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A Rapid Evidence Assessment of the effectiveness of educational interventions to support children and young people with hearing impairment

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A Rapid Evidence Assessment of the effectiveness of educational interventions to support children and young people with hearing impairment

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Glossary

ALN	additional learning needs
ADHD	attention deficit hyperactive disorder
ASL	American Sign Language
AVT	auditory visual therapy
BSL	British Sign Language
CC&R	comprehension check and repair strategy
CRIDE	consortium for research into deaf education
dB	decibels
EA	emotional availability
ECC	expanded core curriculum
educational strategy	umbrella term used to describe an area of intervention (e.g. literacy, communication)
HI	hearing impairment
ISL	Irish sign language
IDP	individual development plan
REA	rapid evidence assessment
SEN	special educational needs
STEM	science technology engineering and mathematics
UNHS	universal newborn hearing screening

1 Introduction

1.1 The Additional Learning Needs and Education Tribunal (Wales) Act (the Act) received royal assent in January 2018. The Act introduces a new additional learning system, which has three overarching objectives:

- a unified legislative framework to support all children and young people with additional learning needs (ALN) from birth up to the age of 25, where they remain in education
- an integrated, collaborative process of assessment, planning and monitoring which facilitates early, timely and effective interventions
- a fair and transparent system for providing information and advice, and for resolving concerns and appeals.

1.2 The Act provides for a single plan – the individual development plan (IDP) – which will replace the range of statutory and non-statutory plans for learners with special educational needs or learning difficulties and/or disabilities.

1.3 The Act forms part of a wider package of reforms, which aim to transform the expectations, experiences and outcomes for children and young people with ALN. One key area of the transformation programme focuses on awareness raising, to facilitate those involved in the ALN system to better understand the evidence of good practice, what can be expected from interventions, the interventions most likely to be effective, and the role of professionals. This is to help inform expectations and the effective deployment of resources.

1.4 This report has been prepared for the Welsh Government and provides a synthesis of the findings of the Rapid Evidence Assessment (REA)[1]. These findings are intended to inform the development of a document regarding evidence based practice for practitioners and parents, to raise awareness amongst those engaging with deaf young learners in educational settings about various interventions and their effectiveness.

[1] GSR Rapid Evidence Toolkit

1.5 The term ‘deaf’ is used in this report to refer to children with all levels of hearing loss. The term ‘Deaf’ with a capital ‘D’ is used only when there is indication in the literature that this is the preferred term by the children and young people themselves or when referring to ‘schools for the Deaf’.

Population of deaf children

1.6 Evidence shows that deaf children have the potential to achieve at the same level as their hearing peers given the right support to access the curriculum (NDCS, 2017). However, the limited auditory input can present challenges when learning and accessing teaching. Deaf children are a heterogeneous group with a range of needs including the level of hearing loss, type of amplification, permanency, mode of communication and the age of diagnosis.

1.7 According to the degree of hearing loss, measured in decibels (dB) these are categorised as follow (BSA, 2011):

- Mild hearing loss 21 - 40 dB
- Moderate hearing loss 41-70 dB
- Severe hearing loss 71-95 dB
- Profound hearing loss In excess of 95 dB.

1.8 The degree of hearing loss affects the access that a person has to sounds. Thus, a mild hearing loss can lead to inattention, mild language delay and mild speech problems. Mild hearing loss can have implications around language development, particularly in the early years when children are still developing language. Children with moderate hearing loss do not perceive all speech sounds at normal conversational level. These children may show inattention, language delay, speech problems and learning problems. They typically respond well to language and educational activities with the help of amplification. In severe hearing loss ,language and speech will not develop spontaneously. Without amplification (e.g. hearing aids, cochlear implants), children with severe hearing loss cannot hear sounds or normal conversations. Lastly, children with profound hearing loss are likely to have

severe language delays, speech problems and possible related learning dysfunction (Northern and Downs, 2002).

1.9 In the last 10 years, the field witnessed two major technological advancements that might be expected to have an impact on deaf children's academic skills and success in school. The first is the introduction of newborn hearing screening and the second is the increasing effectiveness of hearing aid technology, including cochlear implants. In the UK, the implementation of universal newborn hearing screening (UNHS) began in 2000 and was completed in 2005, potentially reducing the mean age of diagnosis of prelingual hearing loss from 17 months to a few weeks. A recent review of the benefits of UNHS (Pimperton & Kennedy, 2012) reports consistent evidence that UNHS, and associated early diagnosis of hearing loss, does bring benefits for language development.

1.10 Central to the access to learning for deaf children is the type of communication they use. Data from Consortium for Research into Deaf Education (CRIDE, 2017) shows that 87% of deaf children communicate using only spoken English or Welsh in school or other education settings, and 10% use sign language in some form, either on its own or alongside another language. Closely related to the type of communication is the type of education setting. Thus, children whose preferred method of communication is oral are mainly educated in mainstream schools whereas children who prefer to communicate using signs usually attend special schools. In England, around 78% of school-aged deaf children attend mainstream schools (where there is no specialist provision), 6% attend mainstream schools with resource provisions, 3% attend special schools for deaf children whilst 12% attend special schools not specifically for deaf children. In Wales, 81% of school-aged deaf children attend mainstream schools, 8% attend mainstream schools with resource provisions, whilst 10% attend special schools not specifically for deaf children (CRIDE, 2017). Those children attending special schools not specifically for deaf children are more likely to have additional or complex needs (23 % for England and 22% for Wales). It is worth noting here that there are no schools for the Deaf in Wales.

1.11 It is only within the framework of these diverse needs and characteristics of deaf children that interventions reported in literature can be considered in relation to their effectiveness in supporting children's learning and access to learning.

Conceptual framework and targeted educational outcomes

1.12 Educational outcomes for learners with a hearing impairment (HI) can be considered as falling into two broad areas:

1. Access to the general curriculum, irrespective of where the learners are placed in the range of educational provisions (schools for the Deaf, hearing resource provisions, mainstream schools)

2. Development of skills which allow learners with HI to be self-determined agents in their lives.

1.13 The above broad distinction is partially linked to current educational policies in many countries (e.g. SEND Code of Practice (2015) in England; the draft Additional Learning Needs Code (2017) in Wales) which has clear expectations of inclusive practice and removal of barriers for learners with HI while at the same time learners are supported to develop their autonomy and independence.

1.14 This broad distinction can be articulated in different ways. Norwich (2007) has described it as a 'dilemma' and 'tension' where on one hand children with additional learning needs (ALN) should be given support to access the general curriculum, but simultaneously support should be focused on enabling those children to enhance their independence and coping skills especially those which are specifically linked to their ALN. More recently in the field of vision impairment education, this distinction has been captured through reference to a dual-model of access that draws on the terms 'access to learning' and 'learning to access' (e.g. McLinden and Douglas, 2014). The same model can be used here to provide a framework and vocabulary to address broad concerns of the field, within which different interventions and targeted educational outcomes can be aligned:

- Access to learning: inclusive practice and differentiation ensuring that the child's environment is structured and modified to promote inclusion, learning and access to the core curriculum, the culture of the school and broader social inclusion.
- Learning to access: teaching provision that supports the child to learn independence skills and develop agency in order to afford more independent learning and social inclusion.

1.15 This distinction is commonly discussed as a distinction between the traditional school curriculum and additional curriculum areas, sometimes described as the 'expanded core curriculum' (ECC). An ECC for students who are deaf has been developed in the USA (e.g. Iowa Department of Education Bureau of Student Family Support Services, 2013) and includes the following eight areas: audiology, career education, communication, family education, functional skills for educational success, self-determination and advocacy, social-Emotional skills, and technology. The principle behind the ECC is that it attends to important curriculum areas which typically fall outside the traditional school curriculum and may be particular to, or particularly important to, students with HI.

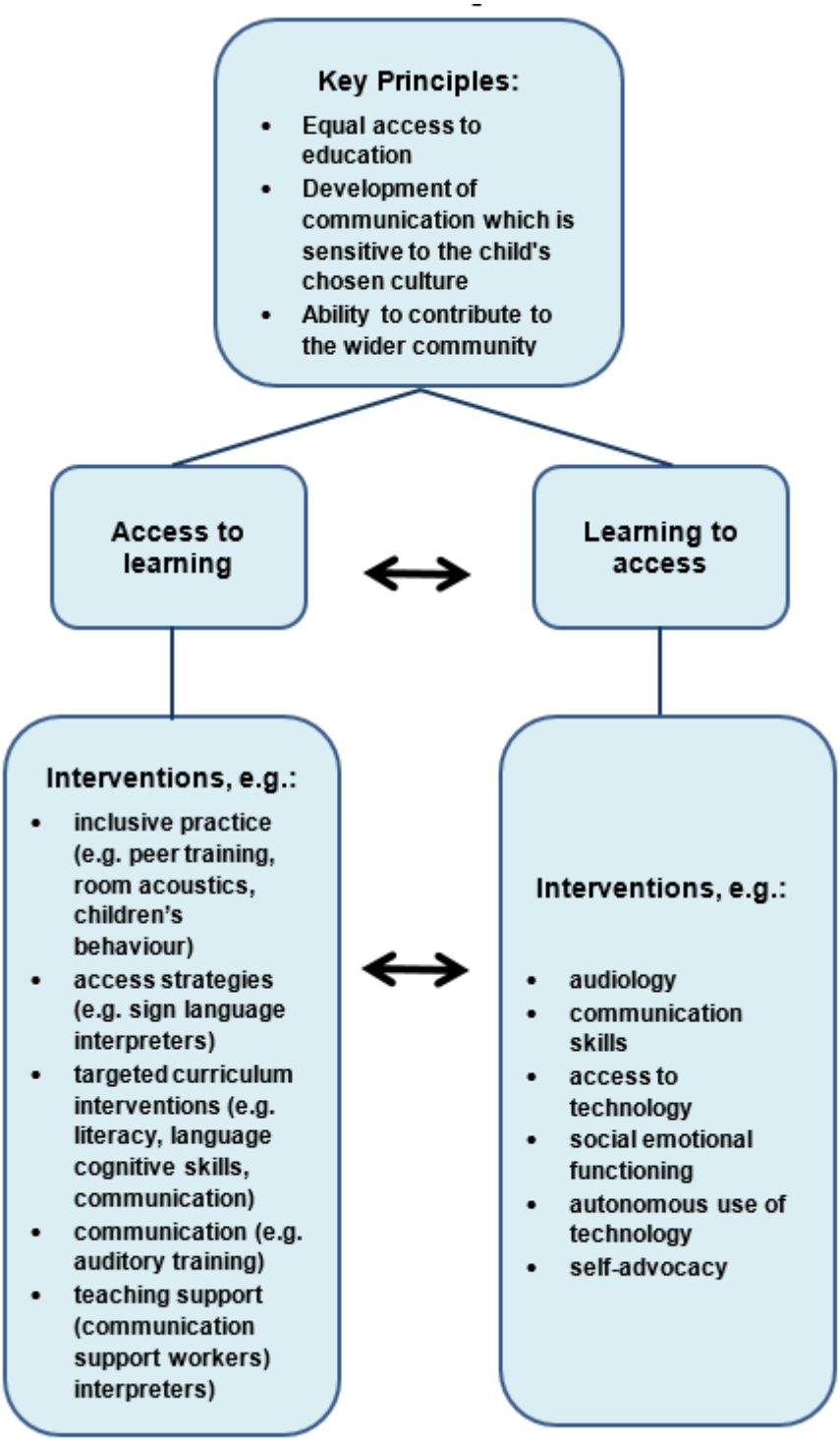
1.16 The importance of 'learning to access' and consequently the importance of an ECC for learners with HI is highlighted by Garberoglio et al. (2017). In their analysis of the National Longitudinal Transition Study (NLTS2), a large-scale dataset on students with disabilities in the United States, the authors suggested that autonomy was a key predictor of employment for deaf young adults. Thus, the more independent young people with HI were, the greater range of chances they had to be employed and to advance in their employment.

1.17 The concept of autonomy and its significance for educational outcomes is linked to the overarching key principles for learners with HI. These key principles are focused on enabling learners with HI to be independent, self-reliant, and able to contribute to the wider community. With these principles as a benchmark, the aim is to support learners to function effectively within

both the Deaf and the hearing world, to be able to make choices and to move freely within any world they choose.

1.18 Figure 1 describes the overarching conception in the field of HI and how it links to the interventions informed by the two interacting approaches of ‘access to learning’ and ‘learning to access’. For example, access to learning for learners with HI can be achieved by: audiology equipment, assistance with communication (e.g. communication support workers, sign language interpreters), good listening environments (e.g. acoustically treated rooms) and adapted materials (e.g. subtitled videos). Learning to access refers to teaching children access skills. For example, these skills refer to the use of technology by the learner (e.g. consistent use of hearing aids and cochlear implants), self- advocacy and promotion of attention and social skills.

Figure 1: Relationship between overarching conception in the field of HI education and how this links to targeted interventions



1.19 The way learners with HI perceive themselves in relation to their hearing impairment (and the way they are then perceived) plays an important role in terms of the support the learners receive. For example, children born in families who are part of a Deaf, sign language using community are more likely to embrace the Deaf identity, to choose to function in a world that

celebrates the Deaf culture and to use signing as the main way of communication (Nikolaraizi & Hadjikakou, 2006). As a result, these learners will receive support in using sign language to communicate and are most likely to be educated in an educational setting that celebrates and embraces this identity. In contrast, a child born in a hearing family with a mild-moderate hearing loss or a child with a profound hearing loss who has cochlear implants might feel more included in the hearing world and embrace a hearing identity. This child might be educated through spoken language and choose to socialise with peers using spoken language. In addition, learners with HI who can lip read choose to identify themselves with both worlds (i.e. Deaf *and* hearing) and to embrace both identities. Within each identity, it is important that interventions and support approaches are aligned with the child and family's choices. For example:

- An early identification of deafness, followed by early support, is a key factor in enabling later independence. Interventions focused on early years are therefore particularly important, but the nature of the interventions will depend upon these higher level identity choices – e.g. access to sign language and/or use of hearing aid technology and strategies for promoting speech.
- It is commonly accepted in the education of learners with HI that targeted support is needed to develop reading skills in learners' with HI for them to become fluent and independent readers. The evidence however may support different strategies, with different groups of children which may be related to their Deaf/hearing impaired identities or other individual differences, as for example in the case of phonological awareness versus sight vocabulary.

1.20 The key approach is to ensure that all appropriately evidenced strategies are recognised as supportive within a framework of inclusive practice which is respectful of the different identities.

1.21 Although Figure 1 presents two different pathways, in practice there is a great deal of overlap and interaction between the interventions designed to support children to access the curriculum and those designed to promote

ECC and learners' independence. The difficulty is to find the right balance between the targeted support offered to learners with HI (e.g. communication support worker) and the targeted support for them to master independent skills (e.g. ability to ask for help from classmates or teachers independently when content of a task is unclear).

2. Methodology

2.1 The design of the REA[2] agreed with the Welsh Government is split into five stages:

- Stage 1: Literature search and inclusion/exclusion criteria framework
- Stage 2: Refining the search
- Stage 3: Assessing the quality
- Stage 4: Data extraction
- Stage 5: Data synthesis/ report production.

Stage 1: Literature search and inclusion/exclusion criteria framework

2.2 The aim of stage 1 was to carry out searches using the databases and search terms specified below and to apply an inclusion/exclusion criteria framework. Details of the search terms and procedure is presented in **Annex A: Database sources and search terms**. This is summarised as bullet points here.

- **Databases**. The search was carried out in four databases: (1) EBSCO Education Databases, (2) PsychInfo, (3) Proquest Social Sciences and (4) Web of Science. Some additional hand searches were also carried out.
- **Search structure**. Our broad search involved a series of searches with the following structure:
- Age (various terms to include research relevant children and young people under the age of 25 years)
- Hearing Impairment
- Educational strategies (thirteen broad educational strategies identified though our initial work on the conceptual framework – see below).
- **Filtering by types of materials and relevance.** Further inclusion and exclusion criteria most notably: literature from 1980 onwards, published in English or Welsh, and based in Organisation for Economic Co-operation and Development (OECD) member countries[3].

[2] GSR Rapid Evidence Toolkit

[3] The 34 OECD member countries are: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

2.3 Educational strategies were drawn from our initial conceptual work and captured broad educational areas and interventions associated with hearing impairment education.

Table 1: Hearing impairment educational strategies – summary descriptions of 12 educational strategies

Educational Strategy	**Description of the educational strategy**
Communication	Supporting the development of communication skills, including focussing upon early communication and language development. Including alternative and augmented communication systems.
Literacy	Supporting the development of reading and writing skills. This includes emergent literacy, morphology, phonology and visual phonics.
Mathematics	Supporting the development of mathematical skills
Access to examinations	Assessment accommodations / modifications.
Mobility and independence	Supporting the development of mobility and orientation (including cane skills), independence and living skills.
Cognitive skills	Supporting the development of a range of cognitive skills (e.g. thinking skills, theory of mind, metacognitive strategies, working memory).
Social and emotional functioning	Supporting development of self-esteem, peer relationships, friendships and peer acceptance.
Use of technology	Supporting the development to use educational, enabling and access technology.
Teaching support	The use of various teaching support techniques (generally human support, e.g. learning support assistant, teaching assistant) to support children's learning.
Teaching strategies	The use of teaching strategies to support learning, often the strategies involve the use of accessible / modified / alternative learning materials (often giving access to curriculum and experiences which would otherwise be difficult with 'traditional' approaches).
Minority language	Approaches which are particularly concerned with the teaching of children with a hearing impairment in a dual-language and multicultural context.
Inclusion	The use of environmental adjustments, inclusive practice, peer, teacher, and parental training to support and enable the learning environment.

2.4 Number of sources identified (four databases and hand searches) The sources (references and abstracts) generated after applying the above were collated in EndNote (a bibliographic data software package) and duplicate citations were removed.

Table 2: Number of results for hearing impairment from each database, plus totals after removing duplicates

Databases	**Number of results**
EBSCO	7,532
PsychInfo	6,485
Proquest Social Sciences	1,535
Web of Science	7,394
Totals	22,946
Totals (removing duplicates)	**19,218**

Table 3: Number of results for hearing impairment from generic databases and websites

Generic databases and websites	**Number of results**
Google scholar	5
e-theses	0
National Deaf Children's Society (NDCS)	0
Action on Hearing loss	0
British Association of Teachers of the Deaf (BATOD)	0
Ingenta Connect Portal	3
Nuffield Foundation	1
National Sensory Impairment Partnership (NatSIP)	0

Stage 2: Refining the search

2.5 The aim of the second stage was to narrow the material down from the initial search by offering a detailed consideration of each source to ensure the most relevant material is selected.

2.6 A separate Endnote database for each subject area was created. The sources in each Endnote database were scrutinised based on the inclusion and exclusion criteria regarding the relevance of the study. More details are presented in Annex A: Database sources and search terms**Error!**

Reference source not found., but this stage of the search involved looking at titles and abstracts of each source.

2.7 Following discussions with the Welsh Government it was noted that the REA was initially very broad in focus, rather than focussing upon a specific type of intervention or targeted educational outcome. The REA was linked to all educational outcomes which the team sought to simplify into twelve areas. This can be contrasted with other REAs undertaken in other disciplines which might seek evidence of the successful interventions in relation to much narrower target outcomes (for example in relation to ADHD, the focus may be linked to the reduction in particular defining behaviours).

2.8 In addition to the point about breadth of the review, there is a related challenge of defining the term 'intervention'. Our working definition of an intervention study was outlined in the proposal as studies which sought to describe the effect of some kind of educational approach upon a targeted outcome. These studies might be qualitative designs, controlled trials, or single subject designs.

2.9 In order to contextualise this definition further, the invitation to tender offers the following definition of the interventions of interest:

> “For the purposes of this research, an intervention is defined as SEP [special educational provision] as set out in the Education Act 1996 ‘education provision which is additional to or otherwise different from the education provision made generally for children of their age in maintained schools, other than special schools, in the area. For children aged under two SEP is considered to be education provision of any kind.” (p11)

2.10 Our proposal also unpicked SEP further and made a distinction between:

(1) **Inclusive practice and differentiation**: ensuring that the child’s environment is structured to promote inclusion and learning throughout their education.

(2) **Additional learning provision:** supporting the child to learn distinctive skills in order to afford more independent learning.

2.11 Such a broad and inclusive definition of intervention is helpful in ensuring valuable evidence is included in this REA which is broad in scope. Nevertheless, such a definition is difficult to operationalise. The working solution was to make a distinction between the following categories of sources: (1) 'excluded/ not relevant'; (2) 'good practice'; and (3) 'intervention'. All the sources in each Endnote database were categorised in this way. The table below outlines the criteria for this categorisation.

Table 4: Working definitions of categorisation of sources

Category	Definition	Example
1. Excluded/not relevant	The source is not linked to a relevant *educational* intervention or outcome (e.g. it is medical in focus), or the source does not provide an analysis of educational practice.	(1) Impact of cochlear implants upon functional hearing. (2) A survey of teacher preparation or parent attitudes not linked to educational practice.
2. Good practice	The source is linked to *educational* practice. While it does not provide evidence of an effect of that practice upon target outcomes, it provides evidence and rationale for the differentiated education provision.	The development of standardised and accessible assessment approaches (e.g. a reading assessment).
3. Intervention	The source presents evidence of the effect of some kind of educational approach upon a targeted educational outcome(s).	The trial of a reading intervention to measure the effect upon children's reading performance.

Outcomes following stage 1 and 2

2.12 The sources which were rated as ‘intervention’ or ‘good practice’ were grouped under each of the 12 educational strategies. The remaining sources were categorised as 'excluded / not relevant' (breakdown not listed here).

