson & Antia, 1999). In general, more opportunities for leadership, participation in extracurricular activities and communicatively easy social interactions are available in special schools and classes within local schools compared to situations in which one or a few students with hearing loss are placed in a classroom with hearing students (Moores, 2001; Ramsey, 1997; Stinson & Foster, 2000; Stinson, Whitmire, & Kluwin, 1996; van Gurp, 2001). Hearing students have been reported to lack understanding of attention-getting signals and clear speaking to assist speech-reading as well as to evidence general unease in interacting with deaf and hard-of-hearing peers (Stinson & Liu, 1999).

A placement option referred to as "co-enrolment" has been reported to minimise negative social-emotional reactions while allowing more integration of deaf and hard-of-hearing students in local general education programmes. The defining characteristic of this approach is that a "critical mass" of students with hearing loss, instead of an isolated child or two, attends class with hearing students (Banks, 1994; Kirchner, 1994, 1996). Although a 1:1 ratio of deaf and hard-of-hearing to hearing might be ideal, the demographics of hearing loss generally do not allow for that. Antia and Kreimeyer (2003) suggested that students with hearing loss should comprise a fourth to a third of the class. Multi-age co-enrolment classrooms allow for the combining of sufficient numbers of students with hearing loss and, because they continue together for more than one school year, allow time for those with and without hearing loss to develop significant friendships. Multi-age groupings also encourage individualisation of instruction depending on skill and developmental levels (Dorta, 1995; Kreimeyer, Crooke, Drye, Egbert, & Klein, 2000). Such programmes are useful in settings such as Ireland where deaf children are widely distributed geographically.

Building on earlier reports of the TRIPOD co-enrolment programme in California (Kirchner, 1994, 1996), Kluwin (1999; Kluwin, Gonsher, Silver, & Samuels, 1996) and Kreimeyer et al (2000) described model co-enrolment programmes with co-teaching by a general- and deaf-education teacher team, sign language instruction for hearing students and the general education teacher and signing aides or interpreters. In such a placement, both groups experience the same curriculum and expectations for learning. Results from these three programmes of research revealed academic achievement on average higher than that typical for deaf and hard-of-hearing students (albeit below that of typical hearing age-mates), and increased social interaction between students with and without hearing loss.

Wauters and Knoors (2008) suggested that peer acceptance in an inclusive or co-enrolment programme had effects beyond the social arena and that frequent friendly interactions also supported cognitive development. Administering an attitude scale to deaf and hearing classmates, they found no differences between the two on measures of how popular they were as playmates or on how positively or negatively they were perceived overall. The distribution of children across categories of popularity (popular/rejected/neglected/controversial/average) also failed to differ significantly by hearing status. On average, however, deaf children were scored lower by their classmates than hearing children on production of "prosocial" behaviours and were said to be more socially withdrawn. Wauters and Knoors note, however, that evidence of overall positive social interaction may have reflected the selectivity with which Dutch students with hearing loss are placed in general education classrooms, as the Netherlands also has separate programmes available for this population. Study participants were either in co-enrolment programmes, where sign language was being learned and used by hearing peers, or had sufficient spoken language skills to support participation in an oral environment. Thus, communication abilities generally were shared between deaf and hearing children in the classrooms.

Knoors and Hermans (in press) have summarised their continuing empirical research on educating deaf children in the co-enrolment pre-school, emphasising that the programme and a separate school have different strengths in providing qualitatively good education. They found the school for the deaf excelled in adapting educational methods to the communicative and individual needs of their students, whereas the co-enrolment programme significantly exceeded the separate programme on measures tapping classroom management and instructional techniques. Their findings indicated that mainstream and special schools 'face different challenges in providing deaf children with qualitatively good education'.

9.2 A co-enrolment model

An example of a co-enrolment programme in which great efforts were made to assure communication skills between hearing and deaf and hard-of-hearing students was described by Kreimeyer et al (2000). It was conducted in a southwestern US state with a relatively large Hispanic and Native American population. Most participating students, 60 per cent, were from low-income families (indicated by their qualifying for federally-supported reduced price lunches). Students tended to stay in the same classroom with the same teachers for three years. Before the co-enrolment classroom was established, children with hearing loss attended a special class in the same school and could interact with hearing students for an hour a day for non-academic activities (accompanied by an interpreter). According to Kreimeyer et al, during this period before co-enrolment, hearing students and teachers of the general education classes considered the attendance of students with hearing loss to be negative and disruptive. Their academic achievement was significantly below grade-level expectations in literacy and mathematics.

Co-enrolment began in a combination second, third and fourth grade class of nine students with hearing loss and 19 hearing students. The former used a variety of language systems, including sign only, sign plus speech and primarily speech with a few signs. Two experienced teachers, one certified to teach deaf children who had fluent sign language, the other an accomplished general education teacher, were supported by a certified speech/language therapist. The goal to increase student interaction and communication was facilitated by providing sign instruction for all students, designation of deaf and hard-of-hearing students as "sign specialists" and a 10- to 15-minute period each day when only non-vocal communication was allowed. This period often included games and all varieties of non-vocal communication (including gesturing and pantomiming) were encouraged. By teacher report, hearing students signed half of the time during interactions by the end of the first year. Girls acquired signs more quickly than boys and tended to be more verbal and less physical. Hearing students became used to tapping on deaf and hard-of-hearing students or using other visual or tactile signals to get attention and begin a conversation. The general education teacher also learned to sign and reported that she combined signing with speaking about 80 per cent of the time by the end of the year and understood the students with hearing loss most of the time without support from the other teacher.

Researchers noted that, at the outset, students tended to self-segregate by hearing status. They employed a single-subject intervention design to track changes in this pattern, first collecting quantitative observational data on interactions of each of the deaf and hard-of-hearing students during the first week (to serve as a baseline), and then collecting the same information over time as the procedures were implemented. Data indicated that classroom interactions increased over the course of the first year. This change was not as evident for one child who had multiple disabilities and was less evident during lunchtime than during classroom activities. Although this research design allowed comparison with a baseline, it did not provide any way to determine whether the observed trends would have occurred over time without the specific interventions implemented – that is, whether the changes were due to hearing students' acquiring signs or simply to the two groups of children having an extended time to get to know each other. Logically, however, the data provide some support for the efficacy of the sign intervention activities and no evidence of negative outcomes.

Indications of academic advantages for deaf and hard-of-hearing students from participating in the co-enrolment classroom were mixed. Scores on tests of academic skills were conducted near the end of the academic year and those of students with hearing loss in this classroom were compared with normative scores provided for deaf peers and for hearing age-peers in the test manuals. Participating students scored above expectations compared to deaf and hard-of-hearing norms for reading comprehension but still below norms for hearing students. Their performance on mathematics did not differ significantly from norms for students with hearing loss and, again, were below the average scores for hearing students. Thus, although use of this co-enrolment model had apparent value in providing experiences for deaf and hard-of-hearing and hearing children to get to know each other, to interact and to learn from each other, there was no consistent evidence of academic benefits. Gains in cognitive processes might be expected for both deaf and hard-of-hearing and hearing groups if experiences in language code switching promote flexibility in perspective-taking and problem-solving. The possibility of such gains was not investigated, however, and there are no data to support this potential effect. Long-term consequences of the co-enrolment experience are yet to be determined.

Despite some advantages, potential benefits of this approach to class placement are limited since it obviously requires considerable resources. Stinson and Kluwin (2003) noted that several such experimental programmes were discontinued after a few years and that continuation depended on trained and motivated staff as well as a large enough body of students with hearing loss to provide a critical mass in the classroom. Kreimeyer et al (2000) as well as Luckner (1999) have emphasised that successful implementation requires more work from staff in terms of planning and co-ordinating activities, relies upon designation of a clear team leader and necessitates the definition of shared educational and social goals. Teachers need to be able to work well as a team and it is advantageous for them to have consciously decided to participate in this kind of approach.

9.3 A mainstreaming model

In the co-enrolment programme described, there was a major effort to assist hearing students and teachers to learn sign language to facilitate deaf and hard-of-hearing students' ability to interact and learn in the general educational classroom. In mainstream settings where students with hearing loss do not use signing, communication barriers may also require significant resources if they are to be surmounted. Hadjikakou, Petridou, and Stylianou (2005) reported on the experience of students, their parents and their teachers on the island of Cyprus, where all students use oral communication at school and where almost 90 per cent of secondary-level students with hearing loss have been integrated in general education classrooms since the 1990s. (Mainstreaming has been common in the primary grades in Cyprus since the 1980s.) The move toward mainstreaming had resulted in large part from parent demands that their children share equal access to educational services. Questionnaire responses indicated a fairly high level of parent and student satisfaction overall with services for deaf and hard-of-hearing students in the general education classrooms.

Cyprus has set up an organised and resource-intensive service system for this population, including one-on-one or small group pull-out classes on Greek language, history and physics (for which general achievement testing is required), as well as for English as a second language. It appears that a significant function of these one-on-one/small group sessions is pre-teaching of lessons and materials that will then be covered in the general classroom. More than half the students reported that these allowed them to understand the subsequent regular classroom lessons. Although all of the 69 secondary students surveyed (100 per cent of the target population) said they could understand material presented during the pull-out sessions, 20 remained unable to participate during the regular class and a few reported that they *never* understood lessons in the regular classroom.

In addition to the pre-teaching and one-on-one or small group work, a few "co-ordinator" teachers, who are trained teachers of the deaf, serve as itinerant consultants for the general classroom teachers and are responsible for monitoring student performance in accordance with goals set in individualised education plans (IEPs). It is of interest that despite the availability of trained counsellors and psychologists in the schools, the deaf and hard-of-hearing students said they were most likely to talk about issues and problems at school with the trained deaf education teachers (and, at home, with their parents). Parents also reported more communication with these specialists than with other school personnel. Specialist teachers also provide in-service training and demonstration "micro-lessons" for the general education teachers, 81 per cent of whom found them helpful. However, students continue to report that many general education teachers do not modify lessons or approaches to them and teachers themselves report that the degree of adaptation varies. Similar reports have been obtained from students and parents in Ireland where the frequent lack of access to communication in the classroom makes such accommodations all the more important.

Teachers, parents and deaf students in Cyprus all indicated that some educational needs were not being optimally served in current classroom environments. Students and parents requested fewer lessons, less homework, clearer and slower speech used by teachers during class and modified written language in texts and on tests. Hadjikakou et al (2005) referred to current integration procedures as "effective and adequate" (p211); however, they added: "Alternative teaching methods and curricular modifications and adaptations should be developed to meet the needs of deaf children in an integrated environment" (p210). Although there are no data reported on the specific academic achievements or interactive patterns of the deaf and hard-of-hearing students surveyed, it seems reasonable to conclude that academic achievements on the whole lag behind those of hearing peers and that teachers face additional challenges in the regular classrooms if they are to meet those educational needs.

9.4 A multi-level model

Unlike Cyprus and some other countries, Norway has a long tradition of natural sign language (Norwegian Sign Language, NSL) use among its deaf population. When legislation allowed deaf and hard-of-hearing students to attend local general education schools, they continued to have the right to be educated in NSL. The system of separate schools that had previously provided sign-based educational programmes was modified to set up those schools as resource centres providing in-service training for general education teachers, instruction in NSL, and support services for deaf students by consulting with the local schools. They continued to serve as part- or full-time education settings for some of the deaf and hard-of-hearing students. In the school year of 2001-02, a third of Norway's students with hearing loss were being educated in general education classrooms, and two-thirds were in special classes either in the local schools or the resource centres. To better accommodate their needs, Norway made some modifications in its national curriculum to provide more appropriate options. These options include changing language-learning expectations by substituting sign language skills for spoken Norwegian and English and changing expectations for the music curriculum. Additional teachers ensure that students using NSL who are integrated into general education settings have a signing teacher in the classroom and, in some situations, pupil-teacher ratios have been reduced. Decisions about these arrangements tend to be made at local school level. As Hyde et al (2005) concluded, the move from separate schools to this more integrated system resulted in the education system in Norway becoming more complicated administratively for students and for teacher preparation programmes. Data on educational outcomes are not yet available.

9.5 Physical setting and acoustic concerns

Complications and additional considerations beyond administration and teaching methods must be faced in integrated general education settings. The appropriateness of the physical classroom must be addressed since background noise creates special problems for most children with hearing loss, including those using hearing aids and cochlear implants, in understanding spoken language (Moeller, Tomblin et al, 2007). For this reason, more than half the educational programmes in Cyprus have improved classroom acoustics (Hadjikakou et al, 2005), and some teachers in Canada place used tennis balls on the legs of classroom chairs. Crandall and Smaldino (2000) point out that typical classroom signal-to-noise ratios are not conducive to learning, especially for students with hearing loss, and Finitzo-Heiber and Tillman (1978) indicate that speech reception is significantly reduced with even moderate classroom noise.

Wilkins and Ertmer (2002) evaluated the needs of children in the US using cochlear implants and enrolled in integrated (or inclusion) settings. They concluded that preferential seating, use of personal and soundfield frequency-modulated (FM) systems and presentation of important material in writing followed by frequent checks of comprehension are needed when students with hearing loss (especially those depending upon spoken language) are integrated with hearing students. They cautioned that teachers in general education classrooms should not assume that deaf and hard-of-hearing students comprehend language as well as their hearing classmates and need to monitor understanding frequently (Marschark et al, 2004, 2005). Given these constraints, integration can be difficult even for children with relatively strong speech and language skills.

The use of sign language does not eliminate concerns about classroom acoustics in that many of these children are also expected to be able to learn and use some auditory processing and auditory-based language skills. Questions also remain about optimal classroom size when a sign/bilingual approach is used. Roald (2002) and Evans (2004) indicate that larger class sizes promote better sharing and learning in a sign/bilingual environment while most others (Moores, 2001; Marschark et al, 2002) indicate that small class sizes more effectively support deaf and hard-of-hearing children's learning. While this issue is still under consideration, it appears that deaf children in Ireland are at a disadvantage in any case. The extremely small size of schools/programmes for the deaf allows for only limited utilisation of same-aged groupings for collaboration on school work. In the smaller schools for the deaf and general education classrooms deaf children's psychosocial development also might be affected by the lack of opportunities for easy interactions with same-aged peers. Extracurricular and/or cross-school activities for deaf and hard-of-hearing children, either in person or online, could help to ameliorate these disadvantages (Antia, Stinson, & Gaustad, 2002).

9.6 Classroom interpreting and real-time text

Beyond improving classroom acoustics, access to instruction can be facilitated directly by the provision of real-time text and, for those using sign language, sign language interpreting. Oral interpreting (also known as oral transliteration) has been used in further and higher education, but apparently not in primary and secondary school settings.

Within integrated classrooms, real-time text (captioning provided in real time) is promoted frequently as a relatively inexpensive means of giving student with hearing loss access to instruction and discussion in the classroom[12]. Despite common assumptions, however, there is relatively little evidence that this is true. At first blush, one would expect that real-time text for deaf students would present a challenge because the speed of verbatim real-time captioning is likely to exceed their reading abilities.

Even controlling for reading level, Jelinek, Lewis, and Jackson (2001) found that deaf nine- to 11-year-olds learned less from captioning on videos than hearing peers, apparently because of differences in background knowledge and information processing strategies (Strassman, 1997).

Stinson, Stuckless, Henderson, and Miller (1988) and Elliot, Stinson, McKee, Everhart, and Francis (2001) surveyed deaf and hard-of-hearing students about their use of real-time text and interpreting. Students in both studies assigned higher comprehension ratings of understanding to real-time text than to interpreting. No direct evidence of comprehension or learning was reported, however, nor did they evaluate students' reading or sign language skills. The validity of student comprehension ratings is questionable, in any case, insofar as Marschark, Sapere, et al (2004) showed that deaf students tend to overestimate their comprehension in the classroom. Steinfeld (1998) found that captioning improved working memory performance (relative to no captioning). Hearing students' memory performance still surpassed that of deaf students, however, and comprehension was not examined despite the author's conclusion that 'providing real-time captions improves comprehension for students who are deaf'.

Other studies indicating the utility of captioning have demonstrated advantages for hearing students who were second language learners or who had learning disabilities (Koskinen, Wilson, Gambrell, & Jensema, 1986; Neuman & Koskinen, 1992), but Koskinen, Wilson, and Jensema (1986) examined the impact of captioning on reading by deaf students.

[12] This issue is distinct from claims that regular use of television captioning and TTYs (minicoms) would facilitate deaf children's literacy skills. No empirical evidence has been offered to support these claims.

Deaf 13- to 15-year-olds in their study saw 10 repetitions of a 30-minute captioned video and received "intensive vocabulary and reading practice". Subsequently, however, students' sight reading of the material was reported to increase only 10 per cent and there was no mention of increases in comprehension or transfer to other materials.

Stinson, Elliot, Kelly, and Liu (in press) compared deaf secondary school and postsecondary (that is further and higher education) students' comprehension and memory of a lecture supported by either sign language interpreting or text. No significant differences were observed between conditions for the college students. Secondary school students, however, showed significantly greater performance on a post-test when they received real-time text or read a transcript of a class lecture than when they received interpreting (see also Marschark, Sapere et al, 2009). Stinson et al suggested that the secondary school students retained more information with real-time text than interpreting due to the completeness of the information, the longer visibility of captioning on a computer display, and the availability of a printed transcript (for studying) afterwards. Deaf college students' greater experience in receiving information in a variety of formats was assumed to override any potential relative benefit of any particular form of support.

Marschark, Leigh, et al (2006) also examined the utility of real-time text in supporting deaf students' learning from lectures in secondary and post-secondary classrooms. In one experiment, they compared the effects on learning of real-time text, sign language interpreting and both. Real-time text alone led to significantly higher performance by deaf students than the other two conditions, but their performance in all conditions was significantly below that of hearing peers who saw lectures without any support services. The advantage of text was not replicated in a second experiment comparing interpreting and two forms of real-time text, at immediate testing and after a one-week delay (with study notes). Marschark, Leigh, et al also failed to obtain significant differences in either immediate or delayed testing when they compared 12-to 16-year-olds' learning under three conditions:

1. A deaf teacher signing in Auslan (Australian Sign Language)

2. The teacher signing in Auslan with simultaneous real-time text

3. And real-time text alone (cf Andrews et al, 1997).

Nor did they find significant difference between interpreting and interpreting plus real-time text in a fourth experiment examining the learning via television captioning. Taken together, these experiments led to the conclusion that neither sign language interpreting nor real-time text has any inherent, generalised advantage over the other in supporting deaf students in secondary or post-secondary settings. At the same time, both provide superior access relative to no communication support even if they fail to fully eliminate learning differences between deaf and hearing students.

That latter qualification remains an important caveat to the preceding findings. In all studies described in this section, as well as in a series of other studies by Marschark and his colleagues (Marschark, Sapere, et al 2004, 2005), any time hearing students have been included, they have outscored deaf students on post-instruction tests, regardless of whether they received real-time text, sign language interpreting, or direct instruction by teachers who signed for themselves. Those results have been attributed in part to the finding that deaf students consistently came into the classroom with less content knowledge than their hearing peers (as indicated by pre-tests), but even controlling for prior knowledge they are outscored by hearing peers. As will be described later, however, Marschark, Sapere, et al (2008) found deaf college students learned just as much as hearing students from classroom lectures when they were taught by experienced teachers of the deaf, regardless of whether the instructors were hearing or deaf and whether they were signing for themselves or utilising interpreters. Those findings have been replicated in ongoing research, but the issue has not yet been investigated with younger students.

9.7 Summary

It appears there is a convergence of opinion at various governmental levels (although not in the conclusions of data-based research) that participation in general education settings is of value to students who are deaf or hard-of-hearing. It was suggested earlier that it would benefit these students to attend maths and science classes, at least at the secondary level, in settings that have teachers who are experts in those fields. To date, however, evaluations of placement effects have failed to indicate consistently significant academic benefits from different placements. Effectively managing specialised learning and communication needs of this student population requires training of general education and special education teachers, as well as modification of the physical environment and class size. Given the prevalence of the model in which itinerant or visiting teachers consult the regular classroom teacher and provide individual or small group tutoring or pre-learning activities, time must be provided for communication between the teachers and other providers of student services. Teacher preparation programmes need to assure that knowledge about the general curriculum and general educational practices, as well as specialised knowledge in communication methods and learning styles of deaf and hard-of-hearing children are provided to the specialist teachers.

Although evidence is scarce, that which is available suggests that, at a minimum, social benefits accrue from co-enrolment and integrated placements where a significant number of children with hearing loss become part of a class which may be led by two co-teachers, one of whom specialises in education of deaf and hard-of-hearing children (such as a programme in Ireland that has a relatively large number of deaf and hard-of-hearing students enrolled in an integrated setting that provides interpreting, co-teaching, and tutoring in a separate classroom) . This kind of approach requires considerable resources and leadership and teaming abilities from teachers, but it is not yet clear to what extent this model can be generalised across situations. It represents the concept of inclusion, however, in that it promotes modifications in the provision of educational services to meet the needs of students with hearing loss while preserving their opportunities to interact with the regular curriculum, other students with hearing loss, and the larger society of hearing students.

Multi-level systems that provide options for full- and partial-day classes as well as placement in classes with a majority of hearing students, also require significant administrative resources but they permit placement decisions to be based on assessment of individual needs. Recent evidence indicates that the learning styles and needs of deaf and hard-of-hearing students differ sufficiently from those of their hearing peers to require specialised programming and teaching methods or strategies if children are to achieve their full potential. Special assistance thus is also required for teachers if they are to build on the strengths and meet the needs of students with hearing loss who are in classrooms with hearing students. Students with hearing loss will need communication accommodations regardless of the language modality(ies) that they use, and neither the use of spoken language nor provision of interpreters can assure equal access to information presented in the classroom.

To the extent that placement in general education classes (that is mainstreaming or inclusion) remains a societal and educational goal for students with hearing loss, more research is needed on methods of matching child needs with environmental supports. Also in need of further investigation are methods and outcomes in the preparation of general and special education teachers who will have to fulfil the responsibilities and roles required in any of the existing models of academic integration.

10. Cognition, Perception and Learning Strategies

The average scores of students with hearing loss do not differ significantly from those of hearing peers on tests of nonverbal cognitive functioning when students with multiple disabilities are not included (Maller, 2003). Their scores on tests of verbal intelligence, in contrast, tend to fall a full standard deviation below the hearing mean (Maller & Braden, 1993). It is generally recognised that this gap reflects differences in opportunities for language development between deaf and hearing children. Although it has been argued that deaf students' performance on the verbal scales of tests of intelligence can provide helpful information for making programming decisions (Akamatsu, Mayer, & Hardy-Braz, 2008), there is no doubt that such scores are not valid measures of students' cognitive capacities. There is no evidence that hearing loss diminishes intelligence or cognitive abilities in general. Marschark (2003. p464), however, cautions that:

> …pointing out that deaf people can be every bit as competent as hearing people should not be taken as equivalent to the claim that deaf individuals necessarily think, learn, or behave exactly like hearing peers… differences in the environments and experiences of deaf children and hearing children might lead to different approaches to learning, to knowledge organised in different ways, and to different levels of skill in various domains.

He goes on to argue that identification of any such differences is critical if optimal support for learning is to be provided (Hauser et al, 2008).

10.1 Foundations of learning: play and theory of mind

10.1.1 Play

There have been indications that even during the early years the expression of cognitive skills may differ according to hearing status and upon rate and pattern of language development. Play behaviours have long been accepted to be an overt expression of the developing cognitive skills of infants and toddlers (Rubin, Fien, & Vandenberg, 1983; P Spencer & Hafer, 1998). However, with the emergence of language, a reciprocal relation is established. Quittner, Leiback, and Marciel (2004) noted that play, along with emerging language, gives evidence of a child's growth in understanding and using symbols and representations.