Table 5: Hearing Impairment interventions – number of sources categorised as 'intervention' under each of the 12 educational strategies

Educational strategy	Summary for categorisation under 'intervention' group	Numbers
Communication	Studies describing the effect of instruction/teaching/ training to support the communication skills (oral and/ or signing).	31
Literacy	Studies describing the effect of instruction/teaching/ training to support reading, and/or writing skills.	48
Mathematics	Studies describing the effect of instruction/teaching/ training to support mathematical skills.	10
Access to examinations	No interventions were identified under this category.	0
Mobility and Independence	Studies describing the effect of instruction/teaching/ training to support independence and living skills.	2
Cognitive skills	Studies describing the effect of instruction/teaching/ training to support a range of cognitive skills (theory of mind, metacognitive strategies, working memory).	22
Social and emotional functioning	Studies describing the effect of instruction/teaching/ training to support self-esteem, peer relationships, friendships and peer acceptance.	14
Use of technology	Studies describing the effect of instruction/teaching/ training using video games or applications to support a range of skills (behaviour, literacy, academic achievement).	16
Teaching support	No interventions were identified under this category.	0
Teaching Strategies	No interventions were identified under this category.	0
Minority Language	No interventions were identified under this category.	0
Inclusion	Studies describing the effect of instruction/ teaching/ training using video games or applications to support a range of skills (behaviour, literacy, academic achievement).	3
Total		**146**

Table 6: Hearing impairment – number of sources categorised as 'good practice' under each of the 12 educational strategies

Strategies	Summary for categorisation under 'good practice' group	Numbers
Communication	Studies examining/ exploring strategies used by teaching staff to support communication abilities but without formally/ directly examining the effect of those strategies.	136
Literacy	Studies examining/ exploring strategies used by teaching staff to support reading /writing and or studies examining the factors which predict students' literacy skills (reading/ writing) but without formally /directly examining the effect of those strategies.	133
Mathematics	Studies examining/ exploring strategies used by teaching staff to support number processing and arithmetic skills but without formally/ directly examining the effect of those strategies.	22
Access to examinations	One study using meta-analysis of the research on assessment accommodations for students who are deaf or hard of hearing.	1
Mobility and Independence	Studies examining/ exploring strategies used by teaching staff to support independent living skills and transitions but without formally/ directly examining the effect of those strategies.	15
Cognitive skills	Studies examining/ exploring strategies used by teaching staff to support a range of cognitive skills (theory of mind, metacognitive strategies, working memory) but without formally/ directly examining the effect of those strategies.	206
Social and emotional functioning	Studies examining /exploring the effect of strategies used by teaching staff to support a range of socio- emotional skills but without formally/ directly examining the effect of those strategies.	66
Use of technology	Studies examining/exploring the effect using video games or applications to support a range of skills (behaviour, literacy, academic achievement).	83
Teaching support	Studies examining/ exploring the effect of peer–tutor strategies but without formally/ directly examining the effect of those strategies.	13
Teaching Strategies	Studies examining/ exploring the effect of seating and classroom acoustics but without formally/ directly examining the effects of those strategies.	6
Minority Language	Studies examining/ exploring the effect of strategies used by teaching staff to support Welsh speaking students and students from ethnic minority backgrounds but without formally/ directly examining the effects of those strategies.	8
Inclusion	Studies examining/ exploring the effect of strategies used by teaching staff to support inclusion of students in mainstream classrooms but without formally/ directly examining the effects of those strategies.	23
Total		**712**

Inter-rater reliability – stage 2

2.13 To offer greater rigour, all sources identified as interventions were reviewed independently by another team member. There was 96% agreement, and if disagreements were noted the sources were reviewed and re-categorised if necessary. A further 10% (N=71) of the sources identified as 'good practice' were reviewed independently. There was 97% agreement, and if disagreements were found the sources were reviewed and re-categorised if necessary. No sources were re-categorised as an intervention. Total agreement across all independent reviews (N=217 sources) was 96%.

Stage 3 and 4: quality assessment and data extraction

2.14 The aim of stage 3 was to assess the quality of the identified research (and the protocol for checking the reliability of this assessment), while the aim of stage 4 was to extract the relevant information from the research articles / sources into a standard database. Clearly the two stages are intertwined.

2.15 In terms of quality assessment, articles which met the inclusion criteria for interventions (in stage 2 above) were viewed as full text and assessed for relevance and robustness, or ultimately excluded because upon examination of the full text they did not meet the inclusion criteria. The quality of the evidence was assessed by assigning a score of 1, 2 or 3 to different aspects of the research articles using the criteria described in Table 2 based on the following categories:

- Score of 1: where there was only impressionistic evidence of impact.
- Score of 2: where there is modest evidence of impact.
- Score of 3: where there is strong evidence of impact.

2.16 These criteria are drawn from a number of studies which have examined the evidence on 'evidence based practice' and assessment of REAs (e.g. Luckner, Bruce & Ferrell, 2016; Houghton-Carr, Boorman & Heuser, 2013; Collins, Coughlin, Miller & Kirk, 2016; Nelson et al, 2011).

2.17 To ensure the matrix was ‘fit for purpose’, four full text articles covering different methodologies were read and assessed using a matrix agreed with the project steering group. Based on the rating of this sample of articles, the matrix was further developed into the criteria presented in Table 6 (empirical studies) and Table 7 (literature reviews) below.

2.18 The combined score assigned to each article enabled the identification of the most relevant and most robust study, and as such were scored highest. This provided an indication of the confidence placed by the project team in the evidence in the selected articles.

Table 7: Matrix table to derive confidence in the robustness of empirical studies

Components	Score 1: Impressionistic evidence of impact	Score 2: Moderate evidence of impact	Score 3: Strong evidence of impact
1) Objectives of study / hypothesis being tested	No clear objectives (e.g. the effect of intervention on students' outcomes is incidental/ byproduct of study).	General objective (e.g. investigation of school impact on intervention).	Clear specific objectives (e.g. investigation of effect of intervention on children's academic outcomes).
2) Approach – quality of outcome measures (valid and reliable)	Limited outcome measures – lack richness and depth (qualitative) or no evidence of valid / reliable measures.	Moderate quality outcome measures – offer some richness and depth (qualitative) or some evidence of valid / reliable measures (e.g. inter-rater reliability).	High quality outcome measures – offer high richness and depth including triangulation (qualitative) or clear evidence of valid / reliable measures including multiple variables.
3) Approach – quality of the research design (appropriate structure)	Design is limited, e.g. no baseline evidence.	Design is appropriate, but rigour is limited, e.g. no use of control or intervention group.	Design is high quality such as using a control and intervention group: either random assignment of participants to conditions or two groups equivalent before the intervention began. In qualitative designs, clear processes of extended periods of observation are recorded (e.g. in action research or case study work).
4) Quality of the intervention	The details of the intervention (independent variable) are not presented, or they are presented in very little detail. The intervention is not replicable.	Moderate quality - details of the intervention are presented, and it could be replicated. Nevertheless little or no rationale for the intervention is offered.	High quality - details of the intervention are presented, and it could be replicated. Rationale for the intervention is offered including theoretical and empirical underpinning.

5) Implication for practice (ecological validity)	Minimal implication on practice, e.g. the intervention in the study has no obvious / explicit link to educational practice, nor are these links made by the authors. Minimal or no discussion of the interpretation of the application of the study.	Moderate implication on practice, e.g. while the intervention was not carried out in a practice setting, there are clear similarities and possibilities for transfer; the authors explicitly make these links.	Strong implication on practice, e.g. the intervention was situated in practice (such as in the classroom, with classroom teachers); the authors explicitly make links to practical application of the intervention. No evidence of 'over-reach'.
6) Sample size	Small number of participants (e.g. n is less than 5 and reported as individual case studies).	Small sample sizes (e.g. studies based in only one or two educational settings), or the sampling / sample design does not account for bias / representativeness.	Large sample size allowing for calculation of effect sizes. The sampling / sample design accounts for bias / representativeness
7) Generalisability	Results only apply to the specific participant/s of the intervention.	Results are representative for a specific group of the population (e.g. results only apply to deaf children with a specific degree of hearing loss).	Results are an accurate representation of the majority population of HI
8) Evaluation – data reporting and analysis	Descriptive summary / review of results only. Minimal, or no, analysis and evaluation of study data.	Beyond descriptive, but not extensive, account of the results. Moderate analysis and evaluation of study data.	Extensive account of the results. Extensive analysis and evaluation of study data.
9) Evaluation – critical reflections on limitations of the study	Minimal, or no, reflection on the limitations of the study.	Moderate reflection on the limitations of the study.	Extensive and rigorous reflection on the limitations of the study.
10) Evaluation – Reporting of evaluation	Unpublished, subject to no peer review.	Reported on websites or in grey literature. Some peer / external review described.	Reported in peer reviewed literature.
Mean scores across all components **(Max 30/10; Min 10/10)**			

Table 8: Matrix table to derive confidence in the robustness of literature review articles

Components	Score 1: Impressionistic evidence of impact	Score 2: Moderate evidence of impact	Score 3: Strong evidence of impact
1) Objectives of the review	No clear objectives.	General objective made clear.	Clear and specific objectives given.
2) Approach – search strategy rationale	No clear search strategy outlining key words and sources. Minimal database search; no clear databases defined.	Moderate search strategy outlining key words and sources.	Strong search strategy outlining key words and sources. Typified by a systematic review.
3) Approach – rationale and breadth of search	No clear rationale for the inclusion of the selected studies.	Moderate rationale for the inclusion of the selected studies. Limited or no searching of grey literature.	Robust rationale for the inclusion of the selected studies. Extensive database search, including publication bias mitigation through identification of grey / unpublished literature. Typified by a systematic review.
4) Implication for practice (ecological validity)	Minimal implication on practice, e.g. the intervention in the study has no obvious / explicit link to educational practice, nor are these links made by the authors. Minimal or no discussion of the interpretation of the application of the study.	Moderate implication on practice, e.g. while the intervention was not carried out in a practice setting, there are clear similarities and possibilities for transfer; the authors explicitly make these links.	Strong implication on practice, e.g. the intervention was situated in practice (such as in the classroom, with classroom teachers); the authors explicitly make links to practical application of the intervention. No evidence of 'over-reach'.
5) Generalisability (of the conclusions of review)	Results only apply to a specific sub-group of hearing impairment.	Results are representative for a specific group of the population (e.g. results only apply to deaf children with a specific degree of hearing loss).	Results are an accurate representation of the majority population of HI.
6) Evaluation – data reporting and analysis	Descriptive summary review of results only. Minimal, or no, analysis and evaluation of study data.	Beyond descriptive, but not extensive, account of the results. Moderate analysis and evaluation of reviewed studies; limited synthesis.	Extensive account of the results. Extensive analysis and evaluation of study data; coherent synthesis.

7) Evaluation – critical reflections on limitations of the study	No, or minimal, reflection on the limitations of the review.	Moderate reflection on the limitations of the review.	Extensive and rigorous reflection on the limitations of the study.
8) Evaluation – reporting of evaluation	Unpublished, subject to no peer review.	Reported on websites or in grey literature. Some peer / external review described.	Peer reviewed literature, including (a version of the review) presented in a peer reviewed academic journal.
Mean scores across all components **(Max 24/8; Min 8/8)**			

Inter-rater reliability – stage 3

Team members outside the research team independently assessed the robustness scorings of a 30% subset of the articles on the final list. The inter-rater reliability was performed based on a protocol presented in **Stage 3: Protocol for inter-rater reliability of robustness scoring**. The results of the inter-rater reliability for each of the 12 categories is presented in the table below:

Table 9: Inter-rating reliability of robustness scoring, percentage of agreement

Strategies	Articles reviewed by second rater (N)	Percentage of agreement
Communication	8	100%
Literacy	6	63%
Mathematics	2	100%
Access to examinations	0	0
Mobility and independence	1	100%
Cognitive skills	3	100%
Social and emotional functioning	3	66%
Use of technology	3	66%
Teaching support	0	0
Strategies	0	0
Minority Language	0	0
Inclusion	2	
Total	26	85%

2.19 In the categories where there was disagreement, the raters discussed how to re-categorise the articles and changes were made where appropriate.

Data extraction – stage 4

2.20 A predefined spreadsheet template was developed to facilitate recording of the most important details of each study on intervention to provide a comprehensive overview. This template (record) is summarised in **Annex A: Database sources and search terms**, and completed templates made available to the funder.

Further refinement of the selected intervention studies

2.21 Following careful reading of all of the identified sources and consideration of the literature as a whole, further refinement was made. First, several sources were removed from the analysis because they did not meet the inclusion criteria. Some did not provide enough detail of methods, interventions or educational impact. Others, on closer inspection, were not intervention studies but correlation or longitudinal studies. This reduced the total number of intervention studies to 85, detailed analysis and summary of these sources is presented in the next section.

3. Characteristics of the evidence

3.1 From the intervention studies we quality rated:

- 85 we consider to be interventions
- 59 are rated moderate (2) to strong (3) quality
- 26 are rated impressionistic (1) to moderate (1.9)
- Literacy and communication are the areas that have received most research attention in relation to intervention studies.

The full list of evidence under each strategy is presented in the Bibliography of evidence.

Table 10: Summary of quality rating ranges by strategy for the identified interventions

Strategy areas	Quality rating: impressionistic – moderate (score 1-1.9)	Quality rating: moderate to strong (score 2-3)	Total sources
Communication	3	12	15
Literacy	11	25	36
Mathematics	2	3	5
Access to examinations	0	0	0
Mobility and independence	0	2	2
Cognitive skills	1	5	6
Social and emotional functioning	3	7	10
Use of technology	6	3	9
Teaching support	0	0	0
Teaching strategies	0	0	0
Minority language	0	0	0
Inclusion	0	2	2
Total	**26**	**59**	**85**

Table 11: Summary of the study designs

Design type	Count
Systematic review	2
RCT or quasi-experimental study	33
Single case experimental design	49
Meta-analysis	0
Mixed methods	3

Table 12: Summary of national research settings

County	Count
USA	54
UK	2
Other countries (i.e Netherlands, Canada, Australia, Israel, Spain, Italy, New Zeland, France)	29

Table 13: Summary age range

Age group	Count
Pre-school focus	23
Primary years	45
Secondary years	15
16+	9

Note: Most studies included deaf students across the age range described in the table (e.g one study included deaf students aged 5-15 years of age).

Table 64: Summary of degree of Hearing Loss

Nature of disability	Count
Mild to moderate HL	28
Severe to profound HL	72
No information provided	11

Note: Most studies included deaf students with mild-moderate to severe-profound hearing loss (HL).

3.2 The final list of 85 studies provides evidence within eight broad educational strategy areas. Nevertheless, within each of these strategy areas there were a range of different interventions (e.g. within literacy there are very different interventions linked to the vocabulary and reading comprehension). The table that follows summarises the nature of the interventions within the different strategy areas.

Table 75: Summary of the interventions linked to each educational strategy area

Educational area (number of studies)	Overview of the types of interventions identified
1. Communication (15)	A noteworthy proportion of the studies involve children with cochlear implants and a variety of interventions (e.g. phonological and working memory skills). A variety of ages are represented but the focus tends towards younger children. Studies show that earlier intervention is more effective on communication skills of deaf children. Language schemes and therapy techniques are explored and assessed including Auditory Verbal Therapy (AVT) and a natural aural-verbal scheme. Some of the studies also explore the effect of listening to music in relation to auditory training. Interventions on communication put emphasis on IT including tele-AVT sessions and electronic storybooks. Also, studies in this category explore the use of lipreading, cued speech, augmentative signs and gesture to improve communication of deaf children.
2. Literacy (36)	Interventions focus on three different aspects of literacy: • Reading skills (i.e. decoding and reading comprehension) • Vocabulary • Writing. Within reading skills (i.e. decoding) intervention studies concentrate on the development of phonological and phonemic awareness, and syllable segmentation, using a range of strategies including instructions on syllable segmentation, phonics and visual phonics. Interventions targeting reading comprehension mainly involve building the background knowledge of the children using sign language, themed play and shared reading. Interventions on vocabulary mainly focus on the development of storytelling ability and retention of vocabulary employing mainly technology/computer based applications. The use of story grammar and structured writing instructions are mainly used to promote writing skills for deaf children.
3. Mathematics (5)	Attainment for deaf children in this category is traditionally low. The importance of incidental learning (often a difficulty for deaf children) is highlighted in these interventions. These interventions focus on teaching techniques to problem-solve, particularly in relation to time sequence problems and multiplication. One intervention aimed at the promotion of early mathematical concepts naturally, in the home, showed an effect

	of altering parents' communicative behaviour in a positive direction.
4. **Access to examinations (0)**	N/A
5. **Mobility and independence** **(2)**	There are only 2 intervention studies identified in this category. One intervention focuses on the enhancement of physical activity of primary school children using exergames. The other intervention concentrates on independent living skills of school deaf children.
6. **Cognitive skills** **(6)**	Interventions focus on a number of different cognitive skills: • Problem solving • Theory of Mind • Metacognitive strategies Studies focusing on problem solving are mainly based on science, technology, engineering, and math (STEM) practices. Studies on social skills looked at the effect of social skills interventions on children's interactions with hearing peers. Within the theory of mind aspect of this category, one study looked at the impact of using thought-bubbles on false-belief tasks. Studies also explored how children can learn metacognitive strategies to enable them to monitor their understanding of content-area text and resolve problems with comprehension.
7. **Social and emotional functioning** **(10)**	Half of the studies in this category explored the use of social skills interventions to promote positive interaction between deaf individuals and their hearing peers. These studies employed a range of intervention programmes including life skills programme, generalisation and maintenance of social skills and social skills instruction focusing on cooperative learning programme and in free play situations. The other half of the studies focused on a range of different aspects of social and emotional functioning. Only one study looked at how emotional recognition deficits can be reduced by enhancing children's understanding of the emotional experience of other people. One of the most comprehensive and most effective intervention aiming at increasing emotional awareness and improving behavioural adjustment was the preventive intervention programme, called PATHS (Promoting Alternative Thinking Strategies). One study focused on the development of self-esteem of deaf adolescents using vocal training. Two

	studies involved pre-school aged children exploring different areas: development of deaf children's interaction using reading of social stories and development of hearing children's interaction with profoundly deaf children by enhancing children's deaf awareness.
8. **Use of technology** **(9)**	Interventions on the use of technology focus on a range of different areas (i.e. the use of technology to promote different skills). Three of the studies explored the role of computer display in speech training. Some studies explored the efficacy of technologies designed to add extra experiential detail in order to increase understanding and improve access for deaf children. Other studies in this category focused on the use of interactive games to promote physical balance.
9. **Teaching support (0)**	N/A
10. **Teaching strategies (0)**	N/A
11. **Minority Language (0)**	N/A
12. **Inclusion** **(2)**	Two different aspects of inclusion are represented in this category. The first is inclusion in relation to learning and behaviour, the other is social inclusion. One study described how modification of the physical environment in the classroom creates positive results. The other explored the effect of three social interventions on the interaction between deaf and hearing peers.

4. Intervention summaries

4.1 In this section, the findings for the different strategy areas are discussed in turn. For each, we present three sub-sections:

- Introduction
- Available evidence
- Implications.

Taking each in turn, the sub-sections have the following purposes:

4.2 The **introduction** re-introduces the broad educational strategy area and how and why the given strategy has been defined in the general field of deaf education. This is often linked to responses to identified need in the population of young people with vision impairment. We draw upon texts in the field, including: recent literature reviews, critical analyses and overarching texts. Importantly, the introduction sub-section uses the conceptual framework outlined at the beginning of the report, most notably the distinction between access to learning and learning to access, and the related concept of the ECC and its contrast with the core curriculum.

4.3 The **available evidence** sub-section overviews each of the sources and articles identified through the REA. For each, this includes details of the intervention under investigation, what the researchers found, how they did this (methodology), and the quality of the evidence generated.

4.4 The **implications** provides a reflection upon the overall available evidence in the context of the introduction, and offers a broad summary of the implications for educational practice.

Communication

Introduction

4.5 Controversies about communication and the deaf child are as old as deaf education itself. Questions about communication modalities have dominated the field and answers produced have been influenced by a number of factors; technological advancement, advancing knowledge of child development including cognitive and linguistic development, early diagnosis of hearing loss to name a few.

4.6 Communication should not be confused with language (although it often is), although communication is inextricably linked with language. Communication skills and functional communication are dependent on language development and on experiencing good models of it, that is, those around the developing person modelling good communication (Wolters and Isarin, 2015). Therein lies one of the problems for the deaf child. Whether a child is deaf and developing along an oral route, or deaf and progressing along a signing route, or a combination of the two, access to good models is key.

4.7 Communicative competence has been shown to be related to better participation in the classroom, and this in turn seems to have been a factor in both social and academic success (Antia and Jones, 2010; Antia et al, 2011, Antia et al, 2007). Deaf children, who are educated in mainstream schools, can experience a 'solitary mainstream experience' if their communication skills are not developing alongside their peers (Oliva 2004). As children grow into adolescents the importance of good communication becomes ever clearer. Functional communication is not necessarily related to modality of communication but rather the level of skill (Antia, 2015), that is the ability to communicate fluently and with ease. It depends on more than having a good vocabulary or being able to articulate words well. It depends on being able to respond to the social context appropriately and craft expression to suit purpose – in other words possessing effective pragmatic skills.

4.8 A young person's communicative skill affects peer status (Asher and Macdonald 2009) and friendship-making (Antia et al., 2010). When a deaf youngster feels they are failing in this, self-esteem and a feeling of lack of

acceptance may follow; and this, in some cases, can lead to mental health issues (Fellinger et al., 2009). As the adolescent moves into adult life it becomes clear that sophisticated communicative skills are demanded in society more generally, including the workplace. Archbold (2015) reminds us that in the present era the need to be a good communicator is greater than ever.

4.9 In summary, although language and communication are different they are inextricably linked. Language (either sign or spoken) is important for communication skills of deaf children and young people. Good communication skills are established early in life and the role of the family on the development of these skills is crucial.

4.10 Given the importance of communication and language (either spoken or sign language), intervention studies mainly focus on supporting communication skills from an early age and as a result promote inclusion of deaf children in mainstream educational settings. Advances in technology (i.e. digital hearing aids and cochlear implants) provide better access to speech and, as a result, improve communication skills for deaf children who use spoken language. Hence, the use of auditory training for cochlear implanted children has been the focus of a number of interventions. The role that the parents play in the development of early communication skills of deaf children is recognised and parent-child communication is one of the focus areas of the identified interventions.