In a longitudinal study comparing three groups of mothers and infants (deaf infants with deaf mothers, deaf infants with hearing mothers, hearing infants with hearing mothers) from age nine to 18 months, P Spencer and her colleagues (Meadow-Orlans et al, 2004; P Spencer & Hafer; Meadow-Orlans & P Spencer, 1996) found no differences at nine months in the amount of time or the types of play in which the children engaged. By 12 months, however, a difference was seen. Hearing children engaged in more play at the representational level (at which toy objects are recognised and manipulated as though they were the actual object and with evidence of pretence) than did either group of deaf children. This play pattern had changed when the children were again observed at 18 months. At that age, the quantity of play by deaf children whose language development was consistent with age level expectations (in this case, these tended to be children acquiring sign language from deaf mothers) matched hearing children's play at the representational level and at a higher level referred to as symbolic. Symbolic play is cognitively more complex in that it is typically defined as either demonstrating evidence of pre-planning or of an intentional substitution of one object for another. Both of these behaviours indicate mental manipulation of symbols separate or distanced from immediate perception and, as Quittner et al (2004) posited, reflect the existence of "inner" or "mental" linguistic symbols that support memory and facilitate comparisons with past experiences.

Although play differences at 18 months did not relate to hearing status itself, they were different according to children's language level which in this study was measured by the diversity of vocabulary and complexity of emerging syntax. In addition, the general quality of mother-child interaction was strongly associated with the amount and level of play in which the children engaged. In a later analysis, it was found that the rate of development of visual attention skills was also related to language and quality of mother-child interaction. Thus a web of interrelationships is suggested (Meadow-Orlans & P Spencer, 1996).

Analysing three different groups of deaf and hearing children aged 24 to 28 months (again two groups of deaf and one of hearing children), P Spencer (1996) again found differences in cognitive play behaviours related to expressive language levels, but not to hearing status itself. Lower amounts of symbolic play were found for children with lower language levels and it happened as in the foregoing study that the group with lower language skills was composed mainly of deaf children with hearing parents. In addition to more pre-planned play behaviours from children with higher language skills (regardless of language modality), those with more complex expressive language also engaged in more play sequences termed "canonical" and that represented logical or realistic activity sequences which formed part of a larger whole or theme. Although it has not been replicated, this may be an important early finding in that the production of canonical sequences of play behaviours indicates sequential order in memory storage and retrieval.

Other researchers also have found that any differences between play behaviours of deaf and hearing children have associated strongly with language levels (Bornstein, Selmi, Haynes, Painter, & Marx, 1999; Brown, Rickards, & Bortoli, 2001; Snyder & Yoshinaga-Itano, 1998; Yoshinaga-Itano et al, 1998). To the extent that ability to engage in complex symbolic play during the early years provides opportunities for learning (P Spencer & Hafer, 1998), this pattern of delayed development can result in differences in the amount and kind of learning experiences a child with hearing loss and delayed language development brings to the educational setting.

Meadow-Orlans et al (2004) suggested that differences in early language development and early play result at least in part from differences in early interactive experiences of children with hearing loss and hearing parents compared to hearing children, with the former group experiencing less responsive and fewer supportive scaffolding behaviours (but see Lederberg & Prezbindowski, 2000, for a contrasting interpretation). This may become a self-perpetuating cycle in that mothers find it easier to scaffold play and other cognitive skills when their children have higher levels of receptive language.

In addition, language learning and play may be directly influenced by hearing status, with deaf children's dependence upon visual communication (whether for watching signs or speech-reading) making the pace and timing of turn-taking exchanges different from that which most hearing adults expect. Although many deaf mothers have been shown to intuitively manage the visual aspects of early communications in positive ways (moving location of signs to accommodate child's existing attention using a defined set of attention-getting signals), such accommodations seem much more difficult for hearing adults (Harris, 2001; Harris & Mohay, 1997; P Spencer, 2000b; Waxman & P Spencer, 1997). Given that infants, deaf and hearing alike, do not develop the ability to flexibly switch attention between object and persons during interactions until about 12 to 15 months, mothers' roles in interactions with children with hearing loss are complicated. Because play situations are as much engines of continued cognitive development as evidence of current levels (Spencer & Hafer, 1998), less than optimal early experiences can result in many deaf children not having had experiences as supportive of cognitive and linguistic development as those of hearing children during infancy and the toddler period.

10.1.2 Theory of mind

Another aspect of cognitive development found to emerge in the pre-school years is termed theory of mind (ToM). This refers to a metacognitive ability, that is the ability to think about something in the abstract, removed from the immediately perceptible environment. Peterson, Willman, and Liu (2005) defined theory of mind as "…the awareness of how mental states such as memories, beliefs, desires and intentions govern the behaviour of self and others…" (p502). Al-Hilawani, Easterbrooks, and Marchant (2002) found no differences between deaf and hearing children from two very different cultures on one type of theory of mind task: recognition of pictorially-represented facial expressions of emotion. However, Odom, Blanton, and Laukhuf (1973) demonstrated that deaf children aged seven to 12 could identify facial expressions of emotion but were significantly worse than hearing peers in their ability to predict those mental states on the basis of behavioural sequences (pictures) which might elicit them. Consistent with this finding of a dissociation between recognising emotions and being able to identify their underlying causes, tasks tapping other aspects of theory of mind have shown consistent differences between children with and without hearing loss.

The most frequently administered and reported task for assessing this, the Sally-Anne task, involves the recognition of a false belief. An object is put in a specific location in view of the child and another person, then moved while the child looks on but after the second person has left the room. The child is asked where the second person will look for the object after returning to the room. This requires the child to remember the sequence of events and to understand that the second person has not had access to what the child has seen, therefore will pick the original placement. A second frequently used task involves an unexpected object (such as a piece of candy) being found in a container clearly labelled to indicate another object is inside. On discovering this trick, the child is asked whether she was surprised and what a friend would think was in the box.

Given that both tasks involve complicated language merely to understand the questions, it is not surprising that language skills associate with correct responses. Accordingly, although typically-developing hearing children often answer correctly by age four or five, some researchers have found that deaf children, most of whom have delays in language development, also have shown significant delays in this metacognitive skill (Courtin, 2000; Courtin & Melot, 1998; Moeller & Schick, 2006; Wellman & Liu, 2004). Courtin (2000) found, however, that deaf children with deaf parents performed better on theory of memory tasks than deaf children with hearing parents (regardless of the language modality used by the children with hearing parents).

This finding appears to support the view that language delay causes theory of mind delays.

Schick, de Villiers, de Villiers, and Hoffmeister (2007) investigated this issue by including tasks tapping similar conceptual processes as those previously described but requiring minimal language to give evidence of theory of mind. They included 176 participating children, representing four groups: hearing children, deaf children from oral language programmes and deaf children who used American Sign Language – about half of whom had deaf parents and half with hearing parents. The children ranged from age four to seven. Schick et al replicated earlier findings insofar as the deaf children with language delays, mostly those whose parents were hearing, performed less well on false belief tasks (unseen change in location understandings tested using a picture-sequence format and an unexpected contents task) than either deaf or hearing children with better language skills. This difference in performance was found even when low-verbal versions of theory of mind tasks (a hidden sticker game and a surprise face game in which children indicated whether a character would have been surprised at a story outcome) were administered. Schick et al concluded that the children with lower language skills actually had problems *reasoning* about the tasks they assessed that focused on people holding false beliefs. Since the deaf children with deaf parents, who had been exposed to fluent language models since birth, performed like the hearing children on these tasks it showed that hearing loss did not itself cause the delay of the other group of deaf children. Schick et al concluded from additional analyses that command of a specific grammatical structure (English complements – Daisy said *she would help cook;* Johnny wanted *to go to the show*) related significantly to theory of mind but that levels of general syntactic abilities did not. It cannot be the surface-level structure of that grammatical form that is important, however, since it is expressed differently in spoken English and American Sign Language, and fluency in the latter also supported age-appropriate performance on the false belief task.

Cheung et al (2004) studied hearing children speaking Cantonese or English, languages which differ in complement structures at surface level. They found that correlations between understanding of complement structures and theory of mind became non-significant when general language comprehension was controlled. They argued that general language skills and not any specific syntactic knowledge drove the development of theory of mind. Schick et al (2007) also found that, in addition to syntax, vocabulary knowledge positively related to theory of mind performance. This led to a suggestion that the opportunity to participate in rich conversational exchanges was the mechanism for advances in theory of mind abilities. This conclusion agrees with that of other researchers (Lundy, 2002; Peterson & Siegal, 1995) and suggests that quality of interactions, identified as an important facilitative factor for play development, continues to have effects on cognitive growth as theory of mind becomes established.

Mechanisms that build theory of mind abilities and differences among performance depending upon task variations are clearly of theoretical importance but have not yet been fully identified. Relevant findings nevertheless suggest that many children with hearing loss may not bring to school-age learning situations the same ability to use varied cognitive skills as hearing children do. Theory of mind skills in particular seem likely to be essential to the teaching-learning enterprise insofar as they allow children to place teachers' language in a larger context. Thus far, however, the link between it and academic achievement has not been explored.

10.2 Visual attention, language and communication

Although there is no indication that decreased hearing results in increased visual acuity, indications of visual attention differences between deaf and hearing persons exist (Dye, Hauser, & Bavelier, 2008; Quittner et al, 2004; Meadow-Orlans et al, 2004). Deaf and hard-of-hearing people must monitor their environment without having auditory signals to alert them to changes and in apparent response to this behavioural and neurological investigations have shown them to be more sensitive to objects and movements in the peripheral visual field (Neville & Lawson, 1987a, b, c; Swisher, 1993). Perhaps as a result, parents and teachers of children with hearing loss have often reported them as visually distractible and even impulsive (Meadow-Orlans et al, 2004; Mitchell & Quittner, 1996; Quittner et al, 2004). Mothers of deaf children, accordingly, have been observed to use a specialised set of attention-directing and maintaining behaviours with deaf infants and toddlers (Harris & Chasin, 2005; Waxman & P Spencer, 1997). Convergent results across studies indicate that visual attention is an area in which deaf children show processing differences from hearing children.

Their performance on tests of sustained selective attention has been shown to be worse than that of hearing children (Dye et al, 2008; Quittner, Smith, Osberger, Mitchell, & Katz, 1994). This may be interpreted in a value neutral way as evidence of a "redistribution of attention… across visual space" (Dye et al, p253). Deaf persons who use sign language have also been shown to have increased facial recognition abilities (Bellugi et al, 1990) and to recognise rotations in three-dimensional block figures better than hearing people (Emmorey, 2002; Talbot & Haude, 1993). Thus adaptation and experience appear to affect the profile of relative strengths in visual skills.

This interpretation is strengthened by data from Smith, Quittner, Osberger, and Miyamoto (1998) who reported increased selective attention performance by deaf children using cochlear implants that provided access to more auditory information. Smith et al suggested this was because opportunities for cross-modal integration of stimuli help to develop focused attention skills, but it is also possible that the ability to hear when environmental changes occur decreases the need for visual vigilance.

Simms and Thumann (2007) emphasise that educators have for too long focused on deficits assumed to result from lack of hearing and recommend instead that curricula be organised to make best use of visual information and processing. It remains, however, that deaf and hard-of-hearing children are more prone to distraction in educational environments characterised by much movement occurring in the peripheral visual field. Dye et al (2008) concluded that learning can best be served by providing a "visually predictable environment" (p260) arranged so that students with hearing loss can see the teacher and their peers at all times. In contrast with the views of some proponents of sign/bilingual programmes (Evans, 2004), and the situation in many mainstreamed programmes as well, this would militate against large numbers of deaf students in a classroom.

It cannot be assumed that access to visual communication, even in small classroom groups or dyadic conversations, resolves complications arising from the need for visual communication. Just as literacy levels vary, so do receptive and expressive communication skills – especially given different ages of language acquisition and, when signing is used, consistency and fluency of models. Communication can be thwarted when language skills are insufficient to support conversation. In addition to this potential difficulty, the differences in patterns of visual attention necessitated by increased dependence on vision for communication, even if only for speech-reading, have potential effects on the optimal pacing of instruction in a classroom with deaf and hard-of-hearing students. It is commonly recognised that information presented verbally (in speech or in sign) to deaf students in an instructional situation must be paced to allow learners time to look away from the speaker/signer to attend to any visual aids presented as supportive information. For example, time must be given for students to look at and read a whiteboard or a PowerPoint slide and then look back at the instructor for discussion about that slide. In most cases, this results in slower progress than in a situation with only hearing students who can look at a visual display while the instructor speaks. The situation is further complicated by a report from Matthews and Reich (1993) that deaf and hard-of-hearing students visually attended to their teachers less than 50 per cent of the time during teacher-directed lessons. Attention was even less likely to peers speaking/signing in the context of classroom discussion.

Developmental differences in visual attention and metacognition, especially in combination with language delays, may lead to differences in the amount of information understood in conversations and in formal lessons in classrooms involving deaf and hard-of-hearing students. Marschark, Convertino et al (2007) measured understanding as well as requests for clarification between communicative partners at the college level, setting up dyadic communication tasks between students who used American Sign Language, those who used oral communication, and mixed dyads in which one person used sign and the other spoken language. They found that understanding, even in this presumably optimal one-on-one situation, was quite low across all three types of dyads although those using ASL performed somewhat better (understanding 66 per cent of communications) than other types of dyads. (Oral dyads understood each other 44 per cent of the time, not significantly different in that regard from the mixed dyads). In addition, participating students frequently gave no evidence that they appreciated their lack of mutual understanding, relatively rarely asking for clarification – although requests for clarification occurred more often among oral dyads than the others. This finding concurs with a report by Jeanes, Neinhuys, and Rickards (2000) who found that students in oral programmes were more likely than those in total communication programmes to seek clarification during conversations.

Marschark, Convertino et al (2007) suggested that the frequent lack of recognition of misunderstandings may reflect metacognitive failures (Marschark et al, 2004), that is the students may not recognise when they have failed to understand. On the other hand, lack of requests for clarification may reflect unwillingness to acknowledge communication gaps – perhaps because many students with hearing loss have learned from experience not to expect complete grasp of communications across many settings. Either explanation suggests that teachers of deaf students need to be especially alert to gaps in understanding and help students recognise and respond appropriately to those gaps.

The ability of students with hearing loss to gain understandings from language used in the classroom has been further investigated by Marschark and his colleagues (Marschark, Leigh et al, 2006; Marschark et al, 2005; Marschark et al, 2004), and they have consistently reported that deaf college students in classrooms with highly trained interpreters scored lower on tests of knowledge gained when compared with hearing students. This was the case even when levels of pre-existing knowledge on the topic were statistically controlled (Marschark et al, 2004, 2005). Background variables such as degree or age of hearing loss, parents' hearing status, reading level and age at learning to sign have not proved to be related to the deaf students' learning outcomes. In addition, whether the interpretation was presented in ASL or in signed English form also has failed to predict or increase the amount learned (Marschark et al, 2005).

More recently, Marschark et al (2008) obtained similar findings regardless of whether teachers were deaf or hearing and whether they utilised interpreters or signed for themselves. In contrast to previous findings, however, the teachers in this study were all experienced teachers of the deaf and deaf students gained just as much as their hearing peers (from pre-test performance), even if they came into and left the classroom with less. Marschark and his colleagues hypothesised that having a teacher who understands what deaf students know and how they learn may be more important than the use of direct instruction over mediated instruction (sign language interpreting or real-time text). Further research will be needed to determine whether this is correct or, more likely, in which settings it is true for which students. Within Ireland, however, deaf children typically are taught by teachers who have little knowledge of the population's cognitive skills in classrooms and are lacking interpreters, notetakers, real-time text and tutoring. This situation was directly observable during the November 2008 site visit, and teachers and parents reported that it put students at a disadvantage academically. Matters are likely to become worse as students progress in school, and enter the classroom with less content knowledge and less flexible learning skills than hearing peers, and thus frequently falling farther behind (Marschark, Convertino, & LaRock, 2006).

It also remains unclear to what degree differences in attention and language levels may complicate deaf and hard-of-hearing students' learning through interpreters or even teachers who sign for themselves. Findings from a series of four experiments (conducted in the US, Australia, and the Netherlands) by Marschark, Leigh et al (2006) found overall that presentation of information through real-time print transcriptions failed to raise comprehension to that attained by hearing students. One experiment involving real-time transcription and provision of notes for review before taking a knowledge test showed some (albeit non-significant) advantages. The notes may have served as a memory aid and assisted in organising incoming information, a possibility currently under investigation.

10.3 Memory processes, perception, and learning

Although it has been a frequent research finding that sequential memory span for words or digits is decreased for deaf compared to hearing persons, these findings seem to depend to some extent on the individual's primary language modality and the modality in which they are tested rather than on hearing status. Deaf persons who have relatively strong phonological and speech skills tend to use phonological coding in sequential memory tasks. Those who depend primarily on visual or sign language are likely to use sign-based codes. Given that sign articulation is slower than that of speech, use of the former will of necessity extend the time required to produce the stimuli and/or to produce the response (Lichtenstein, 1998). Therefore, what has been reported as "shorter" memory span for deaf persons (P Spencer & Delk, 1989) (because on average they can remember and repeat back fewer digits or words in a sequence) may not show a memory deficit, but instead a cognitive difference associated with patterns of visual versus auditory processing. This interpretation is complicated by findings in a series of studies by Pisoni and his colleagues (Pisoni et al, 2008) showing that memory for digit sequences is also shorter for children using cochlear implants than for their hearing peers. These children are expected to be using spoken language mediation in the memory task. However, because most received their implants at a fairly late age (over three years) and were profoundly deaf before they were activated, their performance on the memory tasks may reflect some limits to neurological plasticity. Hall and Bavelier (in press), meanwhile, have argued that sequential memory tasks are inherently biased against deaf signers. They showed that visuospatial place memory is as good or better in deaf signers as in hearing speakers, concluding that memory coding preferences rather than capacity differences are at issue in such studies.

Wilson, Bettger, Niculae, and Klima (1997) gave further evidence of differences in memory processes of deaf and hearing children in a report that deaf children (with deaf parents) using American Sign Language had similar digit span memories whether repeating the digits in the original or the reverse order. In contrast, hearing children show a considerable advantage with forward compared to backward repetitions. Todman and colleagues (Todman & Cowdy, 1993; Todman & Seedhouse, 1994) reported additional research indicating memory differences between deaf and hearing children. The former had better memory for complex visual figures, but their advantage disappeared when parts making up the figures had to be remembered in sequence. In an extensive review of the literature, Marschark, Convertino, and LaRock (2006) found deaf students were less likely than hearing peers to employ sequential processing across a variety of tasks. Marschark and Wauters (2008) have noted, as have Hall and Bavelier (in press), considerable within-group variability in this tendency. However, Marschark and Wauters called for recognition that deaf children, especially those using sign language, may have need for accommodations or alternatively for direct instruction in use of sequential processes in tasks such as reading, where they are required.

10.4 Integrating information and using problem-solving strategies

A critical aspect of learning is the ability to relate initially discrete bits of information to form concepts and identify relationships. Difficulties here have been shown during reading activities with children (Banks, Gray, & Fyfe, 1990) and with adolescents with hearing loss (Marschark, DeBeni, Polazzo, & Cornoldi, 1993). In both studies, deaf and hearing children showed similar memory for details and words, but the latter were more likely to remember and express complete idea units, cause and effect, and conceptual relationships. These findings may reflect, in part, difficulties with reading per se and thus increased cognitive resources required by deaf students for the process of decoding. Marschark et al (2006), however, argued that this relative lack of automatic relational processing is supported by similar findings from a variety of memory and problem-solving studies and may represent a general information processing style among deaf students that can have specific effects on learning.

Consistent with that view, Richardson, MacLeod-Gallinger, McKee and Long (2000) found deaf students had more difficulties than hearing students when required to integrate or synthesise information across texts.

Similar difficulties have been found for deaf children's writing (Marschark et al, 2002; Mayer, in press). These findings also are consistent with an earlier review by Ottem (1980) which showed that deaf children and adults performed less well than hearing peers when cognitive tasks required the relating or integrating of multiple concepts or bits of information. That is, activities such as categorising by single characteristics were performed similarly by deaf and hearing people, but activities that required keeping more than one characteristic in mind (colour and size or shape) were not performed as well by deaf people.

Other indications of problem-solving differences between deaf and hearing students (age seven to 20 years) were seen in responses to a 20-questions game (Marschark & Everhart, 1999). Deaf participants were less likely to employ "constraint" or category-based questions in their responses and were therefore less successful than hearing participants in arriving at the answer. Deaf students who knew the game were more likely to apply consistent, category-based strategies and performed like the hearing students. Thus the group difference seems to have been based not on any inherent deficit but instead on the likelihood of applying relational strategies in this problem-solving situation and/or opportunities to build cognitive strategy use through experience. The findings may also reflect differences in the background knowledge incidentally accrued by deaf and hearing students (McEvoy et al, 1999), a factor that may complicate their problem-solving in many different academic situations. Indeed, Marschark, Convertino, McEvoy, and Masteller (2004) demonstrated asymmetries in deaf students' category-exemplar relations not observed among hearing students. In contrast to the hypothesis of Marschark and Everhart (1999), their results indicated that the category membership of a familiar noun exemplar is just as salient for deaf as for hearing students, but that the former appear less likely to automatically activate high-frequency exemplars in memory when they encounter a category name. This information processing difference would have negative effects, relative to hearing peers, not only on deaf students' reading comprehension, but also on their memory and problem-solving performance. That is, the automatic association of incoming information with background knowledge is an essential component of efficient reading, problem solving and learning. To the extent that the arousal and/or application of prior knowledge is less automatic for deaf and hearing children, their performance will suffer in these domains (Marschark et al, 2006; Ottem, 1980).

10.5 Responses to cognitive intervention

Differences between typical cognitive functioning of children with and without hearing loss have been discussed here. In some cases, such as a relative lack of recognition of failures in understanding – and subsequent tendencies to fail to request clarification, these differences can be thought of as deficiencies. Other instances, such as enhanced memory for visual-spatial versus sequential information and increased attention to peripheral as opposed to centrally-situated visual stimuli, may more appropriately be considered differences than deficits. However, the overall picture is of a tendency for students with hearing loss to face difficulties integrating information, fail to recognise and respond to situations in which understanding has broken down and employ patterns of visual attention that provide them with less information than is available.

Mousley and R Kelly (1998) implemented an approach to promote metacognitive processes and teach 46 deaf and hard-of-hearing university students more effective problem-solving abilities in mathematics. They conducted a series of three experiments involving the Tower of Hanoi problem, a nonverbal task that requires multiple actions to arrange rings on a set of pegs in a prescribed order. In their first experiment, students identified as high- or lower-achievement readers were asked to explain (using sign language) their understanding of the Tower of Hanoi problem and the strategy to be followed in solving it; then record in writing their goals and strategies. This was followed by presentation of a mathematics word problem whose solution required similar logic. Reading ability did not associate with effective solving of the nonverbal problem, but it related to recording of strategies and to understanding and solving the word problem.

The second experiment introduced a procedure in which students were to take at least two minutes to visualise the steps in solving the Tower of Hanoi problem. One object of using visualisation was to prevent too quick, non-reflective actions to solve the problem by including enforced thinking and planning time. A group of eight participants were given the visualisation instructions and eight others proceeded as in the first situation described above. Two students' performances were omitted from analyses because of a high number of moves taken to solve the problem and one student from the non-visualisation group was never able to solve it correctly. Still, the group using the visualisation approach solved the problem on average in significantly fewer moves than the group not using visualisation. The researchers concluded that the visualisation process reduced the number of impulsive moves.