Available evidence – language acquisition

4.11 Cherry's study (1985) represents a particular view of language development based on Bloom and Lahey's model (1978). This is a schema which organises language into form, content and use. Cherry examines an intervention aimed at the language acquisition of four severely-profoundly deaf pre-school children. Noticeably, the emphasis was upon naturalism and child-centred therapy techniques, delivered in sessions held five days a week for two hours. Significantly, parental involvement is also encouraged. Results lack detail but after nine months "the number of content categories,

as well as the total number of relations, increased" and "significant progress in linguistic skills and increasingly intelligible speech were noted for each child". The naturalistic nature of this intervention means there is no prescribed course of action and, therefore, precludes it from further attention. The model it is based upon is less well-used now. However, the feature of parental involvement can be noted. This study provided evidence of moderate quality.

4.12 Natural auditory-verbal education is under scrutiny in Diller et al.'s study (2001). The results of a four year study are described. Natural-aural principles, which are described, had been carried out by professionals and parents on a cohort initially as large as 103 profoundly deaf children up to an age of 24 months. The aims were to 1) explore the relation between the fitting of aids, the educational programme and the hearing and language development of the children 2) and to compare development with typically hearing children. The features of natural auditory verbal principles are spelled out but no further details were provided. A battery of tests was administered and results suggest that the speed and progress in language development could be said to be commensurate with hearing children in half the cases, using the natural auditory-verbal principles. Children with cochlear implants achieved better results and those whose families 'engaged' in the programme enjoyed an even higher success rate. The authors clearly feel that these results merit a roll-out of the principles and training country-wide (Germany). However, they acknowledged the role that 'social standing' of families and their ability to engage in the programme plays in the success of the programme. They also acknowledged the impact on the child when the family does not speak the target language. This study provides evidence of moderate quality.

4.13 Moeller's (2000) large scale study of 112 children is retrospective in nature and explores the effect of early participation in a language intervention programme, with vocabulary skills and verbal reasoning skills as a particular focus. However, the intervention is not described because the spotlight is upon age when the child entered the programme. A statistically significant

relationship was found between age of enrolment and progress made. High levels of family engagement also produced a positive correlation on the same measures. An unexpected finding might be that degree of hearing was not a ‘significant predictor of language outcome’. Given the intervention itself is not described in any detail, this renders the study of little use for the purposes here. This study provides evidence of moderate quality.

4.14 Invalson and Wong (2013) discuss in their literature review some of the most important and iconic studies in the field providing evidence that language delays of deaf children with cochlear implants may be attributed to higher-level auditory skills and cognitive deficits. They also discuss available training programmes to promote the above skills which are linked to successful acquisition and development of language by deaf children. The review identified only a handful of studies targeting auditory skills of children with cochlear implants. The majority of studies used single case study design and employed auditory verbal training. In the field of cognition of children with cochlear implants, the review identified two studies which aimed to train working memory to promote language skills of those children. Although gains in working memory were not maintained, the authors of the review suggested that it is possible to improve language performance of children with cochlear implants by providing training of those underling skills (i.e auditory and cognitive) which is tailored to individual child’s needs (e.g. some children need more support in cognitive than auditory skills). The nature of the Ivalson and Wong review was such that there is no information on how the studies were identified - no systematic way was used - and as a result, important studies in the field might have been omitted. However, the review was judged of moderate to high impact as the interventions were discussed from a critical perspective and details of individual interventions were provided. Despite the limitations of the review, the authors concluded that: “Training cochlear implant recipient children to link the sounds they hear to the objects they perceive could improve both their language performance and their ability to successfully navigate their multisensory world” (p.6).

4.15 The two authors, Invalson and Wong, are joined by Young (2014) to research the effect of auditory-cognitive training on the spoken language performance of young children with cochlear implants. Their hypothesis is that spoken language will be improved by improved phonological awareness and improved working memory in children with cochlear implants. In a quasi-experimental study, nineteen 4-7 year old participants were allocated to two groups, one receiving the intervention on phonological skills and auditory working memory, the other forming a control group. The training was via an interactive software programme by Earobics. Significant gains for the intervention group for expressive language and composite language were reported. Limitations of the study are noted, for example the inability to say which skills are being improved, which in turn relate to the improvement in spoken language. This is a well-conceived study and, with the proviso that the software is still available, may be of further use. This study provides strong quality of evidence.

4.16 A study which might well have appeared in the 'inclusion' section instead of here is the case study reported by Gunning (2018). The account describes a whole school approach by a mainstream school in the Republic of Ireland to encourage Irish Sign Language (ISL) development in a child with moderate conductive hearing loss and her peers. Weekly sessions for child, staff and peers are documented, starting with basic signs and progressing with incentives such as prizes and a points system through the weeks. Signing was encouraged both in the classroom and at playtime. A challenge of signing three to four sentences in a week is mentioned, but it is unclear as to how far the deaf child herself has progressed. She uses signs 'daily' and is 'far less frustrated' but, because this is a report of an intervention, rather than one which has been specifically set up as a research study, pre and post measures are not included. Although the whole-school approach to inclusion is to be applauded, there is little of a specific nature to be drawn from this study and as a result its evidence was judged as impressionistic.

Available evidence – auditory training

4.17 Ertmer et al. (2002) describe the bespoke rehabilitation programmes for two children who have received cochlear implants. In a case study design, the results of auditory training and speech production intervention were analysed. Progress was described as 'substantial' or 'slow' for these two children, but no formal assessments were used. However, the reasons for the different rates of progress are speculated upon in detail. Because the interventions are tailored to individual cases, and one appears to produce limited success, the study is of little general interest. This study was rated as providing impressionistic evidence.

4.18 Rochette and Bigand (2009) sought to engage children in auditory training through the use of a 'sounding platform'. Six children engaged in a 20 week experiment through play and built in tests. The authors report an improvement in non-linguistic elements, specifically accuracy and processing times. The sounding platform is a very specific piece of equipment which makes the intervention non-replicable.

4.19 In a recent study Roman et al. (2016) investigated the effects of using a specific piece of equipment 'Sounds in Hands' on auditory performance in a group of cochlear implanted children of primary age. They also investigated whether this auditory training would transfer to a phonetic discrimination test. Rationale for the specific intervention is lacking and the equipment is not readily available so, even though positive outcomes are reported, this study is not useful for the present purpose and, therefore, was deemed to have moderate evidence of impact.

4.20 Mishra et al. (2015) produced a paper exploring listening-in-noise with a cochlear implant. At first glance, listening-in-noise might be regarded as an area which is tangential to communication per se. Nevertheless, as the study concerns itself with *speech*-in-noise it is felt appropriate to include it here. The intervention, which was home-based, consisted of speech-in-noise tasks, delivered via the software Angel Sound over a period of 5 weeks (40 hours in total) to 13 children with cochlear implants whereas 14 children with cochlear implants served as controls and received no training. They

assessed speech-in-noise performance of all 27 children before and after 5 weeks of the training. Following training, ability to perform all speech-in-noise tasks improved for all trained children. Effects were 'stable and generalised', leading to the authors' conclusion that such home-based auditory training might be included as part of the cochlear implant rehabilitation programmes more widely. What is not explained is the drop-out rate over the period of the intervention – from 13 to 11 children. The auditory training schedule appears to be intensive and repetitive, which might lead to boredom and disaffection which may be a contributing factor to drop-out. The manufacturers of Angel Sound point to its application for those with hearing aids and with auditory processing disorder. This study was rated as being of moderate quality.

Available evidence – Parent-child communication

4.21 The quality of parent-child interaction is under scrutiny in a study by Lam-Cassettari et al. (2015). The technique of video-feedback was employed to enhance parental self-esteem and parent-child communication using a 'psycho-social' video intervention technique. In a study involving fourteen hearing parents with their young deaf children, families were assessed in three sessions of play with their children, using Emotional Availability (EA) Scales, with an additional control group. A 'large effect' on the majority of EA subscale measures is shown pre and post intervention, and the self-esteem of mothers is also significantly improved. Focus is on the parental interaction rather than gains for the child (although there may be assumed to be an effect.) Although quality of parent-child interaction is important, it is doubtful whether, unless this definitely translated into effect on child's communication and language, this might be a focus for concentration for the teacher of the deaf, even a peripatetic one. This study provided moderate quality of evidence

4.22 Roberts et al. (2012) employed a small randomized group design study to investigate a 'parent-implemented' language intervention with their deaf toddlers as a pilot study. In a small randomised study a group of 34 children were divided into an intervention and control groups and entered into a 24 week bi-weekly pattern. Parents engaged in a training session in a teach–

model–coach–review method of parent training. Children in the intervention made greater gains on most language measures. The authors were able to report that the level of the child's receptive language and 'parent matched turns' predict expressive language gains. The important point is made that parents can learn strategies and that these can be employed to facilitate language development. This study provided strong quality of evidence.

Available evidence – Speech production

4.23 Hidalgo et al. (2017) examine whether musical rhythmical training can affect the temporal adaptation in speech interaction for deaf children – hearing aided and cochlear implanted. Details of the test procedure are complex but it appears that children who received the musical training improved in a skill which relates to 'temporal regularity of the speech exchanges' and 'temporal anticipatory skills'. These are needed in more complex interactional situations. There are limitations to this study: not least that the details of the musical training are not available. It has been rated as moderate in terms of impact but in reality may not merit much attention as details of the intervention are not available.

Available evidence – gesturing aids

4.24 Vendrame et al. (2010) examined the effect of gesture on disambiguation of meaning. There has been hesitation as to whether to include this study as the age range is 19-40. However, with the draft Additional Learning Needs Code (2017) which was published by the national assembly for Wales as part of scrutiny of the Bill now covering an age band of 0-25, it is included. Its relevance to younger children can also be speculated upon. The question the researchers set themselves is whether gesture has an effect on discourse recollection and memory for discourse verbatim. In a randomised control design (N=16) participants were presented with gestured and non-gestured versions of fictional events. Results appear to indicate that while co-speech gestures impair the recollection of discourse verbatim, on the other hand they assist in building a mental model of discourse content for oral deaf people. The case is also made that gestures disambiguate words which might otherwise be obscure and, therefore, improve comprehension.

The quality of this study was rated as being of moderate quality because of question marks over its generalisability and the lack of comment about limitations.

Available evidence – dance and song

4.25 Controversially, a study by Vongpaisal et al (2016) on the effect of dance movements on song learning in cochlear implanted children is included here. It could be argued that singing might comfortably sit elsewhere in this study. However, singing is a form of communication. In a control group design, nine deaf children were matched with nine hearing children and learned songs under two conditions - with or without dance. Effect was judged as to whether a child could recognise a correctly tuned song after the intervention. The authors claim a 'better than chance' effect on song learning for those songs that had been learned accompanied by dance. There is *some* rationale for learning songs with dance but it appears very speculative. Implications for practice seem limited and so it is rated as having a modest impact at best.

Implications

4.26 Communication is a broad concept encompassing a wide range of approaches. Most of the identified studies focused on the development of spoken language employing auditory training. Research on the use of manual communication has attracted less attention. Advances in technology such as digital hearing aids and cochlear implants provide better access to sound and, as a result, the majority of interventions focused on the development of speech production and spoken language. The research evidence offers the following steer:

- There is clear evidence that interventions to develop spoken language skills of deaf children have to be implemented from an early age: early identification and as a result early intervention is key to language development.
- Linked to the above, parents can play an important role in the development of communication skills of deaf children. What is unclear is the way that parents can enhance communication and language skills. The

use of video feedback of social interaction between parents and children, although effective in promoting parent-child interaction, provides little evidence to the development of the child's communication and langue skills per se. However, there is strong evidence that methods of parent training such as the teach–model–coach–review method can impact significantly on the development of expressive language of deaf children. Peripatetic teachers of the deaf, sometimes in conjunction with their speech and language therapist colleagues, can offer families systematic language intervention courses.

- The development of spoken language of deaf children can only be supported effectively when also targeting other aspects of development interlinked with language, such as phonological awareness and cognitive skills.
- Evidence on the effectiveness of auditory training and other 'early interventions' focusing on the development of listening and spoken language skills is inconclusive. Although play-therapy-based interventions such as auditory verbal therapy can develop speech production and listening skills of deaf children, the interventions identified in the REA lacked details of their implementation and effectiveness.
- Musical training, although providing little evidence, can potentially play a role in speech interaction between deaf and hearing children.

4.27 In a separate area of communication development some evidence exists that the use of a whole school approach of using sign language can promote communication between deaf and hearing children. However, it is suggested here that this aspect of communication is closely linked to the aspect of 'interaction' and further evidence is provided in the sections of inclusion and social-emotional functioning.

Literacy

Introduction

4.28 Literacy as the ability to read and write is crucial for the academic achievement of all children. Hearing children enter school with knowledge about the forms and functions of written language (i.e print knowledge). It is essential to consider here the prerequisites to develop the ability to read and write. The link between language skills and literacy development is well established for hearing children. According to the simple view of reading (Hoover and Gough, 1990), the two core components underlying reading skills of hearing children are: decoding (underpinned by phonology) and linguistic comprehension (underpinned by vocabulary). Similarly, the ability to master the mechanics of writing (grammar, spelling, structure etc.) is predicted by phonological and visual-motor skills (Mäki et al., 2011). The children's performance in the mechanics of writing can predict composition coherence.

4.29 However, deaf children might have limited print knowledge when they enter school as they lack the auditory input. This knowledge is acquired in a variety of ways including incidental learning and interaction with adults. However, in the last decades there have been a number of advancements and developments both in the diagnosis and amplification of hearing loss; with the roll out of the new-born hearing screening in 2005 in the UK babies are now diagnosed within a few weeks. Digital hearing aids and cochlear implants received earlier in children's life as a result of the early identification are likely to have an impact on language and literacy skills of deaf children. Although the impact of cochlear implants in the language development of deaf children has been well documented (Archbold,et al., 2000; Geers, 2002), evidence about the impact on literacy has been inconsistent. Whilst some studies in the US have demonstrated that children who have received implants early in their lives have achieved age appropriate skills in reading (Geers, 2003), studies in the UK have showed less positive results with some deaf children not achieving age appropriate reading levels (Harris et

al., 2017a). Thus, the case remains the same; some hearing impaired children still lag behind their hearing peers in literacy skills.

4.30 In order to develop appropriate interventions to support those children, identification of the factors that influence the various aspects of reading and writing is essential. Whilst predictors of literacy for hearing children are established there is much less consistency in the key elements which are likely to predict literacy skills for deaf children. The most compelling evidence on the predictors influencing literacy skills for deaf children is presented by longitudinal studies (Kyle and Harris, 2010; Harris et al., 2017b); although these are rare. English vocabulary, speech reading and phonological awareness have been found to be the more consistent predictors for deaf children's reading skills. Studies on the development of writing of deaf children are scarcer. According to a systematic literature review (Mayer and Trezek, 2017), children with cochlear implants perform lower in writing skills compared to reading.

4.31 To sum up, language skills are interlinked with literacy skills and despite the early identification and enhancement in technology, deaf children require continuing support to develop their literacy skills.

4.32 The included intervention studies reflect the scarcity of evidence on writing skills for deaf children. The main focuses of these studies are vocabulary and phonological awareness. However, very few studies have included a large sample enabling generalisation and drawing safe conclusions about the studies' effectiveness to promote literacy skills.

Available evidence – phonology

4.33 Reading is the area of literacy which has attracted more interventions. One debate is whether to target specific skills which predict/ contribute to reading skills or to target reading as a whole. In the area of phonology there has been a debate on whether phonemic skills such as phoneme deletion, alliteration and segmentation or phonological awareness such as onset and rime should be targeted for deaf children. Given that phonology instruction has its greatest impact on the early stages of reading development before formal schooling, interventions on either phonemic or phonological

awareness have typically included early readers, either pre-school children or children in early years.

4.34 Gilliver, Cupples, Ching, Leigh, and Gunnourie (2016) compared the efficacy of two interventions; phonological awareness and vocabulary which both targeted the same pre-set list of words, (included at pre and post-test). A total of 30 children aged 57 months on average, with functional bilateral hearing loss using spoken language were randomly assigned in the two groups by an independent researcher, matched on their vocabulary and phonological awareness skills at the pre-test and participated in 21 sessions lasting six weeks. The target words the participants were asked to blend in the phonological awareness intervention and the same words the participants were asked to recognise for the vocabulary group were presented using interaction tablet games. Children in both intervention programmes showed improvements in both conditions and phonology awareness followed the development of hearing children. The rigorous design of the study (participant allocation, selection of target words), the sample size and the details provided about the intervention sessions all contributed to this intervention been judged of high quality.

4.35 Explicit instruction of phonological awareness was also one of the areas of focus of a reading intervention called Foundations for Literacy (discussed later in this section). A multiple baseline single-case design showed that this programme was effective to promote phonological skills of individual cases (Miller et al., 2013). However, there was no evidence that the enhancement of children's phonological awareness was solely a result of this specific intervention (i.e any explicit phonological instruction might have yielded the same effect). Despite the small sample, and limited generalisation, the evidence was judged of high quality due to the rigorous design of the intervention programme, the clarity of the study's objectives and the quality of the outcome measures.

4.36 The impact of explicit instruction of phonics on children's skills to acquire understanding and generalisation of phonic skills and consequently identify words was investigated by Trezek (2005). A systematic, explicit remedial

phonics programme (the corrective Reading-Recoding series) was adapted (i.e use of visual phonics, computer tutor etc.) to address the visual representation needs of 11 deaf children aged 12-14 years of age with mild to profound hearing loss. The strengths of the study are the quasi-experimental pre- and post-test research design and random allocation of the participants in two groups. Despite the fact that phonemic awareness and phonic skills were the only reading skills assessed, this study was judged as demonstrating strong evidence given the rigorous research design, the high ecological validity and the relatively large sample size.

Available evidence – phonology vs morphology

4.37 The impact of phonological and morphological training on speech production and perception and eventually on reading skills of deaf children was explored by Bow et al (2004). The study followed a multiple base line-balanced experimental condition. Seventeen children of primary school aged with various degree of hearing loss and both hearing aids and cochlear implants were assigned to two groups which received training either on phonology (i.e production of specific phonemes at the end of the words) in the first training session and morphology (i.e grammatical structures) during the second session and vice versa. The intervention was judged of high quality.as it was effective in promoting both morphology and phonology independently. This was a well-designed study with high ecological validity and of great value to participants.

4.38 Encina and Plante (2016) examined the feasibility of a language treatment method that combined enhanced conversational recast treatment with auditory bombardment for young cochlear implant users. As a feasibility study using a multiple probe design it only targeted three children. This intervention study indicated positive outcomes for two out of the three children who showed significant gains on target morphemes after the intervention. This study demonstrated a moderate quality of evidence: the information provided about the theoretical framework of the intervention; and the discussion about the suitability of the outcome measures and of the limitations of the study were limited.

Available evidence – vocabulary

4.39 Interventions focusing on explicitly supporting vocabulary as one of the two core elements of reading have mainly focused on: i) explicit instruction of vocabulary and ii) the use of technology and /or games to teach vocabulary.

4.40 Bobzien et al. (2015) used story book reading with explicit instructions to teach novel words to four pre-school children with a bilateral hearing loss of various degrees. All children showed an improvement in their vocabulary. This was a very well designed study of high quality with clear results (i.e vocabulary learning was generalised and maintained for each child). The strategies used could be incorporated into the curriculum and translated into the classroom. However, it remains unclear if it was the combination of the story book reading with the explicit instructions or just one of those strategies which contributed to the effectiveness of the intervention. The use of explicit instruction of vocabulary was also explored by Hermans et al. (2016). However, the emphasis in the latter study was on vocabulary instruction via the collaboration of teachers and speech and language therapists. The effectiveness of the six month intervention (i.e co-teaching of teachers and speech and language therapists) was mainly based on the development of teachers' vocabulary instruction skills. As this study was discussed as part of a book chapter, limited information was provided about the characteristics of the participants and the outcome measures. Thus, it was rated as being of impressionistic evidence. Researchers from the same team also investigated the use of augmentative signs to promote vocabulary skills of children aged 9-11 years old. The total sample of 52 children consisted of 16 deaf children, 19 hearing and 17 with specific language impairment. Children were presented with pictures of imaginary creatures and pseudo words. Half of the words were accompanied by an augmentative pseudo sign. During the intervention which comprised of four sessions a week (20 minutes each session) the children were presented with pictures of aliens accompanied by pseudo words (half of the words were accompanied by an augmentative pseudo sign). The findings suggested that only the deaf children benefited from the augmentative signs (i.e not the children with specific language

impairment or the hearing children) and scored higher on words for which the signs were provided during the intervention period compared to the words for which no sign was given. Although no receptive or expressive vocabulary assessment was used, the study provides evidence that Sign-Supported speech in bilingual settings can support the spoken language development of deaf children. This study was judged of high quality.

4.41 The use of technology as a medium to promote vocabulary of deaf children is central to a number of intervention studies. For instance, the 'endless alphabet', an iPad application was delivered - three days a week (each session lasted 15 minutes) for five weeks - to two deaf children with cochlear implants and two hearing children, all of pre-school age (Brouwer et al., 2017). Despite the short duration of the intervention, all participants improved in letter-sound knowledge, phonemic awareness and vocabulary knowledge. The evidence of the 'endless alphabet' application is of moderate impact and the intervention has to be implemented on a larger scale. Another study by Cannon, & Kirby (2013) explored the use of LanguageLinks software which is designed to teach students grammatical forms such as determiners, tense, and complementizers, Twenty-six children with a moderate to profound hearing loss, aged 5-12 years used the software for ten minutes per day (one session), five days per week, for nine weeks, and were supervised by the participants' classroom teachers. However, in this study the use of software to promote language skills of deaf children was not effective. This is a study providing impressionistic evidence. The outcome measures used were not clear and there was no control group. The study has limited use for practitioners.