The third experiment of the Mousley and R Kelly study involved the teacher modelling in detail his strategies for solving a mathematics word problem. He communicated his thinking about the problem and walked the students through the solution step by step. Ten students received this kind of extended, problem-focused presentation while 10 others participated in regularly-structured mathematics lessons. Results showed that those who experienced the modelling situation could generalise the problem-solving steps to similar but different maths problems. The researchers concluded that although reading levels had some effects on maths problem-solving abilities, other non-linguistic factors were important. They noted that even at college age, deaf and hard-of-hearing students could not be expected to spontaneously use well-developed problem-solving strategies. More importantly, they found that structured instruction in strategies and devices to help students take time to visualise problem solutions were effective and could increase successful performance.

A different approach to building deaf and hard-of-hearing students' metacognitive skills was reported by Martin et al (2001), who replicated and expanded a previous evaluation of effects of the instrumental enrichment programme developed by Feuerstein (1980). Two groups of US secondary-school students participated in the first study (Martin & Jonas, 1986). Forty-one students made up the experimental group and participated in instrumental enrichment activities (making part-whole comparisons, projecting visual relationships, identifying spatial relations, following directions, setting up classification systems) for a period of two years. Teachers incorporated the activities, plus metacognitively oriented discussions about strategies for problem-solving in at least two lessons weekly. Another 41 students served as a comparison group and participated in the regular curriculum without the instrumental enrichment component. The experimental group showed gains in measures of reading, maths computation and concepts and nonverbal cognitive skills as measured by the Raven's standard progressive matrices. Qualitatively, the experimental group were reported to improve in sequencing, presentation of details and thoroughness when asked to write answers to problems presented in print.

The Martin et al follow-up study was conducted in China (with deaf students only) and England (with hearing and deaf students). Participating teachers received nine hours' training on the system's concepts plus information on creative thinking, multiple intelligences (Gardner, 1984), metacognition issues and teacher as cognitive mediator. Teachers themselves participated in some activities to be used in the classroom and had the opportunity to reflect on their own approaches to creative thinking and problem-solving. They were asked to incorporate the cognitive activities into lessons two or three times a week but, in contrast with the original study, the intervention lasted only six months. Pre- and post-intervention assessments were conducted with experimental and control groups, with a limited number of students from each group taking the Raven's test before and after the intervention. In addition, all students were asked to write or narrate their response to problem situations before and after training and teachers completed a questionnaire about children's creative and critical thinking skills.

The participating students in England, hearing as well as deaf, made gains on the Raven's test, as did those in China. The experimental group in England showed advances in their critical thinking for problem-solving although they failed to differ from the control group in creative thinking. Teachers in both countries reported that they had increased use of questions at higher cognitive levels, that students were more attentive and more likely to use cognitively-related vocabulary after the intervention. It is particularly interesting to note that hearing as well as deaf students benefited from the programme, suggesting that a focus on cognitively-based problem-solving curricula may be of significant usefulness beyond the scope of classes for deaf or hard-of-hearing children.

10.6 Summary

Although there is no difference in general intelligence levels related to hearing status, differences in use of various cognitive processes are reported as early as toddler/pre-school age when differences in sequencing of behaviours and the ability to distance from one's own perspective have been reported. These differences are associated with variations in language abilities and perhaps with differences in early interactive experiences, but they may also be early indicators of specialised processing styles associated with primary dependence upon visual instead of auditory processing. Some visual differences, such as increased attention to movements in the peripheral visual field, are also manifested in recordings of neurological activity and appear to represent adaptive functioning. The corollary of this – decreased selective and sustained central visual attention – can, however, complicate learning in typical classrooms and educational tasks where sustained visual attention is necessary.

Deaf and hard-of-hearing students also show increased memory for complex visual figures and do not present with any overall memory deficit. However, their learning in traditional educational situations seems to be complicated by other characteristics including decreased sequential memory spans, difficulties integrating disparate bits of information, impulsive and non-reflective responses to problem solving and often a lack of metacognitive awareness of one's own understanding or misunderstanding of communications. Of course, there is much individual variation in these characteristics. What is suggested is a difference in their distribution across the populations of learners with and without hearing loss, but with greater variability in the former.

It is not clear to what extent the distributions of these characteristics results from differences in sensory processing, in language skills, or in general interactive experiences; more research is needed that can tease apart and identify causal factors. It is especially important to conduct additional research on responses to cognitively-focused interventions which have been shown in some cases to increase deaf and hard-of-hearing students' use of beneficial learning strategies. Without awaiting the results of such research, however, it is important to recognise that deaf and hard-of-hearing learners may bring to the educational setting needs for training in problem-solving and cognitively-oriented learning strategies that differ in degree and perhaps in type from modal behaviours and needs of hearing students. Design of curricula, characteristics of the physical environment, as well as approaches to presentation and guidance in problem-solving activities and acquisition of knowledge should be based on recognition of these differences.

11. Programming for Children with Multiple Disabilities

It is widely recognised that a large proportion of the population of deaf or hard-of-hearing children have one or more disabilities not caused by their hearing loss. It is difficult, however, to locate data-based studies of these children or evidence of successful educational progress. Meadow-Orlans and her colleagues (Meadow-Orlans, Smith-Gray, & Dyssegaard, 1995; Meadow-Orlans et al, 2004) provided a description of patterns of interaction and parental stress when a child received a diagnosis of hearing loss plus an additional physical, cognitive, or emotional condition expected to require special education services. In a group of 20 deaf or hard-of-hearing infants identified by nine months, five had an identified disability, 10 were considered at risk for disability based on pre- or post-natal medical histories, and eight appeared to have no risk for additional disability. Etiology of the identified disabilities included cytomegalovirus (CMV) and birth trauma. The identified and at-risk groups had significantly lower birth weights than the children deemed not to be at risk and than hearing children in a comparison group.

Meadow-Orlans et al (1995, 2004) were particularly interested in the stress levels reported by mothers of the children with identified disabilities and found a bimodal (speech and sign) distribution, clustering either at the highest stress level or at a reported stress level so low it suggested denial. Reported stress levels from mothers of at-risk children failed to differ from those of non-risk infants. Meadow-Orlans et al pointed out that the latter finding reflected benefits of early diagnosis and support but also might, in some cases, reflect mothers' relief that their children had survived birth trauma or very low birth weight, with hearing loss seen as relatively minor.

The five children in the Meadow-Orlans et al study with confirmed disabilities showed clear developmental delays by age 12 months. Several seemed uninterested in interacting with others and showed aberrant patterns of visual attention to people and objects. A positive finding was that most of those identified at risk for multiple disabilities had shown no evidence of developmental delays or difficulties by age 12 months. In a separate analysis of four infants with moderate-to-severe hearing loss who were at risk for developmental delays, two began babbling during the same age span expected for hearing infants while the other two were considerably delayed (Nathani, Oller, & Neal, 2007).

Therefore, there are widely varying patterns of development in infants with hearing loss who have risk factors for developmental difficulties.

Meadow-Orlans, Mertens, and Sass-Lehrer (2003) conducted a survey study of parents of six- and seven-year-old children with hearing loss, some of whom had significant additional conditions affecting development. All the children were enrolled in programmes for deaf and hard-of-hearing students. The initial survey (n=404) was followed by phone interviews with randomly selected parents (n=62) and face-to-face interviews with three additional parents. Thirty-two percent of respondents indicated that their children had educationally-significant conditions along with hearing loss. (This is very similar to the 34 per cent of children so identified in the 1996-97 Annual Survey of Deaf and Hard-of-Hearing Children and Youth [Holden-Pitt & Diaz, 1998] conducted by Gallaudet University and upon which the Meadow-Orlans et al, 2003, contact list was based.) Of the children with additional complicating conditions, 29 per cent were reported to be in the "other" category, including children with brain damage, epilepsy and health conditions. The next largest group (12 per cent) was reported to have intellectual or cognitive delays, with significant proportions having vision loss, learning disability, attention deficit disorder, emotional or behavioural problems, cerebral palsy or motor disabilities. Clearly, this was a very heterogeneous group and in that respect representative of children with hearing loss and additional developmentally relevant conditions. Indeed, the variability within this population, in part, probably explains why so few actual studies have been conducted. Jones and Jones (2003) pointed out that the heterogeneity in type and severity of developmental difficulties among deaf children with multiple challenges required that decisions be made on an individual basis about appropriate educational placement and programming. They stressed that interventions needed to be family focused and involve a team of specialists based on child and family needs. In agreement with Meadow-Orlans et al (2003), Jones and Jones stated it was crucial for a case manager to co-ordinate services because the children's needs were so complex.

11. Programming for Children with Multiple Disabilities

11.1 Cognitive and intellectual disabilities

Although there are no firm figures, it appears a significant proportion of deaf and hard-of-hearing children with multiple disabilities have cognitive delays or learning disabilities. Knoors and Vervloed (2003) consider it critical that assessments of learning styles and testing procedures for such children be selected from among those for which procedures and instructions are appropriate for children with hearing loss. Of those with diagnosed cognitive delays plus hearing loss, about 30 per cent have an unknown etiology. Most children with this combination of learning difficulties have etiologies of pre- or peri-natal CMV, rubella (German measles), kernicterus (severe jaundice/bilirubin encophalopathy) or, for those with later onset of the disabilities, infections such as meningitis. These etiologies typically have multiple developmental sequelae, and educational programming for these children typically should vary according to the profile of cognitive abilities. In some cases, use of sign language is appropriate (van Dijk, van Helford, Aan den Toorn, & Bos, 1998, cited in Knoors & Vervloed, 2003; van Dijk, Nelson, Postma, & van Dijk, in press), others require direct instruction in a selected and simplified set of signs. Some children may be able to use spoken language or forms of augmentative communication (Knoors & Vervloed, 2003).

Van Dijk et al (1998) found that a group of five deaf adults with moderate cognitive/intellectual disabilities who lived in a residential group home could learn and use signs taught during school time. Although sign supported speech (using Signed Dutch) was the preferred mode of communication at school, the researchers noted that the participants spontaneously, and without modelling, developed some sign structures similar to those in the natural Sign Language of the Netherlands (NGT). Van Dijk et al posited that more interaction with signing caregivers and other professionals who were fluent signers would have accelerated the participants' signed communication abilities.

Although cochlear implants are sometimes provided to children who are deaf and have cognitive or other disabilities, their effectiveness overall decreases with additional disabilities and it is important that parents be informed that results cannot be expected to match those of children without cognitive disabilities (Pyman, Blamey, Lacy, Clark, & Dowell, 2000; P Spencer, 2004). For example, Pyman et al found that basic auditory awareness and discrimination of vowels and consonants increased for children with motor and/or cognitive disabilities after four years of implant use, but only about 60 per cent of the children could identify spoken words in sentences. This compared with 80 per cent of children in their study without cognitive disabilities. Waltzman, Sealchunes, and Cohen (2000) similarly found increases in awareness of sound and increased evidence of being connected or in touch with their environment in a group of children with diverse multiple disabilities who received cochlear implants. Increases in actual language abilities were highly variable within the group, and children with more cognitive disabilities were unable to complete the series of tests administered. A similarly wide range of functioning after cochlear implantation was shown in a study in Germany, in which five of the 10 participating children did not acquire spoken word reception or production skills after three years of using the implant (Hamzavi et al, 2000). Again, however, four of the five lower functioning children gave evidence of some awareness of sound using the implants. Fukuda et al (2003) presented single case data on a child with moderate developmental delay who had a sizeable sign language vocabulary before cochlear implantation and who developed spoken language skills afterwards.

The type and severity of additional disabilities may be the determining factor for spoken language progress using cochlear implants. Holt and Iler Kirk (2005) assessed the speech and spoken language development of 19 children with mild cognitive delays compared to 50 children without cognitive or any other identified disabilities, all of whom had cochlear implants. The children's language and auditory development was tested at six-month intervals. Using a standardised parent report instrument, auditory skills at the awareness and word identification levels were found to advance at similar rates for both groups, although the group with cognitive delays showed slower average progress as well as greater variability. Children with cognitive disabilities required longer experience with their implants to achieve multiword/sentence understanding. Holt and Iler Kirk concluded that their findings were consistent with those of Pyman et al (2000) in showing gains but at a slower rate than for children without additional disabilities. They further concluded that differences with the Waltzman et al (2000) study resulted from differences in type and severity of additional disabilities in the group. Indeed, the investigators were unable to identify specific predictors of outcomes of cochlear implantation for children with multiple disabilities including mild cognitive delay and hearing loss, and they called for further investigation of predictors and methods for supportive therapies.

11.2 Attention and learning disabilities

There is some indication that attention dysfunctions and learning disabilities are over-diagnosed in children with hearing loss. This is partially because of the overlap of symptomatic behaviours associated with learning disabilities in hearing children with those related to late and inconsistent experience with language and resultant communication disabilities (Morgan & Vernon, 1994; Samar, Parasnis, & Berent, 1998). On the other hand, it is possible that learning disabilities actually co-occur with hearing loss at a high rate due to shared etiologies (Calderon, 1998) and may be one source of the cognitive differences between students with and without hearing loss summarised in the previous section (Mauk & Mauk, 1998). Mauk and Mauk note that estimates of the prevalence of learning disabilities in the population of deaf and hard-of-hearing children are highly variable, ranging from 3-60 per cent. Given that learning disabilities are said to occur in 3-10 per cent of hearing children, at least that rate could be expected for those with hearing loss (Edwards, in press; Edwards & Crocker, 2008). Samar et al (1998) posited that relative lack of auditory input could not explain the high rate of phonological and reading difficulties in the population of children with hearing loss, implying that this rate reflected learning disabilities.

Clear diagnostic guidelines for identification of learning disabilities in children with hearing loss continue to evade description. Laughton (1989) proposed that such children who also have learning disabilities will have "…significant difficulty with the acquisition, integration, and use of language and/or nonlinguistic abilities" (p74) relative to their peers with hearing loss. The term "learning disabilities" refers to a learning problem such as dyslexia, auditory processing disorder, visual perception difficulties, memory or executive function disorder, or specific language impairment (Edwards, in press) that is not due to hearing loss, general cognitive delay or experiential deficits. Learning disabilities so defined, whether or not children have a hearing loss, are considered to be of an organic origin with at least minimal evidence of central nervous system dysfunction evident upon appropriate medical testing. In an early EEG study of 286 children in a special school for deaf children, 35 had obvious signs of neurological dysfunction and 21 had signs of minimal brain dysfunction (Zwiercki, Stansberry, Porter, & Hayes, 1976). This suggested a high proportion of children with learning disabilities not directly resulting from their hearing loss. Pisoni et al (in press) reached a similar conclusion in their study of children with cochlear implants, suggesting that many have dysfunctions or delays in basic neurocognitive functioning underlying information processing. They offer that such co-morbidity is a result of periods of auditory deprivation during critical periods of development, while subsequent neural and behavioural reorganisation likely contributes to the large variability observed in language outcomes in children with implants.

Although deaf and hard-of-hearing children suspected of having learning disabilities are most often placed in classes for children with hearing loss, their special difficulties with integration of material and information, in addition to delays in language development (regardless of modality of input) beyond those expected for their linguistic experience, are thought to require a highly structured educational environment for optimal academic development (Stewart & Kluwin, 2001). In addition, greater than typical (for children with hearing loss) problems with memory, sequencing, attention, as well as inconsistent performance over times and contexts are characteristics attributed to deaf and hard-of-hearing children with learning disabilities and may require special educational supports beyond those effective for other deaf children. At the same time, those kinds of difficulties have recently been said to characterise, to some degree, modal learning behaviours of children with hearing loss (Marschark & Hauser, 2008), and it is important to consider whether these central tendencies are being influenced by the inclusion in research studies of students who actually have concomitant learning disabilities.

Reliable and valid assessment of learning disability in a deaf or hard-of-hearing child presents special difficulties and must employ varied methods and measures. Morgan and Vernon (1994) recommended a specific battery of tests including a case history (noting especially medical conditions and family history of reading or learning disabilities), two standardised measures of nonverbal cognitive functioning (to rule out overall cognitive delay), a measure of academic achievement, neuropsychological screening (to look for signs of dysfunction typically found in hearing, learning disabled children), an assessment of adaptive behaviours or daily-function skills, plus testing of hearing using formal audiological means and of communication/language skills (Hauser et al, 2008).

One sign of learning disability is a gap between potential (as shown on a nonverbal cognitive test) and achievement. However, almost all available tests have norms (and instructions) only for the hearing student population and this can lead to invalid and misleading test interpretation. Edwards (in press) asserts that this situation requires more than one test to be used when assessing a specific function, especially but not limited to areas in which a test with deaf norms is available. Thus, diagnosing learning disabilities in a child who is deaf or hard-of-hearing remains a process of clinical judgment and problem-solving on the part of the adults conducting the assessment (see van Dijk, in press).

Effective programming for children with hearing loss plus learning disabilities is complicated by the lack of specific diagnostic approaches. It is made more complex by requiring co-operation among professionals in several different fields and the need to have specialists who understand the particular effects of hearing loss (Laughton, 1989; Mauk & Mauk, 1998). Intervention-focused research in this area could be of much benefit, but additional work continues to be needed on identification of children with a combination of hearing loss and organic learning disabilities. Mauk and Mauk noted that simply using interventions designed for hearing children would be neither sufficient nor appropriate. As noted earlier when cognitive performance and cognitive styles were discussed, selective and sustained attention is often attenuated for children with hearing loss compared to hearing children (Quittner et al, 1994). However, within the population of deaf and hard-of-hearing children, some have been noted to have special difficulties with sustained attention and many also appear to fit a category designated as 'hyperactive'.

Again, the communication histories of many children with hearing loss make it difficult to distinguish between those with organic attention and activity difficulties as opposed to patterns typical of them in general. This situation is made more difficult by a lack of research in the area (Guardino, 2008).

However, Kelly, Forney, Parker-Fisher, and Jones (1993) as well as Samar et al (1998) found a greatly increased prevalence of attention and activity-level disorders in deaf and hard-of-hearing children with acquired hearing loss compared to those with an identified hereditary etiology. This suggests that some non-genetic causes of hearing loss during pre-, peri-, or post-natal periods (such as viral infections, prematurity or meningitis) often may have effects on the nervous system beyond auditory functioning. Interventions designed to facilitate sustained attention in children with hearing loss thus appear to be especially needed.

11.3 Autism spectrum disorders

Diagnoses of childhood autism-spectrum disorders have increased over the past few decades, and this disability can co-occur with hearing loss (Bailly, de Chouly, de Lenclave, & Lauwerier, 2003). Using generally-accepted criteria for the identification of autism in which basic socialisation and interaction processes are disrupted, Jure, Rapin, and Tuchman (1991) concluded that about 4 per cent of a population of 1,150 children with hearing loss had autism. The etiology of these children varied widely, however, and although hearing loss itself is clearly not a causal factor in autism, the two conditions may arise from similar etiologies etiologies (meningitis, epilepsy, congenital rubella syndrome; van Dijk et al, in press). In this context, it is important to note that hearing loss alone does not lead to severe interaction or socialisation dysfunction unless the child has experienced strongly negative environmental factors beyond those typically encountered (Day, 1986; Meadow-Orlans et al, 2004).

As with cognitive and intellectual disabilities, autism spectrum disorder varies in severity and presentation. Treatment and educational interventions therefore cannot be generalised for all children with these diagnoses. Some interventions for autism alone, however, employ signed language or other forms of visual communication as well as structured daily activity schedules and thus may be appropriate for children with autism plus hearing loss (Bonvillian, Nelson, & Rhyne, 1981). It appears to be especially important that language instruction for children with autism spectrum disorders occurs in the natural environment in order to ease demands for generalisation. Again, educational management of these children requires careful co-ordination and a collaborative team of intervention specialists.

11.4 Deafblindness

There is a history of programming and research with children who have a combination of hearing and visual impairment, now referred to as deafblindness (van Dijk et al, in press). Although total loss of either sense is rare, van Dijk et al note that this condition is characterised by enough loss in each area to preclude using it to compensate for loss in the other. Deafblindness can occur congenitally or at an early stage and, if so, has much more severe effects than if acquired later. The well-known stories of Helen Keller (who became deafblind at 19 months) and Laura Bridgeman (deafblind at 24 months) demonstrate, however, the difficulty of communication development even when a child initially has sight and hearing.

11.4.1 Congenital rubella syndrome

Deafblindness may result from many of the same etiologies listed above for other disabilities. These include pre-, peri-, and post-natal illness. Deafblindness can be but is not always associated with cognitive delays or deficits or with autism. However, persons who are deafblind due to rubella contracted during the early gestational period are likely to have a number of developmental difficulties, including intellectual deficits, behavioural difficulties, and symptoms characteristic of autism such as repetitive stereotypical or obsessive movements (Munroe, 1999).

J van Dijk and his colleagues (eg van Dijk, 1986) have developed a curriculum used in many countries to facilitate development of deafblind students. The curriculum stresses building relationships between the child and caregivers, gradually building awareness in the child of others, and supporting transition of communication behaviours from the concrete to the symbolic level. Chen, Klein, and Haney (2007) and Van den Tillaart and Janssen (2006) also have developed curricula based on the van Dijk ideas. A single subject, multiple baseline study conducted with four deafblind children indicated effectiveness of the Van den Taillaart and Janssen curriculum in increasing appropriate teacher behaviours and decreasing inappropriate child behaviours. At least one comprehensive instrument for assessing behaviours of deafblind children with multiple difficulties, the Callier-Azusa Scales (Stillman, 1978; Stillman & Battle, 1986) also has been developed based on the initial ideas of J van Dijk.

The incidence of congenital rubella syndrome has decreased since vaccine use has increased worldwide, but it is still an etiology that occurs in some parts of the world. Those born during previous epidemics, although now adults, continue to need special programming. There is evidence that vision and hearing losses of deafblind persons with the syndrome worsen with age (Kingma, Schoenmaker, Damen, & Nunen, 1997; Munroe, 1999; van Dijk, 1999), so ongoing individualisation of interventions is necessary.

11.4.2 Genetic/chromosomal syndromes

Genetic/chromosomal syndromes associated with deafblindness include but are not limited to CHARGE and Usher syndromes. CHARGE syndrome, the most prevalent etiology for deafblind people in the US (Killoran, 2007), involves a specific "key-hole type" opening in the iris and retina of the eyes causing vision loss, blockage of passages between nasal cavity and naso-pharynx, structural ear anomalies and hearing loss, balance problems, genital anomalies, hypotonia (low muscle strength), feeding and swallowing problems, and asymmetric facial palsy. Children with this also can be medically fragile and require multiple surgeries early in life. Behaviour problems have frequently been noted, characterised by a lack of impulse control. As with the above conditions, severity of these impairments and the number of symptoms differ. Blake (2005) reported that most of a group of 30 individuals he studied required medications for behaviour control and that two-thirds required substantial supervision and support. R van Dijk et al (in press) noted that education and management of CHARGE syndrome children are particularly difficult and can be further complicated if supportive early interaction experiences are disrupted due to parental stress. Clearly, children with this syndrome and their families require consistent and specialised support.

Usher Syndrome occurs in around 4 per cent of children with hearing loss and has several different subtypes. Different characteristics suggest different emphases in educational interventions (Knoors & Vervloed, 2003, R van Dijk et al, in press). Persons with Usher type 1 typically have significant hearing loss at or soon after birth, with visual loss occurring later. They usually are supported educationally through programmes serving deaf children and with essentially the same methods – and arguments about language methods – as other children with hearing loss. Persons with Usher type 2 tend to have lesser hearing losses (in the hard-of-hearing range) with vision loss occurring generally in adolescence. Persons with Usher type 3 have hearing and vision functioning for several years before experiencing deterioration in both.