4.42 Interactive technology to support deaf children's vocabulary was used by two intervention studies. Both Barker (2003) and Massaro and Light (2004) used a computer animated tutor (i.e an avatar) called 'Baldi' to support deaf children's expressive and receptive vocabulary. The purpose of the intervention was to ensure that the children have associated words with their images. Words already known at the pre-test were used to produce baseline scores. During each training lesson, the students would progress through a series of exercises: presentation, perception of the words, reading, spelling,

imitation, elicitation and post-test. Both studies followed the same intervention sessions and they both employed a small number of children. In Barker's study 16 deaf children with profound hearing loss and three hearing children aged between 8 to 14 years took part. Whereas in Massaro and Light study only eight children aged between 6 and 11 years with mild to severe hearing loss were included. However, the two studies followed different research designs. One of the weakness of the single case study design (Baker, 2003), was the lack of comparison group ,whereas Massaro and Light used a within subject multiple baseline design which eliminates the need of a control group as each participant serves as their own control. Both studies showed that the computer animated tutor is an effective way for the direct instruction of vocabulary and grammar for deaf children as students demonstrated rapid learning of the words. Despite the effectiveness of the intervention, the small sample sizes that both studies employed and the difficulty in generalising these findings contributed to both studies being judged of moderate quality.

4.43 Teaching vocabulary to deaf children via games was also investigated by two intervention studies. Brennan (2000) described how they thought the use of 'Sign-o', a sign language game, supported children to remember sight words. The author acknowledged there were no studies conducted to prove that the growth of the children's sight vocabulary was due to the use of this game. Thus, this study provided impressionistic evidence as there is no information about the design of the game, the participants and the outcome measures. In contrast, a multiple baseline study (Davenport et al., 2017) with two preschool age deaf children (with profound bilateral hearing loss) demonstrated that picture racetrack game can be effective on the acquisition, maintenance, and generalisation of expressive sign language vocabulary for deaf children. The baseline assessments determined the known words by the two participants. During the intervention sessions, the children practiced new signs in relation to photo cards. Despite the very small sample, the study employed a simple technique which has a potentially high level of application to the classroom. It is low cost, takes little time to construct and there are many photos available online.

4.44 The effect of vocabulary training was also evaluated by Paatsch et al. (2006). Twenty-one children of various degrees of hearing loss, aged between 5 years 9 months and 12 years 2 months, participated in the study. The participants were assigned either to a group teaching speech production skills or to a group teaching specific words (vocabulary). The children were allocated to the group according to the teacher's availability to teach the specific programme. Both groups of participants received both training sessions but in opposite order. The intervention was effective in promoting word knowledge, speech production and perception and provided high quality of evidence.

4.45 Another intervention of high quality was conducted by Bennet et al. (2014) to promote children's ability to respond to a picture prompt by producing grammatically correct sentences (either using spoken language or English based sign system). The Language for Learning curriculum which consists of 100 lessons about a number of different strategies of learning language such as actions, description of objects, information and background knowledge etc. was implemented to four 11 year old children with moderate to profound hearing loss. The study used a single-subject, concurrent-multiple-probes-across participants design. The results indicated there was a causal relationship between the Language for Learning curriculum and increase in children's language accuracy.

Available evidence – grammatical knowledge

4.46 Another specific aspect which affects deaf children's production of language is their difficulty in producing grammatically correct sentences. Two interventions were identified in this area. They both used the language modelling strategy to promote the correct use of different grammatical aspects to deaf children. Richels et al. (2016) included three pre-school age children with moderate to profound hearing loss in the intervention. Data from the multiple - probes - across participants design indicated that all children were not only able to answer 'wh' questions appropriately but were also able to correctly respond to untrained stimuli. The study was rated as being of high quality. However, the second study by White and Tripoli (1996) is also a single case design and also used a language modelling strategy (

i.e Compact Language Drill) requiring the child to listen / watch a language model and imitate it. The intervention was effective as the only child who participated in the experimental condition was able to make significant gains in production of irregular verbs. Despite the apparent success of the intervention, safe conclusions of its effectiveness cannot be drawn. Thus, the study was rated as providing impressionistic evidence. The study involved only one child and there is very little information on whether it was solely due to the intervention that the child improved and not because of other teaching strategies.

Available evidence – reading comprehension

4.47 Linked to the importance of acquiring vocabulary, according to the simple view of reading as discussed in the introduction of this section, is the need to provide specific support to promote reading comprehension of deaf children.

4.48 Nine secondary school deaf children with mild to severe hearing loss participated in a randomised, counterbalanced cross over design in which they were randomly allocated in two groups (Anderson-Inman et al., 2009). Two conditions, one experimental in which the students viewed videos with expanded captions and one control condition, in which the students viewed videos with standard captions, were employed. Both groups participated in both conditions in an alternating order. Although students indicated that they preferred videos with extended captions, the intervention was ineffective as children did not perform significantly better in post-test multiple choice questions compared to their scores before the intervention. The study provided evidence of moderate quality. There is limited information about the duration of the study and the impression that the reader gets is that all sessions (pre and post- test and intervention) took place on the same day. The main weakness of this intervention was that it focused only on students watching the videos but not on their understanding of the video content which seemed difficult for the participants to capture.

4.49 One of the very few interventions focusing on supporting sign vocabulary was developed by Andrews et al., (1994). During the intervention the teacher told a fable using American Sign Language (ASL), the students then had to read the story, retell the story (based on what they remembered) and finally reflect on the moral message of the story. Using this simple technique based on building background knowledge using ASL vocabulary the seven participants made improvements in retelling the stories and understanding the moral message of the fable even when interventional questions were asked. However, there was no pre-test data collected and the baseline was based on hearing children's performance of the task. The intervention was judged of moderate quality. This ASL intervention technique can potentially be effective to teach summarisation skills to deaf students but more evidence is needed to (e.g intervention over a longer period of time, larger sample, pre-test etc).

4.50 The use of signed English systems by teachers in bilingual settings and its relation to reading skills of deaf children was also investigated by Wilson and Hyde (1997). Sixteen students between 8-13 years with severe to profound hearing loss participated in the study. During the intervention two books were used. One book had only text whereas in the other book Australian Signed English pictures accompanied the text. Students performed better in reading comprehension questions and on a story retelling task with the Australian Signed English text. Although the authors suggested that the use of Australian Signed English pictures in association with printed text can facilitate the reading comprehension of deaf children, details about the intervention are missing and as a result the study provided impressionistic evidence.

Available evidence – story telling

4.51 Researchers in Israel compared the use of virtual reality (three dimensions) to a pictorial presentation to enhance storytelling skills of deaf pre-school age children. The same scenarios (virtual and pictorial) were used by the team to support flexible thinking of deaf children (Eden and Passig, 2007 - see cognitive section of this report) were presented to 65 deaf children aged 4-7 years. The participants in the virtual reality group demonstrated more

significant improvements in their storytelling skills compared to the pictorial presentation group. The intervention was rated as being of moderate to high quality: despite the large number of participants only one measure to evaluate storytelling ability was used and the intervention is of little use to practice. A moderate to high quality intervention was implemented by members of the same team using the same pictorial scenarios to support 34 deaf children aged 4-7 years. The results suggested the intervention was successful in promoting time-sequential perception and storytelling skills of those deaf students, although no control group was included.

Available evidence – strategies to support reading achievement

4.52 In contrast to the theory that phonological skills should specifically be targeted, other intervention studies explored a range of strategies in promoting reading skills of deaf children. One theory is that deaf children need visual strategies in order to learn how to read. Herrera-Fernandez et al, (2014) assessed the effectiveness of an intervention incorporating visual strategies (i.e fingerspelling and sign language) in two sessions a week for six months. The 24 prelingually profoundly deaf children performed significantly better in the standardised reading test following the intervention compared to their pre-test results. No comparison group was used and the procedure of the actual intervention was not described in a detailed way which makes the intervention difficult to replicate. The study was judged of moderate quality.

4.53 Visual strategies such as fingerspelling and visual phonics were also used by an intervention programme called ‘Foundations for Literacy’ (Lederberg et al., 2014) which employed instructional strategies teaching foundation skills (i.e phonological awareness, vocabulary, alphabetic and letter sound knowledge). The study followed a quasi-experimental design with random allocation to experimental and comparison group. A total of 25 moderate to profoundly deaf children, using either spoken language or spoken and sign language, were taught for 24 weeks (four hours a week) in small groups of three to four children by their teachers who received training on the intervention. Each unit is organised around a story (referred to as the Miss

Giggle Letter-Sound stories) that teachers use to explicitly teach letter(s)-sound correspondences and vocabulary in a language-rich narrative context. The rigorousness of the design and the effectiveness of the intervention (i.e significant improvement of reading for the experimental group) call for a large randomised control trial with a bigger sample size. The intervention was judged of high impact.

4.54 Another comprehensive, intensive intervention programme using a range of strategies to promote language and reading skills of deaf children is the Experimental Project in Instructional Concentration programme (Moog and Geers, 1985). Fifteen children 8-11 years of age with severe to profound hearing loss participated in the 3 years programme (i.e experimental group) and 18 children with the same characteristics were allocated to the control group. A number of standardised tests were used and the children in the experimental group demonstrated accelerated progress. However, the study was of impressionistic to moderate quality as there was little information about the intervention and specific details were missing. However the programme can be a useful tool for practitioners.

4.55 Adult-child shared book reading was the focus of three interventions involving both deaf and hearing children. The study by Pataki et al., (2014) investigated the effect of themed play on engagement in story book reading whereas the study by Robertson et al. (2006) used shared book reading to explore its effect on children's memory for text content. Deaf children in both studies demonstrated significantly higher engagement during story book reading in the experimental condition. This indicated that by enriching the context of the story book reading deaf children are able to engage with the activity and interact with the reader more. Despite the small sample and the lack of control group, the intervention by Pataki et al., was effective and rated as being of high quality (i.e. in contrast, the study by Robertson et al. was of impressionistic evidence as information about the procedure of the intervention was limited). The third intervention (Pakulski & Kaderavek, 2012) used shared book reading with deaf-hearing reading buddies to promote narrative production, narrative comprehension and reading motivation interest in deaf children. Out of the two conditions used in the

study (i.e reading only vs reading and manipulatives), the condition in which the shared book reading was accompanied by manipulative objects (e.g toys representing the characters of the story) was the most effective in enhancing narrative quality and comprehension of deaf children. Despite the small size (N=7), the intervention was judged of high quality and reflection and evaluation of the findings was provided by the authors.

Available evidence – writing

4.56 The enhancement of essay writing, central to college students, was the focus of the intervention developed by Berent et al. (2009). Thirty four college students with a profound/ severe hearing loss and with a mean age of 20 years were assessed in grammatical knowledge based on the production of a short- essay topic during the first and last weeks of a ten week course and again five months later. For eighteen of those students (enhancement group) their tutors provided enhanced grammatical instruction (i.e a plus sign before each successfully produced grammatical structure and a minus sign before each incorrect grammatical structure) whilst the other sixteen students did not receive conventional grammatical instruction. The findings suggested that the students in the 'enhancement' group demonstrated a significant improvement in their productive grammatical knowledge and were also able to maintain this progress five months later. Thus, this intervention was rated as being of high quality. However, it did not provide any information either about the students' allocation to the two groups or about the improvement of the participants in each of the nine specific target grammatical structures separately.

4.57 Enhancement of story writing skills was also the focus of a modified curriculum implemented to a class of six children (aged 10 to 12) at a school for the Deaf (Bonnickson, 1985). The modified curriculum aimed for the students to: understand known concepts, provide a language model, increase vocabulary and use it in stories, provide adequate time to master reading and language, provide successful reading experiences and promote independence. This study provided only impressionistic evidence. Hence, the study employed a small sample and the information about the process of the intervention was limited.

4.58 Writing as a holistic process and more specifically writing assignment skills was also the focus of two studies employing different research designs. The first intervention used a holistic approach to writing instruction based on process-oriented writing, Norwegian sign language, drawings, and word processing augmented with a Predictive Adaptive Lexicon (PAL), a word prediction programme. This is a dated intervention, with limited information about the theoretical underpinnings of the intervention and on the outcome measures, providing impressionistic evidence. In contrast, the second intervention looking at writing as a process, used multi-probe design and was rated as being of high quality. Wolbers et al. (2015) involved 31 children with a severe to profound hearing loss aged between 8 and 11 years. Similar to the aim of the Norwegian study, the authors aimed at promoting the skill of children to write for a variety of purposes and audiences. The teaching of explicit strategies for writing (i.e Strategic and Interactive Writing Instruction) was effective as deaf children after the intervention produced better reports and pieces of persuasive writing. The study provided evidence of moderate quality.

4.59 Intervention studies in writing skills of deaf children focused also on specific aspects of writing. For example an intervention study by Haptonstall-Nykaza & Schick (2007) explored whether fingerspelling can provide a link between phonology, semantic meaning and English orthography. A total of 21 deaf children aged between 4 and 14 years educated in bilingual settings (i.e using both spoken and sign language) were trained in two different conditions: (a) Sign condition (i.e the English word and ASL sign were matched, and (b) Fingerspelling condition (Fingerspelling), where the lexicalized fingerspelling, the sign, and the English word were matched. Children in the fingerspelling condition performed better in writing and fingerspelling than in the sign condition. The study provided evidence of high quality: the study employed a good sample size and the design was based on sound theoretical and empirical evidence. However, there was limited information on the matching of the two groups and on the duration of the intervention, and these limitations were not discussed by the authors.

Implications

4.60 Literacy is one of the most researched areas in the field of deaf education. Most of the research focusses upon reading rather than writing. Going back to the simple view of reading, the two underlying core components of reading (i.e phonology and vocabulary) have been targeted separately in the majority of the interventions. Although few interventions focusing on a range of strategies to promote reading of deaf children have provided strong evidence. Evidence on other aspects of literacy such as grammar and storytelling has also been identified.

Phonology

4.61 Acquisition of good phonological skills has for very long been a strong predictor of reading achievement by hearing children. However, the important role that phonology plays for the development of reading skills of deaf children has been established relatively recent. The following implications can be drawn:

- Phonological instruction has its greatest impact on the early stages of reading development, before formal schooling and as a result effective interventions typically include either pre-schoolers or children in early years.
- There is strong evidence that phonological awareness and, as a result, reading skills of deaf children can be enhanced by explicit instruction focusing on blending which provides a secure strategy for reading.
- Visual phonics address the visual representation needs of deaf children and as a result can assist in acquisition of phonemic skills.
- There is evidence that morphology and phonology can individually be enhanced using explicit instruction.

Vocabulary

4.62 Vocabulary is one of the two core elements underpinning reading skills. There is a discrepancy between the need for interventions intended to increase vocabulary for pre-school children who are deaf and the lack of intervention-based research that exist. Most young children who are deaf would benefit from a targeted intervention using evidence-based instructional

methods (i.e. direct instruction). There is a growing body of research on vocabulary interventions with pre-school children who are deaf. The evidence on the effectiveness of interventions explicitly targeting vocabulary skills offers the following steer:

- There is strong evidence to suggest the use of story book reading with explicit instructions can enhance the learning of novel words by deaf children.
- The teaching of novel words with the support of augmentative signs has also proved effective for teaching new vocabulary.
- The evidence on the use of software to promote vocabulary skills of deaf children is inconclusive. There is little evidence to suggest the use of technology itself has a direct effect on vocabulary skills. However, there is strong evidence that the use of interactive software (e.g the use of animated tutor) to provide explicit vocabulary instruction is effective.

Mixed strategies

4.63 In contrast to interventions which focus on specific elements which promote reading, the most effective interventions are the ones which target various strategies that contribute to reading achievement. The following implications can be drawn:

- There is strong evidence that the use of visual phonics in conjunction with explicit teaching of vocabulary can support early reading of deaf children.
- Explicit teaching of phonological awareness, vocabulary, alphabetic and letter sound knowledge provide the foundations of literacy. The key to the success of the intervention targeting the above skills is the systematic and explicit way in which these skills are taught.
- Thematically-related play may lead to increased interaction with the reader, increased participation and satisfaction, and positive emotion, particularly in children with hearing loss for whom early engagement in literacy is crucial to long-term success.
- Shared book reading can be effective in promoting narrative quality and comprehension of deaf children but mostly when it is paired with use of manipulatives (i.e objects related to the content of the story).

Writing

4.64 Wring skills, although less researched than reading skills were the focus of a number of effective interventions. An observation worth noting is that although (as discussed in the introduction of this section), reading and writing are complementary skills and are underpinned by the same core components (i.e phonological awareness and orthography), the identified interventions on writing for deaf children focused solely on writing skills providing no link to reading. Identified interventions of writing instruction can be distinguished into those which focus on writing as process and those on writing as product. Writing instruction taught as process is more effective than instructions where the focus is on the creating of the writing product. The research evidence offers the following steer:

- Essay writing of deaf children and college students can be promoted by offering enhanced grammatical instruction on essays. Specific instruction on correct and incorrect grammar can enhance deaf students' performance on productive grammatical knowledge.
- The use of a holistic approach to teach writing and specifically teaching children to write for a variety of audiences with a given purpose is effective for enhancing their essay writing skills.
- Teaching deaf children to write by making direct links between fingerspelling, sign words and English words can promote deaf children's writing skills.

4.65 Although there is some evidence that teaching writing as process can enhance writing skills of deaf children, most of the evidence is dated and does not come from the UK. Given that deaf children have lower achievement in writing than reading, school based interventions should focus on enhancing writing, in combination with reading.

Mathematics

Introduction

4.66 Research findings consistently show a gap between hearing children and their deaf peers in Mathematics. Results vary but this lag appears to be anywhere between 2 and 3.5 years, depending on the study, over the last 40 years. In a very large scale study (N=414), Wood et al. (1986) looked at the mathematical attainment of deaf school leavers. Hearing young people demonstrated mathematical skills equivalent to 15.5 years whereas the mathematical skills of deaf young people were equivalent to 12.3 years. Other studies also demonstrated that deaf children and young people underachieve in mathematics compared to their hearing peers (Qi and Mitchell, 2012). Studies also generally report that although deaf children progress in their mathematical understanding, they neither catch up nor fall further behind when compared to hearing children.

4.67 The reasons for this lag are not clear. Unlike other areas of learning, mathematical achievement seems to be unrelated to hearing thresholds (Marschark et al, 2013). Other possible factors have been researched: developmental delays in language (Gregory, 1998), disrupted experience of early (mathematical) learning in the home (Gregory, 1998) especially quantitative concepts (Kritzer, 2009), a low level of specialist mathematical teaching (Pagliaro, 1998) and differences in information processing (Marschark & Knoors, 2012). A combination of factors may be involved, which impact different children at different ages, for example language skills and educational background can both affect the ability to problem solve (Pagliaro & Ansell, 2012).

4.68 Language as a contributor seems to be a favourite possibility, considering the complex use of mathematical language. Consider for example the multiple meanings of mathematical language e.g., ‘This number is bigger than that number’ and the multiple words for a single concept (add/plus). The use of sign language, with its visual-spatial characteristic seems to hold out a form of hope, but researchers found that the use of sign may change the form of the problem to be solved, resulting in different interpretation by the child (Ansell & Pagliaro, 2006).

4.69 Nevertheless, what does emerge from the literature is the possibility that visual-spatial skills can be harnessed, through specific training, to assist deaf children with mathematical problem solving (Nunes & Moreno, 2002). Once harnessed and trained these skills need to be applied, via metacognitive awareness. For example, better results may be achieved if students explain a problem as they see it and describe possible strategies for solving it. They learn to do this by experiencing a teacher modelling the technique.

4.70 If deaf children fail to gain early mathematical concepts in the home, there is the chance of re-directing parents' attention to providing opportunities in the home for early learning of both concepts and language. The interventions described below explore these possibilities.

Available evidence – general mathematics

4.71 Mousley and Kelly (1998) examined the effect of three different problem-solving strategies on the teaching of mathematics to forty-six deaf undergraduate students. The three strategies were: 1) peer observer with signed and written explanations 2) visualisation of moves prior to attempts to solve the puzzle 3) the teacher models the process for solving a sample problem. Students were randomly assigned to groups. The authors conclude that these instructional strategies can have a positive effect on mathematical problem-solving. The students' reading levels has an effect. Thinking more carefully and taking the time to visualise solutions should be beneficial to the results. This study provided impressionistic evidence.

4.72 Visualisation is a key teaching strategy within Nunes' et al work (2002) which looked at teaching core mathematical concepts. Implicit to the approach is the notion that hearing children learn mathematical concepts informally but deaf children need specific instructional chances to learn the same thing. A particular focus of this research was strategies which help children to approach time sequence questions. Designed with teachers and delivered by teachers in school, the programme is described in detail. One major strategy is the modelling of how to deal with a written question through visualisation (drawings and diagrams). At pre-test the 23 participants fared

no better than the baseline control group but at post-test were significantly better, and better than the pre-test results would suggest. Although the authors acknowledge the effect that other teaching styles of the teachers involved may have, nevertheless, this study provided evidence of strong quality. Nunes et al. pose the question, if deaf children need direct teaching of mathematical concepts, should they have more lessons and if visualisation helps them to problem solve should this be the general modus operandi?

Available evidence – early mathematical skills and the family

4.73 Kritzer and Pagliaro (2013) report on trialling the Hybrid Version of the Building Math Readiness Parents as Partners (MRPP). This is a scheme which encourages parents of deaf children to change their behaviour and the mathematical language they use in the home to stimulate early learning of mathematical concepts by their deaf children. The theoretical premise being that if otherwise implicit learning can be made explicit, the child may learn. This was a multiple-case/single-unit case study involving four families, who received training and were assessed by video. The research team witnessed a change in the mathematical behaviour and language of parents. What is not recorded is whether this had a facilitative effect on children's concepts, even though this was a stated aim. Clearly changing behaviour and language in this way may well be an important first step for change in what the authors describe as 'the historically poor performance of deaf children in mathematics'. However, this change in the parents' behaviour is as much as can be reported. This only takes the practitioner part of the way in deciding whether to invest energies in training parents, as it cannot be assumed to have an effect on the child. This study provided impressionistic evidence.

Available evidence – multiplication

4.74 In 2009, Nunes et al. published a paper on strategies helpful to deaf children in acquiring mathematical concepts, this time on multiplicative reasoning. The first half of this study devotes itself to analysing the multiplicative reasoning in young children, followed by an intervention using the strategy of 'correspondence reasoning' to solve multiplicative problems. In a large scale

study 527 five and six year old deaf children were matched with younger hearing children with the same cognitive ability. In a randomised control trial an instructor carried out two teaching sessions to the intervention group using full representation of the questions using ‘manipulatives’. This very brief intervention was shown to be effective for both hearing and deaf children, with significance being high in both cases, and the effect tailing off slightly at delayed post-test. As the authors say, this is good news for deaf children being educated in a mainstream environment. A longer intervention may have translated into more stable results. This study is meticulously designed and implemented with important conclusions for the teaching of multiplication to deaf children attracting a strong rating.

Available evidence – peer tutoring

4.75 In a short case study, Burley et al. (1994) explore the effect on acquisition of maths skills of having a hearing peer tutor for a secondary aged profoundly deaf girl. The hearing peer, who was proficient in mathematics tutored the deaf pupil in four key mathematical components for twenty minutes every day. After a brief period of intervention 70% accuracy was achieved in the key objectives giving rise to the authors’ assertion that hearing peers can successfully tutor deaf peers. The paper is sketchy on details of tutoring methods and it remains unclear as to why this method was more effective than previously tried methods by teachers. Given the limited details provided, this study provided impressionistic quality of evidence.

Implications

4.76 As typically hearing children progress through the education system they are assumed to be able to deal with word problem solving activities mentally, but deaf children may need visualizing means to solve word problems successfully. Marschark et al. (2002) propose that word problem solving activities, especially ‘story problems’ involve generic thinking skills as well as reading skills e.g. selective attention, analysis, use of analysis. Pagliaro and Ansell (2002) suggest story problems are an opportunity for deaf children to bring together their wider knowledge and schema to tackle the task, rather than being an aspect of maths that teachers shy away from, thinking children

do not have the linguistic or mathematical skills. In the US, Kelly et al. (2003) found the majority of mainstream teachers had specialist mathematical training, whereas only half of teachers in schools for deaf children had the same. It is not known how this compares with the situation in the UK.

4.77 Based on the evidence identified the following implications can be drawn:

- Teachers should stop avoiding 'story problems' (due to deaf children's impaired language skills) and instead use them as a teaching tool to encourage thinking skills, including synthesis of the child's word knowledge into the problem at hand.
- Lack of vicarious learning of early mathematical concepts can be mitigated by training and encouraging parents to use mathematical language at home from an early age.
- Deaf students can successfully tackle mathematical word problems when explicitly taught techniques of modelling a strategy, visualisation of word problems through drawings and diagrams, and through the use of manipulatives.
- Specialist mathematical teaching skills should be part of teachers of the deaf training as this knowledge has a direct impact on the choices that teachers of the deaf make about the mathematical curriculum.

4.78 To summarise, teaching deaf children explicit strategies, including visualisation techniques, on how to approach mathematical word problems is one way to contribute to the development of problem solving skills which are absolutely pertinent for the acquisition of independent skills by deaf learners.

Access to examinations

Introduction

4.79 This strategy area has a focus on studies describing the relative success of different assessment accommodations/modifications and of different ways to provide access to exams. Formal assessment of children through public examinations is a central feature of most education systems. However, for deaf students, their linguistic difficulties and the access to written forms of assessments can be a barrier to their ability to perform under standard

examination conditions. Under the Equality Act all schools, colleges, universities and awarding bodies are obliged to provide arrangements for all deaf children to access examinations in a fair way.

4.80 Access arrangements for deaf children can vary and depend on the needs of the individual student. Whether or not students will need alternative arrangements to access their exams will depend on the individual student and on the nature of deafness. Zebehazy et al. (2017) also make a similar distinction between testing accommodations or modifications:

- accommodations which are adaptations to the test or instructions that do not have an impact on the skill that is being tested
- modifications or nonstandard accommodations which are adaptations to the test that result in a change to the skill or skills being tested .

4.81 There is a range of available access arrangements for deaf students (NDCS, 2015). These are:

- Extra time: 25% extra time
- Modified language papers: the language and sentence structure of the exam can be changed so that students find it easier to answer the questions
- Live speaker: someone will read out a transcript of a recording (for exams that have pre-recorded parts)
- Reader: the transcript is read out for deaf students who face difficulties with processing written information
- Orla language modification: a person clarifies the wording of the question during the exams
- BSL interpretation: a BSL interpreter signs the questions or paper and the students reply in BSL can be filmed.

4.82 Qualified teachers of the deaf can act as assessors to the above accommodations except from acting as an oral language modifier for which additional specific training is required.

4.83 Research evidence of the success of the above assessment accommodations is limited, controversial and only based on international studies. For instance, Cawthon, et al. (2010) suggest that American Sign Language accommodation in reading and maths assessment did not influence (i.e there was no decrease or increase) the students' performance on the state standardised tests. However, the results should be interpreted with caution as there was no information on how the accommodation was implemented. In addition, given the absence of tests for American Sign Language comprehension or American Sign Language vocabulary, the impact of sign-based accommodations on students' performance has to be treated with caution.

4.84 Although research evidence on the effect of access arrangements on the performance of deaf students on public tests is scarce, deaf students' attainment on public assessments falls behind hearing students. For example, the NDCS commented on GCSE results published by the Department for Education stating that

> "The attainment gap between deaf children and children with no special educational needs (SEN) has widened. Deaf children are now falling 24% behind their classmates, and are achieving more than a whole grade less at GCSE"[4].

4.85 Given the underachievement of deaf students in public examinations, interventions on the effectiveness and appropriateness of different access arrangements are crucial.

Available evidence

4.86 No evidence was identified through the REA.

Implications

4.87 Given the importance of formal assessment and examinations in young people's lives, it is surprising there is no empirical research exploring the relative efficacy of different access arrangements for deaf students.

[4] NDCS Website

Nevertheless, descriptions of the available approaches to access arrangements is more established. The literature describes approaches which seek to make accommodations and modifications to assessments to aid inclusive learning and environment. This suggests the following implications:

- Deaf students should be enabled to adapt their learning environment and take responsibility of their own access arrangements at school.
- All aspects of teaching should be aligned with aspects of assessments and as a consequence the arrangements for access to examinations for deaf students should mirror the arrangements in place in their standard classroom and be part of their everyday learning.
- Technology (e.g. use of radio aids) has potential value for deaf young people as it provides a means to efficiently access assessment materials. This does assume that technology is embedded in young people's standard classroom and studying experiences and that professionals are knowledgeable of managing the latest technologies (Allen et al., 2017).
- Teachers of the deaf must ensure that the access arrangements for examinations are appropriate and meet the students' needs.

Mobility and independence

Introduction

4.88 Although mobility and independence have been considered together in this report, in the field of deaf education, interventions in relation to mobility mainly concerns deaf students with complex needs, whereas independence is a skill pertinent to all deaf students. Hearing loss alone is not a factor particularly identified as influencing mobility skills of deaf children. Students with complex needs include: deaf blind children, deaf with learning disabilities, deaf children with autism and deaf children with other physical disabilities.

4.89 Earlier studies on motor skills of deaf children without complex needs have reported difficulties in balance, general dynamic coordination, visual-motor skills, and ball catching abilities (Wiegersma & Velde, 1983). However, recent research evidence suggests that deficits in motor skills of deaf

children can be attributed to differences in educational settings and additional needs that deaf children experience. Thus, studies comparing the motor skills of deaf with hearing children suggested that there is no significant difference in the motor skills of the two groups. Further to these findings, Gheysen et al. (2007) examined the effect of cochlear implants on balance and motor skill development of deaf children and found no difference between children with and without cochlear implants.

4.90 Given the difficulties that deaf children might face in language and social emotional development (discussed in other sections of this report), some have argued that deaf children have traditionally been over-supported / over-protected which might result in habits of dependency and passivity (Powers, 2001). In this study, Powers (2001) emphasised that although scaffolding and explicit instruction and support to meet the needs of deaf students is extremely important, there is little emphasis on developing living and independent skills of deaf children. For example, providing one-to-one support to deaf children can sometimes hinder the opportunities for the child to take ownership for their own learning. Similarly, Valentine and Skelton (2007) suggested that deaf adolescents leave school with few 'life skills' as choices were made for them, the majority of times without their understanding or consultation. This can result in what Valentine and Skelton call a 'transition shock'. Deaf students experience a shock when they exit education where their needs were met (e.g. arrangement of interpreters or communication support workers) and they have to take responsibility of their own lives and make decisions for themselves.

Available evidence

4.91 Two interventions were identified in this REA, one focusing on balance skills of deaf students without disabilities and the other on independent living skills of deaf students with additional needs.

4.92 Tzanetakos et al. (2017) implemented a programme involving Nintendo Wii Fit Plus (exergames) and a traditional adapted physical education programme for the balance training of adolescents with deafness. This was a control trial with two groups of children (five children in each group) and

involved parallel interventions of the same duration (five weeks, two weekly sessions, 15 mins per session per student). The motor and balance skills of all the children were measured pre and post the intervention using the Flamingo Balance Test. This test is part of the Eurofit Physical Fitness Test Battery which is used for assessing the physical abilities (e.g. speed, endurance, balance) of adolescents aged 17 to 19 years. In addition, interviews were conducted after the intervention with the students who took part in the exergames group, their parents and instructors. Although all students' balance abilities improved as a result of the intervention, no statistical significance difference was found between the two intervention programmes (exergames and traditional exercise group). However, the interviews suggested that exergames constitute a feasible, well-accepted and motivational balance training mode for adolescents with deafness. This study was judged to be of moderate to high quality. It is a good solid intervention about using video games to improve balance of deaf children and adolescents but results cannot be generalised due to the small sample.

4.93 The second intervention identified by Wu et al., 2016 involved four deaf students (17-19 years of age) with developmental disabilities in a special school. The aim was to explore the effect of a technology based intervention (two iPod Touch applications: inPromptu and First Then Visual Schedule) on the acquisition of independent living skills and on the ability to follow activity schedules. During the intervention, the students were presented video clips (using the iPod touch applications) of independent living/vocational tasks under specific categories. A multiple probe (baseline) across participants design was used and involved five conditions: 1) baseline, 2) intervention one: navigation and schedule following training, 3) post-intervention generalisation probes, 4) intervention two: multiple exemplar instruction with intermittent generalisation probes, 5) maintenance probes. Baseline probes were conducted using single opportunity method - e.g. probe session was stopped if participant made an error. Social validity - informal interviews with participants and classroom teachers were conducted following the intervention. All participants successfully acquired a variety of independent living skills using video prompting and three of four participants were able to

follow varied and novel activity schedules, after they learned to follow fixed order activity schedules. Also, all participants successfully generalised using schedules to an untrained setting (e.g. school dorm). The study was judged of moderate quality as it included only a small sample of participants and the results cannot be generalised.

Implications

4.94 Given the centrality of independence within the conceptual framework and ECC, it is surprising that there is little evidence of evaluations of educational interventions which met the REA criteria. Based on the emphasis on the use of technology by both intervention studies and the limited evidence on independence skills of deaf children and adolescents, the following implications can be drawn:

- Balance exergames are accepted by and accessible to deaf students. The inclusion of such games in the everyday school life of students with deafness can increase their motor abilities as well as their interest towards physical exercise classes. They do not appear to be more effective than traditional exercise.
- There is only moderate evidence of the effectiveness of using of high-tech devices to support the teaching of independent living or vocational skills to deaf adolescents with developmental disabilities.

4.95 Beyond these areas, the REA did not identify any evidence of successful intervention or evidence of general principles of mobility and independence education. Given the concerns raised about the development of independence amongst this group (and the importance attributed to this outcome area in the ALN code of practice), it is crucial to broaden our understanding of how deaf children can be best supported to develop their independence skills. The need to understand exactly how independence skills can be supported becomes more pertinent when considering experience of deaf adolescents' of transition from school to independent working life.

Cognitive skills

Introduction

4.96 Cognition is often simply thought of as 'all that goes on in the mind' i.e. all mental activity. It is sometimes (confusingly) equated with 'thinking'. In everyday usage, 'thinking' usually refers to that form of mental activity that is verbally mediated. But cognition is much more than this and includes such 'higher order' mental processes as making plans, having opinions, reasoning, abstract thought, categorising and hypothesising but also 'lower order process' such as the visual discrimination of letters and the recognition of voices. Sometimes cognition is equated with intelligence but Knoors and Marschark (2014) reject this notion:

> "Cognition refers to the processes involved in acquiring knowledge, retaining it and retrieving it under various conditions. The amount and quantity of information that has been acquired is not a part of intelligence per se but reflects achievement…" (p. 108-109).

4.97 Cognitive development is central in the education of deaf children as language and cognition are inextricably linked. Thus, the language delay of deaf children can have an impact on their cognitive development in a number of ways. Cognitive assessments, even non-verbal assessments, require a specific level of language to understand what is asked. In addition, cognitive standardised assessments are developed for hearing children not taking into consideration the language variability of deaf children and the additional needs that some deaf children might have. Research on the cognitive skills of deaf children has primarily focused on specific aspects: visual attention, problem solving, flexible thinking, social cognition and theory of mind.

4.98 It is often assumed that deaf people can see better or have a better visual attention than hearing people based on the assumption that when one sense is limited the other senses takeover of this capability and as a result they improve. However, this is not supported by research evidence. For instance, Marschark et al. (2005) compared deaf children who use spoken language, deaf children who sign and hearing children on how they comprehend

information presented in the visual periphery. No differences in visual attention were identified between these three groups. However, it is commonly recognised that if instructions presented to deaf children are solely verbal it can slow down their learning as they require more time to process the information given the limited auditory input. Thus, visual presentation is important with learning taking place in a predictable visual environment where deaf students can see the teacher and their peers at all times (Dye et al., 2008).

4.99 Another important aspect of cognition is executive functioning. Executive functioning includes metacognition (thinking about thinking) and behaviour regulation. An aspect of executive function in which deaf children have been found to differ to hearing peers is working memory. Working memory is:

> "usually described as a capacity-limited system involved in the active maintenance and manipulation of incoming sensory information over brief periods of time….In others words, sequential processing is central to working memory" (Hermans et al., 2015, p. 235).

4.100 There has been consistent evidence that deaf children score lower than hearing children in working memory which plays a crucial role in learning, in predicting reading comprehension (Garrison et al,, 1997) and mathematical learning (Gottardis, Nunes & Lunt, 2011). There are many explanations for why deaf children face problems with working memory. For instance, Marschark et al. (2002) claim deaf children are less likely to activate frequently used categories from their memory.

4.101 The above function of working memory is well linked to flexible thinking. Research on flexible thinking in deaf children has switched over the decades from considering deaf people as 'inferior' to 'concrete' to 'intellectually normal' (Paul, 2001; Moores et al., 2001). A study conducted by Ebrahim (2006) with 72 deaf and hearing children, using the Torrance Test of Creative Thinking, concluded the performance of the two groups were similar and that hearing children scored higher than deaf children in only one of the six variables (i.e abstract thinking). These findings support the fact that deaf children do not perform worse than hearing children in flexible thinking.

Thus, deaf children are a heterogeneous group and there are a number of factors playing a vital role in their performance including rehearsal of strategies.

4.102 Another situation when executive functioning is crucial is when a learner is faced with a new task: problem solving. Marschark and Everhart (1999) in their study included thirty-six deaf and thirty-six hearing students and involved them in problem solving tasks. They found that deaf children used less efficient strategies in order to solve the problems. Most studies on problem solving have been conducted in the area of mathematics (interventions on how to problem solve in mathematics are discussed in the corresponding section). Problem solving is a situation where prior knowledge has to be applied to a novel situation. Teaching deaf children usually takes place in a very structured environment and deaf children are rarely faced with a novel situation without scaffolding taking place. Structured situations provide little opportunity for deaf children to explore ways to solve situations themselves, as Marschark (2014) highlights:

> "If we want deaf children to develop cognitive flexibility and become independent learners, we need to let them tackle (appropriate) challenges themselves" (p. 120).

Available evidence: Working memory: problem solving and flexible thinking

4.103 The low number of deaf individuals involved in science, technology, engineering, and mathematics (STEM) resulting from the difficulties that deaf learners face with problem solving, was the target of the intervention study developed by Marshall et al. (2016). A total of 74 college students (34 in the control and 40 in the intervention group) participated in the study. Four case studies (i.e situations where open problems were discussed) were used to assess the participants before and after the intervention. The intervention group demonstrated a significant increase (compared to the pre- test) in the assessed problem solving skills: no change was observed for the control group. Information about the allocation to the intervention and control group

was missing. Nevertheless, the study was rated as being of high quality being an innovative intervention with an under researched group of participants (deaf college students).

4.104 Related to the ability to problem solve is the ability to generate a flow of ideas in changing situations (flexible thinking). The feasibility of promoting flexible thinking using virtual technology was explored by Passig and Eden (2003). A total of 44 deaf children aged 8-11 years with moderate to profound hearing loss were randomly assigned to the control or experimental group. A hearing control group of 16 children also took part. Pre and post assessments employed standardised tests of flexibility and problem solving. The children in the experimental group were asked to play for 15 minutes a week over a period of three months, three virtual reality games involving the control of three-dimensional blocks. In post-test assessments, these children scored significantly higher compared to the deaf control group and at the same level as the hearing control group (closing the gap identified between the hearing and the deaf control group at the pre-test). Despite the effectiveness of the intervention, the rigorous design (randomised control trial) and the large sample size, this intervention was rated as being of moderate quality.

4.105 The effect of music lessons on auditory processing and working memory was explored by Rochette et al. (2014). The auditory and cognitive performance of a group of 14 severe to profound deaf children, which received music training 1 hour a week for 2.6 years on average, was compared to 14 deaf children who did not receive any music lessons. Improvements in auditory performance, in the phonetic discrimination task, and in the auditory working memory task were observed. The pre-existent differences in auditory and cognitive performance between the two groups of children and the different schooling programme for 50% of their time does not allow to draw any safe conclusions about the effectiveness of the intervention which can be attributed to confounding factors. The evidence is of moderate quality.

Metacognition

4.106 Benedict et al. (2015) investigated the use of the metacognitive Comprehension, Check and Repair (CC&R) strategy on strategic and non-strategic reading behaviour and on reading comprehension of three deaf children aged between 9-11 years with bilateral haring loss of all degrees. Multiple baseline design was used across three teacher-student dyads. They used the instructional passages to instruct students in the use of the CC&R strategy during the intervention phase. The purpose of the CC&R strategy is to teach students how to use a self-questioning technique to monitor their own comprehension. The assessment passages were used to assess during comprehension across the baseline, intervention and follow up phases. All three children were able to learn the metacognition strategy which enabled them to not only monitor their own understanding of the content of the text but also to be able to solve any comprehension problems they might face. This was a single case study intervention with a small number of participants which nevertheless employed a rigorous and structured methodology, and is of great value to practitioners. Thus, it was rated as being of high quality.

Theory of mind and social cognition

4.107 The impact of a false-belief training programme on theory of mind development of Australian signing children of hearing parents was examined by Wellman and Peterson (2013). A group of children who received pictorial training using thought bubbles was compared to a baseline control group (to control for any spontaneous gain over the study's time frame) and to a non-theory of mind training group. The use of thought bubbles to learn how to represent false-belief tasks proved effective as children who received the training were able not only to improve their understanding of general theory of mind tasks but also to generalise these tasks in different situations. The study was rated as being high quality in regard to not only the effectiveness of the intervention but also the rigorousness of the design, and the use of reliable and appropriate outcome measures for deaf children. Overall, this is an intervention which can be replicated and be of use to practitioners to support deaf children's theory of mind development.

4.108 Justice reasoning is one aspect of social cognition and is closely linked to peer- cooperation. A group of deaf children (n=32) and a similar number of hearing control children were involved in training sessions on justice reasoning (i.e reasoning about the fairness of a reward). Children were asked to make reasoning for justice both before and after they were shown videos of adults allocating chocolate unequally in favour of a boy (while the girl should have got the same reward). Details about the training session and the reliability of the pre and post-test measure were limited. The evidence was of impressionistic quality. Although deaf children scored lower than hearing, confirming previous studies in the field, when deaf children gave explanations about their decision allocation they performed higher in the post test. However, this intervention is of little use to classroom practitioners.

Implications

4.109 Given the centrality of cognitive skills within the field of hearing impairment, it is surprising that there is little evidence of evaluations of educational interventions which met the REA criteria. Although identified interventions focused on the aspects of cognition of deaf children (i.e problem solving, flexible thinking, metacognition, theory of mind and social cognition) identified in the literature as the most pertinent for this group of children, effective interventions of high quality are limited. The evidence suggests:

- The effect of music training to promote working memory, although evidenced in the literature, was not confirmed by the only identified intervention.
- Virtual reality and games have a role to play in the development of problem solving and flexible thinking of deaf children but interventions and/or apps which are accessible and easy to use by practitioners are yet to be developed.
- Problem solving has to be emphasised and supported using technology, throughout the school years. Training deaf children on problem solving tasks from a very young age can be beneficial and a skill that has to be developed early in life to achieve independence at a later stage in life.
- The use of thought bubbles and other strategies based on false belief tasks is an effective way to promote theory of mind.

- Metacognition (thinking about thinking) is a strong predictor of different aspects of learning. For instance, reading comprehension (an area with the most difficulties for deaf learners) can be promoted by providing deaf children with effective strategies to monitor their own understanding and to solve any problems they face.

4.110 It is surprising that despite that the inextricable link between cognition and language, as highlighted in the introduction of this section, none of the interventions identified here attempted to support language alongside cognitive skills or even recognised that cognitive skills cannot be promoted effectively when language fluency is absent. At the very least, it is suggested here that further research is needed to understand the full complexities of the cognitive skills (i.e false belief tasks) and its relation to language fluency and theory of mind (Marschark et al., 2000).

Social and emotional functioning

Introduction

4.111 It is well established that good social skills and the ability of children and young people to manage their behaviours and friendships is important for children's development and also a significant predictor for both academic and future success (Von Hohendorff, Couto, & Prati, 2013; Webster-Stratton & Reid, 2004). Despite the advancements in early identification (e.g since the implementation of universal newborn hearing screening in 2005 in the UK), deaf children (specifically those with low language level) exhibit more emotional and behavioural difficulties compared to their hearing peers (Stevenson et al., 2011).