No intellectual disability is associated with Usher syndrome and R van Dijk et al (in press) indicated that clinical practice has suggested considerable emotional strength in this group. Vermeulen and J van Dijk (1994) administered a personality assessment instrument to 16 adolescents with Usher syndrome and reported that they showed strong ego functioning, social competence and self-esteem. Researchers noted that the group's scores indicated a relative lack of assertiveness, however, which they attributed to probable over-protection by parents and educators. Damon, Krabbe, Kilsby, and Mylannus (2005) surveyed 67 people from six EU member-states who had one of these syndromes and also found that respondents had generally positive attitudes and strove to maintain their independence. They were quite interested in methods and technologies to support socialisation and independence.

Cochlear implants are considered a viable option for children with Usher syndrome or others with hearing loss and visual impairment. Yoshinaga-Itano (2003) reported on one child with profound hearing and progressive vision losses who began receiving intervention services at age six weeks. Her family used American Sign Language along with some pidgin Signed English with her, and she scored at the 99th percentile on the MacArthur communicative development inventory words and sentences form (Fenson et al, 1993, 1994) using signs but compared to hearing norms, when she was 20 months old. At that time she produced no spoken language. After cochlear implantation at 21 months, this child began to use more vocal behaviours and to build auditory awareness. By 51 months, she had become primarily a spoken language user, a particularly fortunate transition due to her deteriorating vision which seriously interfered with her reception of sign language. Yoshinaga-Itano presented this case as an example of how sign language can support emerging spoken language development when auditory reception is improved through implant use. Of equal importance here is that this child showed that those identified as deafblind do not necessarily experience significantly delayed development.

11.4.3 A broader view

Despite the organisation of this section by type of disability, current educational philosophies emphasise individual differences instead. Evidence presented in each of the preceding categories illustrates a range of functional skills and needs so that placement decisions could not validly be based on etiology or labelling of the disability associated with hearing loss. Ewing and Jones (2003) accordingly argued for a noncategorical approach to placement and programming that is inclusive rather than exclusive. Importantly, they noted that many children with hearing loss and multiple disabilities required specialist expertise. Even if the children are placed in generic special education settings this kind of service needs to be available.

Ewing and Jones called for a transdisciplinary approach to assessment and programming for multiply disabled deaf and hard-of-hearing children which they characterised by indirect instead of direct service. This approach is highly collaborative with around 10 specialists potentially needed to programme sufficiently for a single child. Only one or two professionals, however, are primary service deliverers or facilitators so communication with parents, therapists and other educators is more coherent and consistent. Such an approach would be responsive to parents' complaints that they often had to deal with too many professionals many of whom seemed unaware of colleagues' recommendation s and thus gave divergent advice (Giangreco, Edelman, MacFarland, & Luiselli, 1997).

Ewing and Jones (2003) also recommended the use of person- instead of category-centred programming and mentioned the McGill Action Planning System (Forest & Pearpoint, 1992) among other examples. A person-centred approach is based on identifying the strengths and learning abilities of a student, motivating factors, environments and contexts in which learning is facilitated and specific instructional procedures that best promote learning. The process of identification should include family, child and professionals and would follow best from actual teaching-learning trials instead of use of standardised tests or procedures. Although this would be an ideal approach with all students, it may be a necessity for students with hearing loss plus additional disabilities.

Furthermore, because few curriculum materials are designed for specific combinations of disabilities, teachers need to be knowledgeable about a wide range of disabilities even when are working with a supportive team.

11.4.4 Summary

Although the relative frequency of etiology has changed over time, the phenomenon of additional disabilities in the population of students with hearing loss continues and may even be increasing as children born prematurely or with severe birth complications are increasingly likely to survive. As with other deaf and hard-of-hearing children, assumptions generally cannot be made about their academic and functional capabilities based on their etiologies, but the effect of disabilities multiplies as they increase in severity and number. With at least one-third of students with hearing loss diagnosed as having some additional disability, educational planning must provide for handling a diversity of needs. Service provision for children with multiple disabilities requires multiple specialists and, typically, more intensive service delivery than that for children with hearing loss alone. Collaboration between disciplines and among teachers and other service providers is critical.

As with other students with hearing loss, those with multiple disabilities will vary in their abilities to acquire language skills and options ranging from oral through sign-only approaches may be appropriate for specific individuals and must be available. In many cases, the additional learning difficulties shown by children identified as having multiple disabilities may be only mild cognitive delay or learning problems similar to those recognised as "learning disabilities" in the hearing population. The options for such children will differ significantly from those for children with more severe learning challenges and will affect educational placement decisions accordingly. Ongoing assessment of developmental progress is critical so that placement and service decisions can be modified as needed if those initially chosen prove ineffective.

12. Issues and Trends in Best Practice

This review began by stressing two realities:

1. Hearing loss in childhood is a low incidence condition but has great impact on development unless appropriate educational support is provided.
2. Programming for children with hearing loss has proceeded historically without reference to a strong evidence base, and it is difficult to establish such a base due to the low incidence and the great variability of characteristics and experiences in the population.

Reflecting evidence from studies summarised in this review, several emerging realities about deaf and hard-of-hearing children must be considered for significant progress in understanding the factors contributing to their development and in improving their academic outcomes. These generalisations are not mutually exclusive, but highlight what we know, what we do not know, and what we only thought we knew in several areas.

> *Identification of hearing loss and immediate provision of effective intervention can raise the general levels of language skills attained by deaf and hard-of-hearing children.*

Emerging data suggest that literacy levels and general academic achievement levels also can be raised. Effective early intervention is characterised by a family-centred approach with educators and therapists serving roles as consultants to parents or caregivers. Support for family emotional needs as well as information on hearing loss and intervention approaches should be available and the family's degree of involvement with the child's development and education must be supported. The degree of family involvement is a consistently-identified predictive factor of developmental and academic success. For optimal development, early access to positive interactions and accessible language must be assured. The language approach chosen should be based on child and family factors not pre-determined educator bias.

Decisions can and should be changed if circumstances and assessment data indicate a need. Despite advances documented following early identification and intervention, the lag between average achievement levels of children with and without hearing loss has been decreased – but not eliminated.

A variety of approaches to supporting language development continues to be available and each has been effective with some children with hearing loss. Natural sign languages are learned readily and develop at a pace typical of hearing children's spoken language – but only when fluent sign models are available. In addition, the transition from using a natural sign language for communication and a written code for a spoken language for literacy purposes is not automatic. Sign supported speech or use of total or simultaneous communication does not typically provide a complete model of either a signed or a spoken language. However, children are shown to be capable of integrating auditory information when it can be accessed along with visual information from phonological and syntactic systems. Such integration has been shown to occur regardless of whether the visual input is signed, via Cued Speech, or via instructional approaches such as Visual Phonics. Development of spoken language may be well supported by intensive experience with listening to and using speech as provided in oral and auditory-verbal programmes when sufficient auditory awareness is available. Nevertheless, addition of visual information (signs) has not been found to interfere with the process of developing spoken language. It remains difficult to predict an individual child's language development using any specific approach. Most factors predictive of success are shared among the various communication approaches. They include presence or absence of disabilities in addition to hearing loss, level of nonverbal cognitive abilities, degree of family support for the child and for education, consistent exposure to a fluent language model within the child's sensory processing capabilities, and behaviours such as attention skills that reinforce interaction experiences and promote learning in general. Degree of hearing loss associates with some aspects of language learning in auditory and oral modalities.

Advanced hearing aid technology and use of cochlear implants have provided increased access to auditory information and spoken language for many children with hearing loss. Spoken language achievements are significantly more probable than in the past.

Cochlear implants in particular seem to support spoken language across a variety of language approaches and positive effects tend to increase with early first use, consistent with the predictors of language development listed previously. Although reports of striking improvements in early spoken language accomplishments are emerging for children with implants obtained before age two, it is not clear if this will continue with age – and some children, especially those with additional disabilities, show significantly fewer positive outcomes.

An evidence base is beginning to accrue related to educational approaches to promote literacy skills regardless of the modes or approaches used for language development.

In general, direct instruction provided in meaningful and interactive contexts supports a range of reading and writing skills. Vocabulary as well as syntax and phonological knowledge continue to be deficient compared to hearing children unless direct instruction is supplied. Research provides no clear guidance, however, on how that instruction should proceed. Early shared reading and writing experiences appear to provide significant support for emerging literacy skills, although the research base is not strong. Incorporation of structured but responsive approaches, such as that described in the dialogic reading programme, may be useful for families of children with hearing loss, as may modelling and support for using turn-taking strategies appropriate to visual communication.

Students with hearing loss show delays and deficits in the areas of mathematics, science and other content areas as well as in literacy.

These difficulties have been attributed to a variety of factors including under-use of metacognitive strategies, decreased visual attention to information provided in classrooms, lack of language skills for understanding written texts and information presented during class and relatively infrequent exposure to true problem-solving activities during class time. Achievement tends to be higher when teachers are subject-matter specialists and are also knowledgeable about the special learning needs of students with hearing loss. Few data are available that directly address programming characteristics and outcomes, but approaches that emphasise visual modelling and presentation of mathematical concepts visually appear to have promise. In addition, embedding writing activities into science and related classes appears to have a mutually positive effect on concept development and literacy skills.

Although a social and political consensus seems to support integration of students with and without hearing loss in classes, specific placement options have been found to have little effect on academic outcomes.

A variety of approaches to integration can be found, but models that allow for a variety of placement options based on individual need, and co-enrolment models and congregated settings in which a "critical mass" of children with hearing loss is placed within a somewhat larger group of hearing classmates, appear to have more positive social-emotional effects. Because deaf and hard-of-hearing students tend to have special learning needs in addition to potential communication barriers, teachers or a teaching team should have a mix of expertise and strong collaboration skills.

Research with students with hearing loss, especially those in upper grades, indicates frequent occurrence of patterns of cognitive skills and problem-solving approaches that are poor matches with practices in most educational environments.

Specific differences between students with and without hearing loss have been identified in sequencing skills, integrating information across sources and time, relative focus on detail versus conceptual conclusions, selective and sustained visual attention, prior content knowledge and creative problem-solving. Structured interventions have shown some success in promoting better metacognitive abilities and their use in learning contexts, but without intervention these patterns will interfere with learning across the curriculum. It is not clear to what degree these differences reflect sensory as opposed to communication experience differences but effects may vary across individual skills. Research, especially focused on assessing outcomes of varied interventions, is critically needed.

Children with significant disabilities in addition to their hearing loss present even more varied and variable needs than those with hearing loss alone.

Children with severe difficulties in social interaction or cognition may require highly specialised settings and curricula. Most children identified with multiple disabilities, however, present with a combination of mild to moderate conditions that magnify the challenges presented by hearing loss alone. Given the great individual variability among these children, there is essentially no well-defined evidence base to guide instructional practice. Use of single-subject designs to test effectiveness of specific interventions on individual children may provide helpful guides for individual children and, with appropriate aggregation of records over time, begin to suggest patterns of successful approaches.

Although information about levels of hearing loss has not been a focus in this review, every section includes some mention of potential effects.

Children referred to as "hard-of-hearing" with access to varied amounts and quality of auditory information comprise the largest segment of the population of children with hearing loss. This is a group for which development of an evidence base is especially important now that many who would have functioned as profoundly deaf in the past can access more auditory information with use of technology.

13. Evidence-Based Best Practices for Educating Deaf and Hard-of-Hearing Children in Ireland: Recommendations and Implications

This literature review, taking into account limitations of the research base described at the outset and current realities in deaf education outlined in the previous section, offers recommendations for providing deaf and hard-of-hearing children with opportunities to thrive in educational environments and reach their full potential. These recommendations are, in some sense, self-evident given our current knowledge of the development and education of this population. At the same time, the context of education in Ireland will make for specific implications of these recommendations, as would the context of any country or existing educational system. It is therefore worthwhile to articulate several caveats which offer a "reality check" – but do not diminish their importance – for those who might seek to implement them in the context of the *Implementation Plan: Plan for the Phased Implementation of the EPSEN Act 2004* offered by the National Council for Special Education (2006).