Social skills

4.112 It is well established in the literature that some deaf children can face difficulties in communicating, initiating/entering and maintaining interactions with their peers in inclusive settings. For example, over 80% of deaf children's initiation of interaction (deaf children of preschool age) was ignored by their hearing peers (DeLuzio & Girolametto, 2011). Studies on deaf adolescents' social functioning are inconclusive compared to studies on younger children. Findings from a longitudinal study (Antia, Jones, Luckner,

Kreimeyer, & Reed, 2011), which followed children in mainstream classrooms for five years (from 7 years until they were 14 years old), suggested there was no difference in social skills between deaf and hearing students, as rated by their teachers and students themselves, and that deaf children's social skills did not deteriorate over time. However, a recent systematic review and meta-analysis (Stevenson, Kreppner, Pimperton, Worsfold, & Kennedy, 2015) of studies reported that deaf children and adolescents showed a higher level of emotional and behavioural difficulties compared to their hearing peers. What is important to note is that this review of studies identified peer problems as the area with the most difficulties for deaf children and adolescents. Similarly, a follow up study of 76 deaf adolescents (Stevenson et al., 2017) concluded that, although deaf adolescents with no additional disabilities did not show an elevated level of overall emotional behavioural difficulties compared to hearing adolescents based on parental reports, adolescents were self- identified as exhibiting a significant higher level of peer problems.

Emotional skills

4.113 Emotions play an important role in everyday life and the way they are understood and acted upon is crucial in social interaction. Fluency of language is linked to understanding of the social environment and, in turn, to emotional understanding. In addition, deaf children face difficulties in understanding other people's emotions which is closely linked to impairment in theory of mind (discussed in the cognitive skills section of this report). Although it has been suggested that deaf children of primary school age are able to identify their own emotions and multiple emotions evoked by a specific situation, they underperformed compared to hearing peers when a situation evoked multiple negative emotions (e.g sad and angry). Also, very young deaf children (3 years of age) with cochlear implants are shown to have difficulty not only in identifying emotions but also in understanding other people's emotions (Wiefferink et al., 2012). Thus, it is evident that deaf children need support from early life, not only to identify other people's emotions but also to understand and regulate their own emotions.

Psychosocial factors

4.114 Psychosocial refers to the interrelation between psychological (i.e behavioural) and social aspects. There is little consensus between earlier and recent studies on whether deaf children face more difficulties in this domain compared to hearing children. For instance, a meta-analysis of 42 studies on children and young people suggested that deaf people have lower self-esteem compared to their hearing peers, although concerns were raised about the methodology that the various studies used and more specifically about the reliability of the measures and their appropriateness for the deaf population (Bat-Chava, 1993). However, in a study employing self-reports of adolescents with cochlear implants and their parents' reports, deaf adolescents did not report feelings of lower self-esteem and/or loneliness as compared to normative samples. Also, a research study in Denmark (Dammeyer, 2009) suggested that good communication skills (independent of the modality - i.e. sign or spoken language) was a strong predictor of psychosocial difficulties of deaf children. Thus, deaf children with good communication skills are less likely to develop psychosocial problems.

Available evidence – social skills

4.115 Antia and Kreimeyer (1996) explored the effect of two interventions (i.e. social skills and integrated activities) on promoting social interaction between deaf children and a) their deaf peers, b) hearing peers who participated in the intervention and c) hearing children unfamiliar with the deaf children who did not take part in the interventions. In the social skills intervention the teacher modelled and prompted targeted social skills whereas in the integrated activities intervention the deaf and hearing children were brought together to participate in regular teaching activities. A total of 136 children aged between 4-6 years (91 hearing and 45 deaf children) were assigned either to the social skills' intervention or to the integrated activities intervention, whereas an additional group of 43 hearing children did not participate in either interventions. Although the deaf and hearing children were matched for gender, chronological age and communication skills, according to their class teachers, the study provides no information on how the children were allocated in the two interventions. Pre and post-test and

delayed post-test peer interaction data was gathered by observation of free play sessions. Social acceptance data was gathered by an adapted rating scale (i.e children had to rank their peers photographs according to whether they would like or not to play with them). The social skills intervention had a positive effect on the social interaction of deaf children with their deaf peers, whereas the same intervention had no effect on the social interaction between deaf and hearing peers. The integrated activities interaction showed no effect in social interaction for any of the two groups of children. A follow up study by Antia and Kreimeyer (1997) demonstrated that the social skills intervention not only had an impact on the peer social behaviour of deaf children (solitary and parallel play was significantly reduced as a result of the intervention) in a free play setting with no presence of the teacher but these children were also able to maintain these skills for a year and to generalise them in a different free play setting. Both the 1996 and the 1997 studies by the same authors employed large sample size , showed high ecological validity, employed large sample sizes and rigorous research design. The quality of evidence was rate high for both studies.

4.116 Peer social behaviour during play and the generalisation of those skills in different setting was also the focus of an intervention study with five preschool deaf children (moderate to severe hearing loss) employing a multiple baseline design (Ducharme and Holborn, 1997). The targeted behaviour as identified by the children's teachers and parents were similar to the ones targeted by Antia and Kreimeyer (1996, 1997). Similarly, the social skills training sessions included modelling, prompting and reinforcement by the teacher. Based on teachers and parents' questionnaires, the children produced high mean of social peer interaction. Despite this invention's positive effect on social interaction of deaf children, the small sample size, the lack of reliable outcome measures and the limited reflection by the authors of the limitations of the study contributed to been judged as of impressionistic to moderate quality.

4.117 Another study of impressionistic quality is a social skills instruction programme based on the cooperative learning method (Avicoglu, 2007). The programme targets basic social skills, starting and continuing a relationship

and working in groups. Using a multiple baseline design the author concluded that this programme has been affective for deaf children learning social skills. However, little/no information is provided regarding the characteristics of the participants, the process of the intervention and the outcome measures.

4.118 The promotion of interaction between deaf and hearing children was the aim of the intervention programme developed by Vandell et al. (1982). The study followed an experimental design; 16 preschool deaf (severe to profound) and 16 preschool hearing children from the same primary school in Texas were randomly assigned to the experimental and comparison group. Activities raising deaf awareness (such as explaining what deafness is) and strategies on how to interact with deaf children were provided to the experimental group in 15 sessions on consecutive school days. Despite the rigorous design of the study, the intervention was ineffective; hearing children in the intervention group demonstrated fewer and shorter interactions compared to the hearing control children. Given the ineffectiveness of the intervention the study was judged of moderate quality.

4.119 Interaction of deaf children and improvement of their social skills was also the aim of one of the most comprehensive preventive intervention programmes called PATHS (Promoting Alternative Thinking Strategies) (Greenberg & Kusche, 1998). The PATHS curriculum is a daily programme designed to promote self-control, emotional understanding, interpersonal relationships, and social problem-solving skills. A total of 57 severely and profoundly hearing-impaired children from six primary schools took part in the programme. The study employed an experimental design and the experimental and control group was matched for age gender, social class, parent educational attainment and aetiology of deafness. Children who took part in the intervention improved on problem solving, social competence, cognitive functioning and reading comprehension skills. The PATHs programme is a very well designed, very well-known intervention, exemplar of interventions in the social emotional field of deaf children. The study was rated as being of high quality.

Available evidence – emotional skills

4.120 The recognition of emotions of other people was the target of the Funny Faces Programme (FFP) (Dyck & Drew, 2003). The intervention followed a one group pre-test and post-test design, included 11 sessions and was delivered to 14 children with moderate to severe hearing loss aged between 9-13 years. The programme was delivered in five modules focusing on understanding of emotions (i.e. happy, sad, angry), how to respond to these emotions to different situations and in situations which are changing. The results suggested that the intervention was effective based on the higher post-test scores on emotional recognition scales. The intervention was of moderate quality; there was no control group and the effectiveness of the programme was not assessed using reliable measures. However, the Funny Faces programme is very prescriptive and can be easily used by practitioners and incorporated in the curriculum.

4.121 Another way to provide scaffolding for deaf children to understand emotions is the use of social stories. Two studies employing social stories as part of the intervention programme were identified in the literature. Richels (2014) used three social stories which included three target emotions (identified in the baseline) to teach the emotion words. During the intervention the stories were read to the children, probes about the stories and related structured play activities followed the reading. Only a small group of children with a moderate to profound hearing loss aged 3-4 years old participated in the study. Each participant demonstrated an increase in the correct use of all target emotion words during both the social story reading and demonstration tasks, from baseline to intervention. A similar single subject design employing social stories was used by Raver et al. (2014). However, the latter study included only deaf children with profound hearing loss and examined the effect of social stories in two learning environments (i.e. a setting for deaf children and a mainstream preschool) in two different interventions on communicative and social skills. In intervention one, the social stories were read followed by verbal prompts before play whereas in intervention two, the social stories were read with teacher prompt, verbal prompt and reinforcement during play. Intervention one was more effective compared to

intervention two in improving communicative and social skills of the pre-schoolers. Individual children's outcomes were observed but the use of dyad-specific social stories with different levels of teachers' instructional support can be effective. Both interventions using social stories involved only a small sample with no comparison group but they were both well designed detailed interventions, proved to be effective; providing moderate to strong quality of evidence.

4.122 Linked to the understanding of emotional intention in spoken language is emotional prosody. Emotional prosody refers to the melodic and rhythmic components of speech that listeners use to gain insight into a speaker's emotion through prosody. Good et al. (2017) explored the effect of music training on the emotional prosody of deaf learners with cochlear implants (aged 6 to 15 years). Eighteen participants were assigned either to a music or art training intervention for a period of six months. Those in the experimental group received music lessons, training with a piano. There was a pseudorandom allocation to the two groups, matched according to age at testing, age at implantation, and experience of cochlear implants. Children in the two groups did not differ with regard to speech perception skills. Only participants in the music training demonstrated improvements on the emotional prosody. This study is of moderate quality as there was no random allocation to the two groups, home practice of the taught skills was not monitored and there was no evidence about the maintenance of the acquired skill.

Available evidence – psychosocial factors

4.123 Holt and Dowell (2011) explored the effect of vocal training of adolescents 13-17 years of age with cochlear implants on a number of psychosocial factors (i.e self-esteem, stress, depression, anxiety and confidence in relating to peers). They hypothesised that better voice production could lead to better outcomes in the aforementioned psychosocial factors. The intervention included actor vocal training workshops of three hours duration over a 10-week period. The vocal training included activities such as breathe control and expressivity. However, results from the post testing (speech rating scale, self- esteem rating scale) did not indicate any significant

changes in speech perception scores and self- esteem. This intervention was judged of impressionistic to moderate quality. It involved a small number of participants (n=7) who already exhibited high levels of self-esteem (at ceiling at pre-test) and as a result, the study was unable to provide reliable outcomes and their self-esteem did not improved.

Implications

4.124 The urgency to promote socio-emotional skills of deaf individuals especially of secondary age, as highlighted in the introduction of this section, is not reflected in the published intervention studies discussed above. Most of the interventions involved deaf children of preschool age and of specific degree of hearing loss (i.e. severe to profound). Most of the intervention studies were designed and implemented in US and abroad and there were no identified studies in the UK. Practice to support social and emotional skills of deaf children should take into consideration the following aspects, as identified by the available evidence:

- Strategies such as prompting and modelling of targeted social skills by teachers can only promote the interactions of deaf children with their hearing peers if is used as part of an inclusive curriculum and not in isolation.
- Raising deaf awareness of hearing children in inclusive settings should be developed as part of an inclusive curriculum taking into consideration academic and language skills as well as communication needs of deaf children.
- Deaf children's understanding and their own complex emotions and recognising other people's emotions can be supported by targeting emotion words.
- Comprehensive intervention studies such as the PATHS programme which focus on a number of different skills can easily be adapted in the UK and incorporated in the curriculum.

4.125 This review highlights that the children who are deaf still face challenges and difficulties in communicating, initiating/entering, and maintaining interactions with hearing peers and further research concerning interventions that

promote their social interactions in inclusive education (Xie et al., 2014) is pertinent. Interventions should also target children with varying degree of hearing loss including children with mild to moderate hearing loss.

Use of technology

Introduction

4.126 Digital technology, in its many forms, has seen rapid development during the timescale under consideration. Excitement has grown from the 1980s onwards about the potential such technologies might have for children's education and, more particularly in this context, for deaf children's learning. There are many areas of the curriculum which hold potential difficulty for deaf children, notably those that are heavily language-based and those relying on literacy skills. It has been hoped that new technologies might help to 'unlock' these areas for deaf children in a variety of ways.

4.127 One example is that of multimedia approaches (the digital combination of words and pictures). Using multimedia approaches appears to promote a deeper learning in hearing students (Mayer, 2003) and it was speculated that this would be the same for deaf children. Effective navigation of hyperlinks relies on a range of attributes e.g. use of working memory, integrating information from different sources, and is not as straight forward as 'linear reading'. Technology holds out the hope of additional capability for deaf children's education, (and builds on or even replaces outmoded methods) but the benefits of digital technology are not automatic, it seems.

4.128 Ordinarily, because particular areas of the curriculum present difficulty, the deaf child is likely to make slow progress, perhaps display unwanted behaviours and even become disaffected, with a poor attendance record at school. The other hope that technology held out was that, because of its highly visual, interactive appeal, deaf children were likely to find it focussing and motivational or motivating – words that appears repeatedly, both in research studies identified in this report and in the literature in general. This is particularly true of computer games (Kafai, 2001) because of their relationship to play (Rieber, 1996) and this being something that almost every child enjoys. However, the danger is that the technology is a novelty at

first but that, over time, the novelty factor fades, the software loses its motivating effect and the effect is not sustained.

4.129 Another possibility was that, following such motivation, deaf children might make some sort of measurable improvement in learning e.g. comprehension might increase over and above that expected with traditional methods.

4.130 Research studies which include interventions stretch back into the 1980s. When looking at these early studies it becomes clear that some of these examples of technology have long since passed into history, or been superseded by other more powerful, up-to-date software. An example of this is the 'speechviewer', (Oster, 1989, 1995) – an electronic display of spectrograms – which held promise for deaf children's articulation of speech sounds. It was used with deaf children for a number of years, but has now faded from use as other technologies have appeared. The Visual Speech Apparatus (Arends et al., 1991), designed for a similar purpose, has been excluded on the same grounds. Studies such as these, before the year 2000, have been omitted. However, this does not mean that all pre-2000 studies have been consigned to this pile. For example, the place of word-prediction software is investigated by Laine and Follansbee (1994). Word-prediction is an element still very much employed in various software, both computer and mobile phone. Therefore, though pre-dating 2000, this study on the effect of word prediction facility on word fluency and flexibility has been retained. A study by Bloor et al. (1995) on a piece of software using hypertext and another by Volterra et al. (1995) exploring the use of an interactive multimedia application are retained for the same reason.

4.131 The available articles are examined under three broad headings: technology and behaviour, technology and comprehension, technology and other aspects of learning.

Available evidence - technology and behaviour

4.132 Tasks that relate to language and, more particularly, to literacy skills are a potential source of difficulty and frustration for deaf children. In the classroom this can lead to disruptive behaviours and profound reluctance to engage in the tasks set. The question researchers have set themselves is

whether digital technology, especially software packages, can motivate pupils to re-focus on such tasks. These first two studies pursue this line and have a common theme in the writing skills of deaf children.

4.133 Bailey and Weippert (1992) refer to the motivational effect of technology in the introduction to their paper. The aim of the research was to find out whether software packages may have a positive effect upon the behaviour and attendance at school through case studies of two deaf aboriginal girls. It also explored whether the three pieces of software introduced as an intervention programme improved touch-typing skills, attention and language development. The two six year old girls, who were deaf with behaviour disorders, have a 12 week intervention of 30 minutes a day. Behaviour was 'rated' before the intervention, and computer skills assessed. On all parameters being assessed there was said to be improvement: attitudes improved, typing improved, word processing target was met, there was an increase in signs mastered, attention skills 'became excellent' and there was a development in written expression. Despite the lack of any specific measures the authors assert that there is 'some evidence' that computer-based learning can improve learning, attention and concentration. The quality of the evidence was judged impressionistic.

4.134 Laine and Follansbee (1994) explored the motivating power of computer assistance (word processing software) and word-prediction technology on the written production of 'low-functioning' profoundly deaf students. In a case study format, four 11-12 year-old profoundly deaf, 'lower functioning' children, with sign as their first language, wrote journals in their own classroom setting. The authors make a point of this 'normal' writing activity taking place in a familiar writing. Although it was routine, it was a task that the students usually found 'difficult and frustrating' causing the teacher to comment, 'they hate to write'. For the sake of the research four adaptions were made to the task including 1) the use of word processing software Primary Editor Plus and 2) the use of word-processing plus word-prediction software, Writeaway. Primary editor Plus includes a drawing programme. Results were compared with previous 'paper and pencil' examples.

Generally, the students stayed focussed on the task slightly longer, especially when they used the drawing component of Primary Editor Plus, as this helped them to express their ideas more than words. Pupils declared that computer was more ‘fun’ than the pencil-and-paper task. Word prediction enhanced word fluency (word count) but not word flexibility (word variety). Spelling errors decreased, pupils used the drop-down word lists to choose a spelling, whereas they did not use notebook word lists or dictionaries. Detailed comments are made about each student but in general ‘writing programmes changed the ways the students approached the writing of their daily journals’ to a more positive approach and cut down on disruptive behaviours previously seen. They point to increased interest and focus of the children, and the motivating feature of the on-screen dictionary. At first, they treated this experimentally but later more systematically. No comment was made as to whether the effect of the use of technology was sustained. The quality of the evidence was judged as moderate.

Available evidence - technology and comprehension

4.135 In this section there are five research papers, each of which looks at a different technology and, in some cases, asks whether or not it gives deaf children the possibility of enhanced understanding of particular subject matter. What is of interest here is whether the innovation that the new technology brings is more effective, in terms of results for the child, than its predecessor.

4.136 The section begins with an intervention based on a technology which has now become commonplace for many deaf students. Elliott et al. (2001) reported on C-Print speech-to-text transcription technology. At the time, this technology held great promise beyond the notetaker and interpreter for the young deaf college student, particularly in a lecture situation. Elliott et al. stressed the ‘real time’ nature of this technology, thus enabling the student to take part directly in the learning experience and the ‘take-home’ hard copy of the notes produced. The study aimed to answer four questions: 1) whether students would respond favourably to the real-time text display of information provided by C-Print 2) how students perceived the print out produced 3) whether C-Print could be used without an interpreter or note taker 4) whether

student characteristics were related to the ratings of C-Print e.g. the reading ages of the participants. Thirty-six college students (who were ‘deaf or hard-of-hearing’ took part in a ten-week study where C-Print was used in all class lessons. Students used the new technology for all classes within a ten week term before they rated it through questionnaire and in-depth interview. Students, ratings and interviews indicated good comprehension with C-Print, better than with an interpreter alone and that a hard copy of text was also helpful. Questions could be raised regarding the potential for cognitive overload as a result of attending to a combination of speaker, interpreter and transcript. Quality of evidence was judged to be moderate.

4.137 The next paper is by Volterra et al. (1995). It describes an interactive multimedia application used with twenty-five deaf children ranging in age from 6 to 16 years. The app was ‘designed to facilitate deaf children's access to new information’. The app, in the form of a videodisk introduces four different forms of knowledge, two of which are non-linguistic and two of which are linguistic (film, graphic explanations, written text and sign language). After an exploratory phase, the children answered questions on their newly acquired knowledge, based around animals of the savannah. Evidence of ‘success’ was collected for a number of different tasks, including in the form of observations, choices made by the children and analysis of the construction of answers to comprehension questions. Lack of detail leads to tentative conclusions being made about the efficacy of the intervention. However, the researchers concluded that when deaf children are able to approach information through visual transmission (in contrast to the usual talking and writing media), they are more motivated to learn. However, there is no way of knowing whether learning is more effective using the videodisk app than via more conventional techniques. This technology was ‘cutting-edge’ at the time (interactive video disk and CD-Rom). Nevertheless, the creation of a programme which a child can explore themselves, employing their own learning choices, and making use of their knowledge of sign language increases the potential for developing active learners with improved meta-cognition (Caselli et al, 2015). Some of these elements can

be seen in more creative, open-ended programmes today. The quality of the evidence was judged as moderate.

4.138 The study by Vogel et al. (2006) is a larger scale study and examines whether 3D virtual reality computer games could aid mathematical learning in deaf and hearing children more than conventional computer-assisted instruction games. Again, the justification for using game-based computer-assisted instruction is to increase students' motivation to learn, by presenting the learning material in a form that encourages engagement and thereby increases practice. In this quasi-experimental unequal control group design, 44 participants aged from 7-12 years old were given 10 minutes intervention a day. Comparison between pre- and post-test measures came up with the surprising conclusion that scores for both deaf and hearing children improved significantly with the conventional computer-assisted presentation, which was based on a linear instructional format, rather than the 3D game version. The authors postulated about the counter-intuitive result, wondering whether children 'skipped over' the instructional element of the 3D programme in order to arrive quickly at the game, and thus found themselves ill-equipped to be successful. Participants in the 3D condition did not improve significantly in mathematical skills from pre to post-test. The authors concluded that computer learning games are potentially useful but must be carefully designed to engage children through the learning phase into the game phase. The quality of the evidence was judged to be moderate.

4.139 Mich et al. (2013) report on a study involving a multimedia literacy web tool called LODE (LOgic-based web tool for deaf children) which comprises the following features: 1) interactive illustrated stories 2) a visual dictionary 3) comprehension exercises (particularly with reference to temporal relations) with intelligent feedback. The aim of the research was to discover whether this tool improved the reading comprehension skills of deaf children. The interactive stories, which were simplified and animated, had comprehension exercises and dynamic feedback. Digital technology gives a number of options at the design stage, for example, larger font, simplified illustrations which are relevant to the meaning of the text. Each child was able to operate

the story session on screen independently and then receive feedback on screen. A group of eighteen deaf children formed younger and older subgroups, whilst a group of 18 hearing children formed a control group. There were different stories for children with specific ages with varying levels of simplification. Unfortunately, the design of the actual research element seems to have confounded the results. However, what could be concluded is that 'simplified stories, illustrated with drawings and extended with definitions, turned out to be more effective for the reading comprehension of deaf children' than the original version or a simplified version with no images. The quality of this research is judged to be moderate.

4.140 In the most recent of the technology research papers, Parton (2017) employed the use of augmented reality software, in association with the QR reader, to create an extra layer of information via a 3D Google Glass device. The extra layer consisted of video clips of ASL signs, relating to a range of high frequency nouns, represented by real objects and flashcards. The purpose of the research, which was a description of a pilot study, was to assess whether deaf pupils can successfully use the glasses to access this additional layer in an instructional setting. The participants were four male fifth grade students (10 or 11 years old). Although degree of deafness was not stated, the students were all at a residential school for the Deaf. Success in use of the device was judged by questioning of the students and by teachers' observations. The author concluded that deaf students were able to operate the device to perform QR scans. This study has limited use and quality of evidence was judged as impressionistic.

Available evidence - technology and other aspects of learning

4.141 The following selection of papers explore interventions based on a new technology directed at an aspect of learning other than improving comprehension.

4.142 Messier and Wood (2015) concentrated on vocabulary acquisition of cochlear implanted children through the use of electronic storybooks. At first sight this appears similar to the paper by Mich et al. (2013) above, but the emphasis in this study was on vocabulary acquisition rather than

comprehension. The electronic nature of the storybooks allowed for a multimedia treatment of the story with exploration of vocabulary through a variety of means, which the authors describe as ‘engaging’ for children. In an unusual alternating weekly design, eighteen children of primary age with cochlear implants either received the intervention, or a straight read through of the electronic storybook. The participants were recruited from settings educating deaf children within the mainstream classroom, total communication classroom, or an auditory/oral programme. Both groups made progress but children in the intervention group who had an auditory/oral means of communication derived particular benefit from the multimedia approach of the extra embedded information. This intervention has possibilities for classroom practice as it is based on reading books, with an augmented focus on vocabulary. Despite limitations of the study, the main one being that it does not define which specific elements of the intervention contribute to the learning of vocabulary, it was judged of strong quality.

4.143 The research paper by Bloor et al. (1995) explores the implementation of a programme designed to teach employment-related language to deaf school leavers. The unique aspect of this programme is the hypertext within it, a facility which was gaining in popularity through the World Wide Web in the early 1990s. The aim was to ‘teach language through materials which would aid deaf students to find employment’. A reading test to gauge the level of the materials to be delivered is also online. The programme was tested out with seven grammar school students. No formal/standardised measures were used to assess the effectiveness of the intervention. Teachers were only asked for their opinions as to ease of use. In general, students found the system ‘helpful’. Once again, the lack of a robust method of data collection diminishes the usefulness of this study in terms of the efficacy of the technology in finding employment. Quality of evidence was deemed to be impressionistic.

4.144 Finally in this section is the study by Constantinescu et al. (2014) using face to face video technology for telepractice. Undertaken in Australia, the vastness of the country prohibits families travelling to even their nearest

Auditory Verbal Therapy (AVT) centre. Telepractice seems to hold out an alternative. This study investigated whether this method of delivery is as effective as physical attendance at therapy sessions. Impact was measured by language outcomes for the children involved. The outcomes for fourteen children in two matched groups were retrospectively analysed using the Preschool Language Scale 4 (PLS-4). There were no significant differences between the groups. Data issues e.g. self-selection of the participants, the small sample size and retrospective analysis made generalisation of the results difficult. Quality of evidence was judged to be moderate.

Implications

4.145 The majority of the interventions discussed above focused on the use of different types of technology to support deaf children's learning of different subjects (e.g. reading comprehension and vocabulary). Thus, the majority of the identified interventions in this category focused on how technology can enhance/support 'access to learning' for deaf children. However, there were also interventions identified that aimed at supporting aspects of the ECC curriculum and ultimately leading to acquisition of independent skills by deaf children - 'learning to access' (e.g. interventions on minimising disruptive behaviour and enabling concentration). Based on the above evidence, the following implications can be drawn:

- Telepractice can be used in deaf education specifically to promote independent skills of deaf children. There may be other applications yet to be found, particularly in situations where families may live remotely from treatment centres such as cochlear implant centres, speech and language centres, paediatric centres.
- There is little and inconclusive evidence of the use of technology to teach employment related language to deaf students and of the use of 3D games for enhancing reading comprehension skills of deaf children.
- However, the print to text technology can have a clear application in the field of live captioning and transcription services for deaf young people. In addition, there are apps which convert speech to text without a mediating stenographer.

- In addition, technology holds out potentials which traditional means could not offer, such as extra embedded elements available at an extra click (hyperlinks technology), embedded videos of new signs, storybooks can be re-designed with new fonts and font sizes, and new text and illustrations which can directly amplify meaning.

4.146 Overall, careful design and implementation of applications and software, together with a corresponding pedagogy are required to ensure success for deaf children. (Knoors & Marschark, 2014).

Teaching support

Introduction

4.147 The 'teaching support' intervention area is concerned with use of various teaching support techniques and configurations to support children's learning. This commonly involves support offered by non-teaching staff, e.g. learning support assistants or teaching assistants. While the use of teaching assistants in the education of deaf children appears to be common practice in Western countries, there appear to be few empirical studies evaluating their role.

4.148 Teaching assistants comprise 41% of the primary school workforce in Wales as indicated by the StatsWales (2018) and many deaf students receive support from a teaching assistant. The nature of the work undertaken by teaching assistants varies considerably. Given deaf pupils are not a homogenous group, the support they require will differ significantly. A description of the role of the teaching assistants in supporting children with ALN is given by Webster and Blatchford (2013):

> "Teaching assistants in English and Welsh schools have a predominantly pedagogical role, spending most of their time supporting pupils with SEN and lower-attaining pupils" (p. 464).

4.149 This suggests then that teaching assistants can take on the broad roles of supporting 'access to learning' (e.g. the preparation of materials in advance, or within classroom activities), or reinforcing 'learning to access' approaches (e.g. reinforce children's use of their independence skills).

Available evidence

4.150 No interventions were identified through the REA.

Implications

4.151 No educational intervention in relation to teaching support has been identified in the REA. This is surprising given the common use of teaching assistants in the support and education of deaf children. According to Salter et al.(2017), the term 'teaching assistant' can be applied generically to:

> educational practitioners, excluding qualified teachers, who support teaching and learning in the classroom and includes individuals with particular skills and knowledge to support specific students (p. 41).

4.152 Blatchford, Russell and Webster (2012) carried out research exploring the effectiveness of using teaching assistants to support children with special educational needs more generally, and have raised concerns about how this practice can inadvertently mean that these pupils get less contact with the teacher and reduction in quality of instruction. Similarly, Sharples et al. (2015) found that teaching assistants are more focused on task completion and less concentrated on pupil's understanding. In addition, that report demonstrated the negative impact that support from research assistants can have on pupil's with ALN attainment: those pupils who were supported by teaching assistants made less progress than those who received little or no support. Despite the negative impact, they also found that individual interventions delivered by teaching assistants can have a positive impact on attainment.

4.153 While empirical evidence has not been identified (though the REA) which details the effectiveness of particular approaches in the use of teaching support, it seems very likely that teaching assistants working with children and young people with ALN can provide a valuable role in relation to:

- 'access to learning' (e.g. ensuring that instructions for various activities are presented in an accessible to deaf students way).

- ‘learning to access’ (e.g. reinforce children’s independence skills by encouraging them to take responsibility of checking their audiology equipment is working).

4.154 The challenge in the management of this valuable role is in relation to:

- providing the right balance of this support, and if done incorrectly may prevent the development of independence skills and agency.
- preventing the development of relationships between the deaf pupils, their teachers and peers.

4.155 Particular concerns are raised regarding the impact of a teaching assistant on the teachers’ opportunity to develop understanding and awareness of the deaf students’ specific needs (Salter et al., 2017). Specifically, when consulted, teaching assistants:

> …. considered that their own presence affected direct interaction between the deaf students and teacher, limiting the opportunity for teaching staff to develop their understanding of the student (Salter et al., 2017, p.47).

Teaching strategies

Introduction

4.156 This strategy area has a focus on studies examining the use of teaching strategies/approaches to support learning of deaf children that is a particular focus upon pedagogy. The difficulties that deaf children face, discussed above, are underlined by differences in knowledge organisation between deaf and hearing children. Marshcark and Hauser (2011) suggest that deaf and hearing children have different backgrounds, experiences and learning strategies.

4.157 Thus, deaf children face difficulties in category knowledge and, as a result, in the more general process of using knowledge during problem solving and learning. Acquisition of new concepts and learning is feasible when appropriate experience is provided. Strategies adopted by teachers to overcome these limitations are based on developing problem skills of deaf children. Experienced teachers mainly provide two methods to support deaf

children's learning. One approach involved the use of concept maps and diagrams (i.e.the use visual aids in supporting learning). The second is the use of activities aimed at demonstrating similarities and differences between concepts at different levels including, categorical, lexical, names and so on.

4.158 The overarching aim is to provide deaf children with strategies that they can use/ adapt in many situations based on learning to access. The strategies discussed above form the basis of the strategies discussed in other sections of this report. For example, the use of visual aids (i.e. diagrams etc.) are used in mathematics to promote deaf children's understanding of word problems.

Available evidence

4.159 No interventions were identified through the REA.

Implications

4.160 No interventions were found in relation to general teaching strategies for deaf children. However, looking at the general principles of strategies used to support learning of deaf children in various areas (i.e. literacy, maths, social emotional etc.), the following implications can be drawn:

- The strategies used by teachers and parents should emphasise the importance of providing opportunities to develop social interaction skills.
- Strategies and approaches emphasising the importance of providing opportunities for deaf children to gain independent skills. Luckner and Muir (2001) suggested that the deaf children who successfully achieve independent skills are those who take part in the ECC.
- Systemic strategies and approaches should aim to adapt the environment to promote access to participation and learning. For instance, appropriate seating arrangements and use of classroom amplification systems support access to learning for deaf children.
- Use of technology (e.g. use of interactive software) can support learning and academic achievement of deaf children.

Welsh language provision

Introduction

4.161 This section focuses on the Welsh language i.e spoken/ signed by pupils with a hearing impairment as a first, second or additional language.

4.162 Based upon Welsh Government figures, in 2017-18 16% of pupils in Wales are taught through the medium of Welsh, and significant numbers of additional pupils have some of their lessons taught through the medium of Welsh (StatsWales, 2018a). Based upon Welsh Government figures, in 2017-18 there were approximately 535 deaf pupils in Wales taught through the medium of Welsh (in terms of SEN provision: 40 with statement of SEN, 340 with school action plus, 155 with school action – see StatsWales, 2018b). It is therefore important to consider whether linguistic background has any specific implications for the educational provision of those with hearing impairment.

4.163 Figures on languages used, by severely or profoundly deaf children in school or other education settings, provided by the CRIDE for Wales (2017) report show that 68% communicate mainly using spoken English only, 7% mainly use spoken Welsh only while 34% mainly use sign language in some form, either on its own (7%) or alongside spoken English (24%) or spoken Welsh (3%). In January 2004, BSL was recognised by the Welsh Assembly Government as a language in its own right for about 4,000 Deaf people living in Wales. The Welsh Government has since supported training to increase the number of qualified interpreters in Wales, and ensured that legislation, policies and programmes recognise the importance of accessible communications to everyone. Thus, in 2010 the Welsh Government initiated the BSL Futures scheme to increase BSL teaching capacity and ultimately ensure that public services in Wales are able to deliver their services in BSL.

4.164 People with hearing impairment are born into families with a variety of linguistic backgrounds; e.g. those who speak English or Welsh, those who use BSL (and/or its Welsh variant), and those speaking minority languages in Wales. While the numbers of children with hearing impairment are low, it is still very important to consider implications of this linguistic background for

their educational provision. Firstly, it is clearly recognised that deafness is associated with individuals' feelings of isolation and exclusion (Antia et al., 2011). Secondly, the availability of hearing impairment educational support for the Welsh language can be variable. Overall, there are 15.7 (FTE) Teachers of the Deaf reported as being able to provide support through the medium of Welsh, amounting to 25% of the total Teacher of the Deaf posts in Wales (CRIDE, 2017). 95% of these posts are occupied by a fully qualified Teacher of the Deaf with the remaining posts occupied by teachers in training (4%) or qualified teachers without the mandatory teacher of the deaf qualification and no immediate plans to begin training for this (1%).

4.165 There is paucity of Welsh language resources for those with hearing impairment, even some of the publications from the National Deaf Children's Society to support families of deaf children are not available in the Welsh language. On a positive note, a new project was launched in 2018 which aims to teach sign language to young children through the medium of Welsh. This is the first to teach BSL through Welsh rather than English.

Available evidence

4.166 No interventions were identified through the REA.

Implications

4.167 No educational interventions in relation to hearing impairment education in the Welsh language were identified through the REA. The broad principles and interventions identified in the REA are not language specific. However, as communication and inevitably language is one of the main aspects for which specialist support is needed, many interventions do require specialist staff who are able to communicate in the appropriate language and are able to access language-appropriate resources. With this concern in mind, we explored the issues associated with specialist services delivered through the medium of Welsh.

4.168 Issues raised included:

- In relation to standardised assessments in the Welsh language, the only standardised receptive vocabulary test normed specifically on Welsh-

speaking children (aged 7-11), is the Prawf Geirfa Cymraeg[5]. The scarcity of standardised assessments in Welsh language is a particular issue when considering pre-school/young children.

- There is a need for the Welsh language to be given full consideration within the mandatory qualification programmes for teachers of deaf children – for trainees working within Wales but having to attend courses in England.
- Since there are no special schools for the deaf in Wales, NDCS (2013) questioned whether, in the case of deaf pupils, peripatetic sensory services (based at a local authority or regional consortium level) are better placed to provide Welsh language provision.
- Consideration and additional resources/funding must be given for children and young people, who are educated in Welsh-medium provisions but whose first language is not Welsh.

Inclusion

Introduction

4.169 The concept of 'inclusion' in the 1960s and 1970s signified a change from segregated schooling for children with special educational needs to schooling on the same premises as other. It was not long before the realisation dawned that mere physical proximity produced limited results. It led at best to some sort of social integration of children, but not necessarily to any sort of academic integration, and with the children with special educational needs being expected to make the major adjustment (the medical model of disability).

4.170 'Inclusion' became a more popular term, carrying with it an aspiration to 'resolve the barriers leading to learning' (Booth and Ainscow, 1998). The UNESCO Salamanca Agreement[6] of 1994 upholds the right to an inclusive and qualitative education for all. However, discussion remains as to whether the drive towards inclusion inevitably leads to the closing of the special school doors, or instead to a change of attitudes among key stakeholders,

[5] Gathercole, V. C. M., & Thomas, E. M. (2007). Prawf Geirfa Cymraeg, Fersiwn 7.11. *Prawf Geirfa Cymraeg, Fersiwn 7.11*. www.pgc.bangor.ac.uk..
[6] UNESCO Salamanca Agreement

leading to the same quality education for everybody. The question is a serious one, with apparently serious consequences for deaf children if a range of provision is not available. Huber (2015) documents this through an examination of mental health problems in deaf children and different types of provision.

4.171 Most of the research papers examined during this study considered factors leading to the successful inclusion of the deaf child in the mainstream environment. Stinson (1999) examined key issues concerning participation, arriving at a list of strategies, involving all stakeholders in accommodations. In a similar vein, Eriks-Brophy (2006) looked especially at factors leading to the successful inclusion of oral deaf children in mainstream school. Antia (2002) concluded that if students are to be in a mainstream classroom they must have 'membership' within it, not just 'visitorship'.

4.172 Considerable concentration has been focussed upon the place of cochlear implants and inclusion. For example, Langereis and Vermeulen (2015) considered children in different types of settings with cochlear implants and their academic attainment. Tobey (2004) looked at speech intelligibility of 8 and 9 year old children with cochlear implants and type of provision. Again, a cochlear implant represents a major accommodating move on the part of the deaf child. Other researchers have focused on the part that communication mode plays on social inclusion (Minnett ,1994; Hulsing, 1995; Constantinescu, 2015). Of particular note is the work of Minnett, who looked at preschool children and play choices.

Available evidence

4.173 Interestingly, although much of the research relates to inclusion in the mainstream environment, one of the two studies – that of Guardino and Antia (2012) –investigates an intervention that does not relate to mainstream, but is inclusion in terms of learning and behavioural norms. This reminds us again of Booth and Ainscow's (1998) definition of inclusion: resolving 'the barriers leading to learning'.

4.174 This study focussed upon whether there was a functional relationship between modifications to the classroom setting, academic engagement and disruptive behaviour. The authors also stressed the possible importance of consultation with individual teachers as to bespoke changes that might be made rather than adopting a 'one-size-fits-all' approach. The participants in the study were aged between 9 and 11 years old, had additional disabilities (i.e motor delays, intellectual disabilities and behaviour, attention and hyperactivity issues) and were located in three different classrooms in the same school for the Deaf. The researchers altered the physical environment through changes such as seating, lighting and organisation of resources in a multiple-baseline-across settings design. Disruptive behaviour e.g. speaking/signing without permission and academic engagement were measured by observation at intervals in each class of 4 or 5 participants (n=14). A functional relationship between the alterations made and changes in engagement and behaviour was demonstrated. With these physical changes to the environment, an inverse relationship between poor behaviour and engagement was also found. A limitation of the study may be that it is not possible to say what effect each *individual* modification made in each classroom, as the modifications were made collectively. Teachers mentioned in particular the reduction in visual stimuli, which are known to be distracting to deaf learners, because of a more highly developed sense of peripheral vision (Bavelier et al., 2006). It is also not possible to say whether the teachers' behaviour may have changed with the modifications and/or with being observed. Nevertheless, the robust design of this study, with its multiple baselines and partial-interval measurement system creates a sense of a strong study. This study provided evidence of strong quality.

4.175 In the other study in this section, Fisher et al. (1989) sought to increase the social integration between 'hearing-impaired' and 'normally hearing' peers. The assumption is made that this is a desirable aim – that deaf and hearing children should socialise during recreational breaks – but it emerges that this is not something that this group of deaf children actually desired. Nevertheless, what is heartening is that the measures adopted are *not* based purely on the deaf child being required to make the major adjustment,

but rather deaf children and peers coming together in joint activities. The researchers focussed on four children, with very varied communicative abilities (signed and oral), in a New Zealand primary school in a single case study design. Three new elements were introduced: 1) a signing class for hearing peers 2) play equipment and 3) a buddy system. The exact basis for the choice of these three interventions is not discussed, although the background for choice is alluded to in the literature review. Detail of the three interventions is sparse, but detail of observation measures is elaborate and extensive. Interaction increased but the design of the study does not permit an analysis of the relative impact of each intervention. There is some evidence of generalisation and stability. This study provided evidence of moderate quality.

Implications

4.176 Only two intervention studies were identified under 'inclusion' as an educational strategy. However, both interventions are based on the fact that teachers of the deaf are 'agents of change' either by adapting the environment or by influencing others around the child (e.g. their peer) to meet the needs of deaf children and ultimately contribute to 'learning to access'. Based on the two intervention studies identified the following implications can be drawn:

- Teachers who make a careful and thoughtful arrangement of the physical environment can bring better engagement and improved academic achievement. Adaptations to environment to reduce visual and auditory distractions, carrels or partitions are recommended.
- The use of activities (e.g. signing classes for hearing children) to bring deaf and hearing peers together might have a positive effect on inclusion of deaf children but is only based on moderate evidence.

5. Conclusions

5.1 It is important to emphasise that the work undertaken is a REA and not a systematic review. Although the REA employed a systematic and robust methodology, critically appraised and synthesised the available evidence, the aim was to identify the most relevant literature on interventions to support deaf children and to extract the key messages from those studies.

5.2 We presented a conceptual framework in section 2.2 to illustrate how the education of deaf children can be conceptualised under two broad areas of intervention approaches and targeted educational outcomes, namely ensuring young people have:

- Fair and optimised access to the school curriculum.
- Opportunities to develop their independence and social inclusion.

5.3 At the heart of this conceptual framework is a distinction between two overlapping imperatives: 1) facilitating equitable access to education and 2) promoting the development of individual agency. The educational response to this – and the associated *educational interventions* – can also be considered as two broad overlapping approaches:

- Access to learning approaches: inclusive practice and differentiation ensuring that the child's environment is structured and modified to promote inclusion, learning and access to the core curriculum, the culture of the school and broader social inclusion.
- Learning to access approaches: teaching provision which supports the child to learn independence skills and develop agency in order to afford more independent learning and social inclusion.

5.4 The REA was undertaken with reference to these broad approaches, and the literature was searched for, and presented within, different educational strategy areas which can be linked back to each. In section five (intervention summaries) we presented detailed descriptions of the evidence, and also drew out the implications of this for practice. In this section we offer

overarching themes, reflect upon the nature of evidence available, and consider the implications for educational practice in Wales.

Overview of the evidence

5.5 The twelve educational strategy areas (communication, literacy, mathematics, teaching strategies, access to examinations, mobility and independence, cognitive skills, social and emotional functioning, use of technology, teaching support, inclusion, minority language) broadly capture the areas of discussion and debate in the field of deaf education. Whilst there is broad consensus in the education literature about the importance of each of these areas there is a difference in the amount of evidence identified by the REA within each. Perhaps unsurprisingly, literacy had the most associated evidence although the focus is mainly on reading rather than writing. In part this reflects the high importance attached to literacy within deaf education, but also reflects that literacy is commonly identified as an area which children can find difficult despite the technological advances (i.e. digital hearing aids and cochlear implants) providing better access to sound for deaf children. Associated with literacy are 'specialist' approaches to support the development of the underlining core elements of reading (phonology, vocabulary, morphology) that have received relatively large amounts of research attention. We return to literacy in section 0 below (Navigating the balance between educational strategies) because it provides a useful illustration of the relationship between 'learning to access' and 'access to learning' approaches, and the importance of ensuring there is appropriate input from educational specialists to promote these.