First, their goals are not immediately attainable and it is unlikely that all of the recommendations can be implemented fully at one time. Introducing significant changes into the educational system will require collaborative efforts not only between government agencies but among all of stakeholders. At the same time, the goals of the EPSEN Act and the genuine motivations of educators of deaf and hard-of-hearing children offer the possibility of using recent research to create a "state-of-the-art" educational system without having to dismantle intermediate, less effective systems of the sort that have developed over time in other countries, often based on partial information or research that is inconsistent with the characteristics of deaf children today. This situation offers Ireland exciting opportunities for innovation and collaboration rarely if ever available anywhere in the past.

At this point, it should be evident that no single educational setting will be optimal or even suitable for all deaf and hard-of-hearing children, nor is there yet empirical evidence to support any particular instructional model as generally superior. Deaf children are considerably more heterogeneous as a population than hearing children. Variability associated with the etiologies of their hearing losses, possible associated conditions, and their early language, social, and educational environments make for individual differences far greater than those observed among hearing children. As a result, a classroom containing only a handful of children with significant hearing loss can be far more challenging than a classroom with 20 or 30 hearing children. Nevertheless, recent research provides sufficient evidence concerning the foundations of learning by deaf and hard-of-hearing children, as well as likely outcomes of various intervention, language and educational methodologies, for us to be able to make specific recommendations.

The recommendations below are not exhaustive and observers from various perspectives may well imagine others. They are, however, ones for which there is clear evidence from quality, existing research. They would also have significant, measurable impact on the education of deaf and hard-of-hearing children in Ireland in the short and long term. To their credit, the implementation of these recommendations has absolutely no potential to do harm either to deaf and hard-of-hearing children or to the integrity of educational or social structures in Ireland. To their detriment, their implementation will not be simple – but, then, no one expected this process would be.

When the evidence contained in the preceding review was collated, the number of recommendations that emerged was surprisingly small, at least from the authors' perspective. Perhaps as an indicator of their theoretical and practical coherence, they also fell into a surprisingly small number of categories: *early identification and intervention, language* (including cochlear implants), *educational models*, and *teaching and learning*. For convenience, each category will be considered in turn, together with their implications within the current Irish educational context.

13.1 Early identification and intervention

13.1.1 Recommendations

There is no single aspect of raising and educating deaf children with as much positive evidence and international support as the importance of implementing universal neonatal hearing screening. Infants can be screened while still in the birthing hospital efficiently, effectively, and at low cost.

Accompanying such nationwide screening, comprehensive and philosophy-neutral early intervention programming can support children and their families. Parent education is an essential component of such a programme as their acceptance of children's hearing losses and their ability to make informed decisions are central aspects of any successful educational system. Only with philosophy-neutral approaches to communication methods and educational placement can parents make informed decisions based on the characteristics of the individual child, the parents and the entire family. For such screening and early intervention to succeed will require an aggressive audiological programme that includes options for hearing aid provision/fitting, cochlear implantation, and ongoing support for technology, child development and parent education.

13.1.2 Implications

Implementation of these recommendations will require perhaps unprecedented co-operation between the Department of Health and Children and the Department of Education and Science. This collaboration will need to include better training or restructuring of the Visiting Teachers Service and special educational needs organisers as well as a national network of audiological/speech/language services. Ultimately, however, that collaboration will result in savings financially (education, health, social services) and in terms of human potential. In the long-term, these changes will feed back into the system by providing higher academic achievement, greater employment and fewer demands on social services.

13.2 Language (including cochlear implants)

13.2.1 Recommendations

Issues associated with language have been contentious in deaf education for centuries. In the present context, however, the "oral-manual debate" is not at issue as there is no evidence that one language modality or another is universally superior for deaf children nor, contrary to popular claims, that language acquisition in one modality interferes with language acquisition in the other. Although early sign language, with or without accompanying spoken language, generally is associated with better early outcomes, some children succeed with spoken language alone. Unfortunately, there are no good predictors of which children will benefit most from language in one modality or another. In any case, the ultimate goal of an educational system should be the greatest level of achievement independent of an individual's preferred mode of communication.

To provide access to education and society for children with significant hearing loss, the first step should be universal newborn hearing screening and early intervention described earlier. In the context of early intervention services during the first two to three years of life, children can be exposed to alternative modes of communication and their strengths and needs assessed.

Cochlear implantation is increasingly popular for deaf children with profound hearing losses. Contrary to early expectations, implants neither "make deaf children into hearing children" nor "leave deaf children stranded between deaf and hearing worlds". Most deaf children with implants function more like hard-of-hearing children than hearing children, still a significant advantage in educational settings, as long as limitations are recognised. At the same time, many if not most children with implants acquire sign language at some point in their lives, and emerging evidence suggests that while implants may be changing the nature of the Deaf community, predictions of its death were greatly exaggerated. Nonetheless, given the sensitivities associated with paediatric cochlear implantation, an incremental and transparent programme might be most effective.

For all of the above reasons, an aggressive programme of providing deaf children and their families with instruction in Irish Sign Language is highly recommended. As indicated above, there is no evidence of any negative implications associated with early sign language acquisition and, indeed, early sign language has been shown to support later spoken language for children with and without cochlear implants. Providing parents with Irish Sign Language instruction will facilitate their involvement in their children's education, improve parent-child relationships, and ensure that children have consistency in language exposure across settings. Given the sensitivity associated with ISL, largely because of a lack of information, an incremental programme might be most effective.

The preceding review has indicated that as intuitively appealing as bilingual (spoken and sign language) education might be, evidence of its impact on academic achievement thus far is minimal. Nevertheless, a cautious approach to bilingual education is recommended insofar as it does no harm and clearly does contribute to social-emotional and interpersonal growth.

13.2.2 Implications

Implementation of the preceding recommendations will require significant changes in the provision of services by both the Department of Health and Children and the Department of Education and Science. The recommended cochlear implantation initiative will require a network of implant team services, as support for children with cochlear implants is necessarily collaborative and ongoing over many years. Similarly, expansion of sign language instruction will require additional certified instructors as well as utilisation of an existing human infrastructure that may not be readily apparent (deaf special needs assistants and other members of the Deaf community as well as associated hearing individuals).

Providing deaf and hard-of-hearing children with greater opportunities to acquire fluent language skills again will result in medium-and long-term financial savings from educational, health and social service provision perspectives. Implementation of these recommendations also will go a long way toward satisfying the requirements of both the Education Act of 1998 and the EPSEN Act of 2004. More importantly, perhaps, they will allow deaf children in Ireland full access to the education they have been promised and all deaf individuals access to the social contract of rights and responsibilities.

13.3 Educational models

13.3.1 Recommendations

As described above, no single educational model has proven optimally effective for all deaf and hard-of-hearing children, while the failures of forcing children into inappropriate settings are all too evident. Available research clearly points to the need to make available an array of alternative educational settings ranging from separate school/programmes for the deaf to fully inclusive classrooms in which children can obtain all necessary support services while integrated with hearing peers. What evidence is available, in the literature and within Ireland, points to a mixture of such settings as optimally beneficial. In such contexts, children can move into and out of alternative settings and discover those in which they are most likely to thrive.

Academic achievement requires age-appropriate instruction throughout the school years. It is recommended, therefore, that special secondary programmes for deaf and hard-of-hearing be established within regular schools as well as within schools for the deaf. Because deaf students may have experienced significant lags in academic growth, those who need additional secondary schooling beyond age 18 should not have to leave schools for the deaf that are serving their needs.

For the purposes of instruction and the larger educational enterprise, deaf individuals who are qualified or could be qualified to become teachers need to be encouraged and supported. Similarly, deaf and hearing special needs assistants with backgrounds and/or experience in deaf education should be encouraged and supported in their present positions, where they help to provide deaf students with access to the curriculum, and in the pursuit of higher education to obtain teaching credentials.

13.3.2 Implications

To establish a bridge between the early intervention recommendations and those associated with education during the school years, bridging pre-schools would be beneficial. These would offer opportunities for children (and their parents) to continue obtaining support for audiological needs, assistive listening devices, sign language and special educational interventions until such time as the school takes over those responsibilities.

Consistent with existing research and the insightful self-examination of deaf students in Ireland, more age-appropriate congregated settings are needed. In such settings, children will find social groups, develop the ability to collaborate on academic and other tasks and be able to develop stable and mature social identities.

Clearly, for these recommendations to succeed, more teachers of the deaf and more sign language interpreters will be needed. In some cases, professional development for current teachers may be sufficient or provide a temporary solution to the teacher shortage. Some teachers in Ireland already have engaged in self-directed or mentored development activities aimed at enhancing their abilities to effectively educate children with significant hearing losses. Those efforts should be supported and extended to other personnel who can facilitate students' access to the curriculum. Some people functioning now as special needs assistants offer excellent examples in this regard, although there may be other existing or potential category of professional who can provide such services.

Education need not stop when a child reaches 18 years. A support service network (sign language interpreting, real-time text, tutoring) needs to be created to support deaf and hard-of-hearing students engaged in further and higher education. While services for deaf students might be more apparent, hard-of-hearing students and those with cochlear implants frequently "fall between the cracks" because their spoken language skills and partial hearing lead educators to believe they can function like hearing students. Students who can are a minority, and both deaf and hard-of-hearing students need services they can access without fear of exclusion or hardship.

If implications for the expansion and/or establishment of new services created by the above recommendations are far-reaching, so are the potential implications to raise the academic achievement and contributions to Irish society of individuals who are deaf and hard-of-hearing. The opportunities EPSEN offers have the potential not just to change the lives of those individuals, but of everyone in the country.

13.4 Teaching and learning

13.4.1 Recommendations

Recommendations associated specifically with classroom instruction and student learning overlap to some extent with those relevant to alternative educational models. Most obviously, there needs to be encouragement and support for teachers of the deaf training programmes and professional development for existing teachers in order to accommodate deaf and hard-of-hearing students in a variety of educational settings. Recent research has demonstrated that deaf children have different knowledge, learning styles and problem-solving strategies than hearing children. Teachers need to know how their deaf students think and learn if they are to accommodate their needs and utilise their strengths.

Sections 3 and 8 of the EPSEN Act indicate that parents must be consulted about individual education plans, be facilitated to be involved in their preparation and receive a copy of them, be advised of any significant changes, and receive a report of any review of the plan. In May 2006, the NCSE published *Guidelines on the Individual Education Plan Process* (available on the NCSE website at http://www.ncse.ie), which goes significantly further on parental involvement and other aspects of IEP creation and execution. Although IEPs are not mandatory at the time of this writing, evidence from other countries indicates the long-term potential benefits of parental input into IEPs both for children's educations and for optimising relations between parents and schools. As indicated in the NCSE *Guidelines:* "The key objective should be to maximise parental involvement and to make the experience for parents as positive and supportive as possible. Ideally, parents should be coming to the process of education planning having already been actively involved in the assessment process." IEP meetings also should include other professionals involved in a child's education (for example SNAs, SENOs, sign language interpreters); deaf parents should be provided with appropriate support services so that they can fully participate.

Deaf and hard-of-hearing students require more and more appropriate support services in the classroom to allow them curriculum access equal to that of their hearing classmates. Existing models in several countries provide sign language interpreters, oral interpreters, real-time text, notetakers and/or similar services in ways that are efficient and effective.

Finally, as indicated by existing research and students themselves, deaf and hard-of-hearing students in Ireland need to have high educational expectations placed on them by parents and educators. With high expectations and appropriate teaching and support services, those children can and will succeed.

13.4.2 Implications

The enhanced teaching and learning opportunities offered by the above recommendations will require more audiological technology in classrooms in addition to specific educational technologies. FM and/or infrared systems, loops and continuing support for hearing aids and cochlear implants are essential for students to utilise residual hearing.

If current teachers are to access professional development to help deaf children satisfy curriculum requirements, training activities are vital. Opportunities (during the school year and/or summer) and incentives to participate also will have to be created.

The IEP meeting recommendations may make them more complicated – but also more effective. Along with ensuring the individualised plan is appropriate for each child, waste can be avoided and parents will gain greater confidence in the educational system.

These recommendations will contribute to greater academic achievement, longer persistence and a better educated population. These, in turn, will feed back into educational and societal structures financially and by optimising the utilisation of human potential.

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