5.6 In contrast to literacy, relatively little evidence of the effectiveness of different educational interventions was identified in relation to other educational strategy areas. This seems surprising given the importance attached to some of these areas. For example, areas typically associated with difficulties that deaf children face are for example cognition and social emotional skills (all of which form part of the ECC, e.g. Greenberg and Kusche, 1998). In spite of this, the REA identified little evidence of the effectiveness of the associated interventions. As discussed below, this may be because traditionally in the field of deaf education (due to academic

underachievement of this population) emphasis has been placed on scaffolding and supporting academic achievement and there is relatively little emphasis/support on strategies/approaches for deaf children to become independent and take ownership of their learning. This has been well documented in the literature of social-emotional development of deaf children. For example, Valentine and Skelton (2007) suggested that the shift from educating deaf children in specialist schools into mainstream education has resulted in marginalisation of deaf children and paucity of deaf/deaf role models, which may hinder deaf children's transition to independence due to the lack of control over their own everyday lives. Similarly, in the same study, adolescents who were educated in schools for the deaf 'felt ill-prepared to leave a D/deaf aware school environment and participate in the 'dis-abling' environment of the hearing world' (p.111).

5.7 The little emphasis placed on 'learning to access' for deaf children is also evident by the very little evidence (i.e. one intervention) in the area of independence identified through this REA. The sole use of video clips to promote awareness of how deaf adolescents can acquire independent and daily living skills did not prove effective. Literature focused on the development of independence only of deaf adolescents with additional needs. However, the challenges that all deaf children (i.e. with and without additional needs) might face in independent living and self-sufficiency skills is well documented in the literature. For instance, the NatSIP report (2016) highlighted the need of deaf adolescents to feel they are independent, to have the confidence and self-esteem to tell people they are deaf and to get information about equipment which can benefit them. What is more important is that it is evident in this report that for deaf children to acquire the essential skills for adult life, support/ training should start early and all stakeholders involved (i.e. teachers, services parents etc.) should work together. Exactly how and when deaf children should be supported to acquire independent skills has not been identified though the evidence in this REA and further research is needed.

5.8 Related to access to learning are interventions identified in the area of ‘use of technology’ and mathematics. However, there is little, mostly inconclusive evidence of the use of technology to train deaf students in independent and employment related skills. Although very few interventions were also identified in the area of mathematics, the strong evidence (mainly represented by one group of researchers) relates to the use of visual manipulatives (i.e. diagrams) for the acquisition of problem solving skills.

5.9 Similarly, relatively little evidence (15 studies) was identified in the area of communication. Central to communication of deaf children is acquisition of language. Given that 78% of school aged deaf children in the UK are educated in a mainstream school and that 66% of severely profound deaf children use spoken language as their preferred method of communication (corresponding figures for Wales: 81% and 68%), it is not surprising that the majority of interventions to promote communication skills of deaf children focused on the development of spoken language. These studies provide clear evidence that interventions to promote language skills of deaf children should start early and parents have an important role to play. For instance, there is strong evidence that methods of parent training such as the teach–model–coach–review method can be effective in spoken language acquisition by deaf children. Teachers of the deaf and other professional working with deaf children also play an important role not only in the supporting/training parents but also in delivering interventions based on auditory therapy (although evidence on these sort of therapies is scarce and inconclusive). Although, as discussed at the beginning of this paragraph, it is perhaps unsurprising that the vast majority of interventions in this area focus on development of speech, it is important to emphasise the need for interventions to develop sign language skills of deaf children (no intervention provided strong evidence on this). This is extremely pertinent given the difficulties that deaf children face are related to language skills. Access to any langue is key as:

> “not having a solid foundation in any language - not being able to converse with native fluency and with complete ease - this is not all that linguistic deprivation encompasses. Linguistic deprivation carries with it a

spectrum of problems beyond strictly language pathologies" (Humphries et al., 2012, p.3).

5.10 Very little evidence was also identified in the educational area of inclusion. This is concerned with environmental adjustments, inclusive practice, and peer training to support and enable the learning environment. These broad approaches are commonly implemented in UK schools, so it is surprising that no formal evaluations were identified through the REA.

Reflections upon the type of available evidence

5.11 This REA broadly focusses upon deaf education generally, rather than upon a specific intervention area. Even so, 85 sources were identified which met the inclusion criteria. This suggests that relatively little evidence exists which is concerned with the relative efficacy of educational interventions in this field.

Regarding the type of available interventions three observations can be made.

5.12 First, it is interesting to consider the design and quality of the studies identified in the REA. Based upon the criteria employed in the REA, 59 of the 85 sources (69%) were judged to be of moderate to strong quality and 26, of the sources (31%) were judged to be of impressionistic to moderate quality. Of the evidence gathered, about half were case studies or small sample multiple baseline studies (45/85, 53%); studies rarely incorporated control groups. It is quite surprising that almost half of the identified interventions employed experimental or quasi experimental design given the heterogeneity of the deaf population.

5.13 Second, it is also interesting to consider the countries where these interventions were developed. The vast majority of the interventions (54/85) were developed and implemented in the USA. This raises questions about the implications and appropriateness of these interventions to use in the UK (i.e. where the national curriculum and generally the way deaf education is conceptualised is different). It is interesting to note that only 2/85 interventions were developed in the UK. Although a number of interventions

are broadly used in schools for the deaf and resource provisions across the UK, these are not evidence based. For instance, deaf children in the UK with limited access to sound are encouraged (by their teachers) to decode words when reading with the help of Visual Phonics by Hand system[7] (Harris,et al., 2017a). This system focuses on discrimination among phonemes using visual cues based on the BSL fingerspelling alphabet. This system was developed in the UK by an experienced teacher of the deaf, is distinct to the visual phonics system identified in the available evidence of the interventions on literacy (see section 5.2) and there is no available evaluation of its effectiveness in the literature.

5.14 Third, it is worth mentioning that a very small number of the identified interventions (28/85) focused on supporting children and young people with mild to moderate hearing loss. The relatively few identified interventions on this group of children is not surprising. Children with mild to moderate hearing loss are usually overlooked as seen of having only minor difficulties. However, as Archbold et al. (2015) highlighted:

> "There is an urgent need to address the challenges that mild and moderate hearing loss bring to a home and at school, and which may be overlooked as they are often not apparent, particularly at a time of financial challenges for services" (p. 45).

Thus, there is an urgency for interventions to support the unmet needs of this group of children.

Definitions of interventions, the role of assessment and educational specialists

5.15 The nature of the evidence, and the requirement to individualise the precise interpretation of the intervention according to the needs of a given child or young person, has significant implications for how educational interventions should be implemented. It suggests the educator (and often the *specialist*

[7] Visual phonics by hand website

teacher) has an important role in designing interventions and monitoring learning progress.

5.16 Given the evidence that a particular intervention is unlikely to work for *every* deaf child, a different kind of approach is required. On one hand, tools which can sensitively assess the individual needs and progress of deaf children and young people are required. On the other hand, there is need for educators who can interpret evidence gathered through observation and these assessment tools and make judgements about how interventions should be modified, adjusted and implemented.

5.17 First, considering assessment tools, the REA searched for evidence of the effectiveness of *interventions*. The planning of the interventions, and ultimately their effectiveness, was based on the outcome measures used. There is a range of available assessments of a child's developmental progress. However, caution is needed when considering appropriate assessments for deaf children. Standardised assessments in the various educational areas have been developed and standardised on the hearing population. Thus, although standardised assessments provide information of the performance of the target sample in comparison to the population enabling comparisons between groups (e.g. between hearing and deaf children), the appropriateness of these assessments to evaluate deaf children's developmental progress is doubtful. For instance Harris et al. (2017) suggested that deaf children's underachievement in reading comprehension can be partially attributed to the fact that the comprehension questions asked in the standardised test required the children to make inferences to provide the correct answer. However, many deaf children find inferences like these, that draw on world knowledge, challenging.

5.18 As well as a range of assessments of a child's developmental progress, there are also assessments of how a student is included which focus upon the broader learning environment (e.g. environmental audit checklists). These are important in order to ensure that teaching and learning take place in rooms which provide a good listening environment and have good acoustics.

5.19 Second, considering the role of the educator. The educator (using the term in a general sense to refer to an appropriate adult) must make use of information from assessments and then make decisions about interventions that may be beneficial to the given child's learning and development. Drawing upon the educational strategies identified in the REA, these interventions may focus upon environmental and resource adjustments, pedagogy or curriculum (or most commonly combinations of all these things). The challenge for the educators involved is deciding upon the appropriate combination of interventions and having the appropriate skills to implement them.

5.20 *Specialist* staff are commonly needed to undertake and/or advise on additional learning provision (defined as special educational provision as set out in the Additional Learning Needs and Educational Tribunal (Wales) Act, 2018) *and* inclusive practice and differentiation. While the availability and organisation of professionals varies in different countries, in Wales the traditional coordination of this complex arrangement of educational support is generally undertaken by qualified teachers of the deaf. Given deafness is a low incidence need, mainstream education practitioners are unlikely to develop or retain specialist knowledge through their ongoing practice (as they will only rarely come across a deaf child). This makes the advice on interventions they receive from teachers of the deaf especially important.

Navigating the balance between educational strategies

5.21 In section 2.2 (Conceptual framework and targeted educational outcomes), we highlighted that there are likely to be tensions between types of interventions which focus upon different educational outcomes. In deaf education, this is linked to the different emphasis which is given to the two traditions outlined in the conceptual framework: emphasis upon equal access versus development of individual agency; and emphasis upon 'access to learning' versus 'learning to access'.

5.22 Through the REA, the access to learning/learning to access distinction helps to reveal some of these dilemmas and provide the basis to make informed decisions about the type of interventions which are most appropriate at a given time. In the table below we provide some examples of alternative approaches and interventions, as well as suggestions for choosing between them. Presented in this way, interventions can be thought of as complementary rather than oppositional. Decisions can be navigated in a child-centred way rather than lead to intractable dilemmas. A key part of this decision making process is linked to the developmental age of the deaf child, and accounting for the preferences of child and parents. To some extent, the evidence identified in the REA offers some steer about which approach works and at which point in the young person's development.

5.23 As described in the previous section, the design and implementation of the interventions often requires professionals with specialist training. It also requires professionals who can take a researcher-practitioner role, i.e.: 1) able to assess individual children and modify interventions appropriately based upon evidence of progress; and 2) emphasise that interventions should increasingly seek to promote young people's independence and agency over time.

5.24 The table below draws upon the implications presented Section 5 (Intervention summaries), and gives a framework for the content of the guidance which accompanies this report.

Table 86. Complementary interventions - 'access to learning', 'learning to access' and a balanced approach

'Access to learning'	'Learning to access'	Balance (evidence rating: strong, moderate and practice)
Access to reading (meaning): • Extended captions to videos • Use of story books • Use of visual strategies	**Access to reading (meaning):** • Teaching of the use of interactive software • Explicit and structured teaching of vocabulary and phonology • Teaching of visual phonics • Teaching of fingerspelling	Access to reading(meaning): • Good phonological awareness and vocabulary acquisition from an early age can provide a successful route to reading (strong) • Interactive technology can be effective in developing expressive and receptive vocabulary skills (moderate) • The use of story book reading with explicit instructions can enhance the learning of novel words by deaf children (strong) • Sigh language games can be used for the acquisition of sight words (practice)
Access to write: • Use of visual aids • Modified curriculum	**Access to writing:** • Explicit teaching of phonology	Access to writing: • Enhanced grammatical instruction can have a significant improvement in productive grammatical knowledge (strong)

‘Access to learning’	‘Learning to access’	Balance (evidence rating: strong, moderate and practice)
	• Enhanced grammatical instruction • Writing for a variety of purposes/audiences • Understanding known concepts	• The use of modified curriculum to understand known concepts provides a language model that can be a successful strategy to acquire writing skills (practice) • The teaching of explicit strategies for writing (i.e. Strategic and Interactive Writing Instruction) to promote the skills of children to write for a variety of purposes and audiences can be effective in supporting deaf children to produce persuasive pieces of writing (moderate) • Fingerspelling can provide a link between phonology, semantic meaning and English orthography (strong)
Communication/language: • Whole school training in signing • Peer and staff deaf awareness training	**Communication/language** • Teaching of phonological awareness and cognitive skills	**Communication/language** • Interventions to develop spoken language skills of deaf children have to be implemented from an early age in order to be effective (strong) • Training parents in methods such as the teach–model–coach–review method can impact

‘Access to learning’	‘Learning to access’	Balance (evidence rating: strong, moderate and practice)
• Use of audiology equipment	• Auditory training	significantly on the development of expressive language of deaf children (strong) • Auditory verbal therapy can develop speech production and listening skills of deaf children (moderate) • The advances in technology (i.e cochlear implants) in combination with auditory training and speech production interventions can have an effect on language skills (moderate)
Social emotional skills: • Peer and staff deaf awareness training • Whole class communication activities • Use of social stories	**Social emotional skills:** • Promotion and modelling of targeted social skills by teachers • Explicit teaching of emotion words	Social emotional skills: • Promoting and modelling targeted social skills by teachers can only promote the interactions of deaf children with their hearing peers (strong) • Deaf children’s understanding of their own complex emotions and recognising other people’s emotions can be supported by targeting emotion words (moderate) • The use of social stories to promote understanding of deaf children’s own and other people’s emotions (moderate)

‘Access to learning’	‘Learning to access’	Balance (evidence rating: strong, moderate and practice)
		• Use of whole school activities to promote deaf awareness (e.g. explaining what deafness is) can be effective in promoting social interaction (moderate)

Note: the evidence categories (moderate, strong, practice) broadly cross reference to the intervention summary evidence presented earlier in the report

Implications for Wales

5.25 The Additional Learning Needs and Education Tribunal (Wales) Bill was passed by the National Assembly for Wales on 12 December 2017 and became an Act on 24 January 2018 after receiving Royal Assent. This will create the legislative framework which aims to improve the planning and delivery of additional learning provision, through a person-centred approach to identifying needs early, putting in place effective support and monitoring, and adapting interventions to ensure they deliver desired outcomes (Welsh Government, 2018).

5.26 The transformed system seeks to:

- Ensure that all learners with ALN are supported to overcome barriers to learning and achieve their full potential
- Improve the planning and delivery of support for learners from 0 to 25 with ALN, placing learners' needs, views, wishes and feelings at the heart of the process
- Focus on the importance of identifying needs early and putting in place timely and effective interventions which are monitored and adapted to ensure they deliver the desired outcomes.

5.27 The Act requires that learners with ALN will have a single plan – the individual development plan (IDP). This will replace the current range of statutory and non-statutory plans for learners with special educational needs or learning difficulties and/or disabilities.

5.28 The new emphasis of the legislation aims to bring about many changes, but fundamental will be the attention to the support of learners with ALN up to the age of 25 years, and a focus upon targeting services to deliver *outcomes*. Drafts of the ALN Code of Practice place great emphasis upon targeted outcomes, including reference to developing young people's *independence* as part of accessing a broad and balanced curriculum.

5.29 The conceptual framework for deaf education presented in this report aligns with this policy transformation – the emphasis upon equal access to education ('access to learning') balanced with development of individual agency ('learning to access'). The framework presented, and the associated eleven educational strategy areas, offers a vocabulary for identifying the needs of, and educational interventions for

deaf children and young people. The analysis of available evidence through the REA identifies relatively little evidence of the effectiveness of many of these interventions. Nevertheless, it is argued that educational practice demonstrates the general value of many of the interventions. However, it is commonly the case that such evidence does not provide precision of what works, when, and with whom. In some cases, there is a complete absence of evidence. Two implications of this are: 1) more research evidence is needed, and 2) practitioners must design broad interventions based upon the evidence and practice available, and then modify and adjust that intervention based upon assessment of progress.

Annex A – Bibliography of evidence

Communication

Cherry, R. S. (1985) A three dimensional language acquisition program for hearing-impaired preschoolers. *The Volta Review*, *87(3),* 155-164.

Diller, G., Graser, P., & Schmalbrock, C. (2001). Early natural auditory-verbal education of children with profound hearing impairments in the Federal Republic of Germany: results of a 4 year study*. International Journal of Pediatric Otorhinolaryngology, 60(3*), 219-226. doi:10.1016/s0165-5876(01)00536-5

Ertmer, D. J., Leonard, J. S., & Pachuilo, M. L. (2002). Communication intervention for children with cochlear implants: two case studies. *Language, Speech & Hearing Services in Schools, 33(3)*, 205-217. doi:10.1044/0161-1461(2002/018)

Gunning, T. (2018). Mary's Story: The Inspiring Journey of a Pupil with Special Educational Needs and the Innovative Approaches Devised by her Special Education Teacher and Adopted by the Pupils in her School to use Irish Sign Language (ISL). *Reach, 31*(1).

Hidalgo, C., Falk, S. and Schön, D., 2017. Speak on time! Effects of a musical rhythmic training on children with hearing loss. *Hearing research*, *351*, pp.11-18.

Ingvalson, E. M., & Wong, P. C. M. (2013). Training to improve language outcomes in cochlear implant recipients. *Frontiers in Psychology, 4.* doi:10.3389/fpsyg.2013.00263

Ingvalson, E. M., Young, N. M., & Wong, P. C. M. (2014). Auditory-cognitive training improves language performance in prelingually deafened cochlear implant recipients. *International Journal of Pediatric Otorhinolaryngology, 78(10*), 1624-1631. doi:10.1016/j.ijporl.2014.07.009

Lam-Cassettari, C., M. B. Wadnerkar-Kamble & D. M. James (2015). Enhancing Parent-Child Communication and Parental Self-Esteem With a Video-Feedback Intervention: Outcomes With Prelingual Deaf and Hard-of-Hearing Children. *Journal of Deaf Studies & Deaf Education 20(3):* 266-274.

Mishra, S. K., Boddupally, S. P., & Rayapati, D. (2015). Auditory Learning in Children With Cochlear Implants. *Journal of Speech Language and Hearing Research, 58(3*), 1052-1060. doi:10.1044/2015_jslhr-h-14-0340

Moeller, M. P. (2000). Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics, 106(3).* doi:10.1542/peds.106.3.e43

Roberts, M. Y. and A. P. Kaiser (2012). Assessing the Effects of a Parent-Implemented Language Intervention for Children With Language Impairments Using Empirical Benchmarks: A Pilot Study. *Journal of Speech Language and Hearing Research 55(6)*: 1655-1670.

Rochette, F., Moussard, A., & Bigand, E. (2014). Music lessons improve auditory perceptual and cognitive performance in deaf children. *Frontiers in Human Neuroscience, 8.* doi:10.3389/fnhum.2014.00488

Roman, S., F. Rochette, J.-M. Triglia, D. Schon and E. Bigand (2016). Auditory training improves auditory performance in cochlear implanted children. *Hearing Research 337*: 89-95.

Vendrame, M., Cutica, I., & Bucciarelli, M. (2010). "I see what you mean": Oral deaf individuals benefit from speaker's gesturing. *European Journal of Cognitive Psychology,* 22(4), 612-639. doi:10.1080/09541440903126030

Vongpaisal, T., Caruso, D., & Yuan, Z. (2016). Dance Movements Enhance Song Learning in Deaf Children with Cochlear Implants. *Frontiers in Psychology, 7.* doi:10.3359/fpsyg.2016.00835.

Literacy

Anderson-Inman, L., Terrazas-Arellanes, F. E., & Slabin, U. (2009). Supported eText in Captioned Videos: A Comparison of Expanded Versus Standard Captions on Student Comprehension of Educational Content. *Journal of Special Education Technology*, 24(3), 21-34.

Andrews, J. F., Winograd, P., & Deville, G. (1994). Deaf children reading fables- using ASL summaries to improve reading- comprehension. *American Annals of the Deaf, 139(3)*, 378-386.

Barker, L. J. (2003). Computer-assisted vocabulary acquisition: The CSLU vocabulary tutor in oral-deaf education. *Journal of Deaf Studies and Deaf Education, 8(2),* 187-198. doi:http://dx.doi.org/10.1093/deafed/eng002

Bobzien, J. L., Richels, C., Schwartz, K., Raver, S. A., Hester, P., & Morin, L. (2015). Using repeated reading and explicit instruction to teach vocabulary to preschoolers with hearing loss. *Infants & Young Children*, *28*(3), 262-280.

Bennett, J. G., Gardner Iii, R., Leighner, R., Clancy, S., & Garner, J. (2014). Explicitly teaching English through the air to students who are Deaf or Hard of Hearing. *American Annals of the Deaf, 159(1*), 45-58.

Berent, G. P., Kelly, R. R., Schmitz, K. L., & Kenney, P. (2009). Visual Input Enhancement via Essay Coding Results in Deaf Learners' Long-Term Retention of Improved English Grammatical Knowledge. Journal of Deaf Studies and Deaf *Education, 14(2),* 190-204. doi:10.1093/deafed/enn032

Bonnickson, K. (1985). A functional language program that works: A pilot study. *The Volta Review, 87(2),* 67-76.

Bow, C. P., Blamey, P. J., Paatsch, L. E., & Sarant, J. Z. (2004). The Effects of Phonological and Morphological Training on Speech Perception Scores and Grammatical Judgments in Deaf and Hard-of-hearing Children. *Journal of Deaf Studies and Deaf Education, 9(3)*, 305-314.

Brennan, K. B., & Miller, A. D. (2000). How many words can your students read? Using a sign language game to increase sight word recognition. *Intervention in School & Clinic, 35(3)*, 147-150. doi:10.1177/105345120003500303

Brouwer, K., Downing, H., Westhoff, S., Wait, R., Entwisle, L. K., Messersmith, J. J., & Hanson, E. K. (2017). Effects of Clinician-Guided Emergent Literacy Intervention Using Interactive Tablet Technology for Preschool Children with Cochlear Implants. *Communication Disorders Quarterly, 38(4*), 195-205. doi:http://dx.doi.org/10.1177/1525740116666040

Cannon, J. E., & Kirby, S. (2013). Grammar structures and deaf and hard of hearing students: A review of past performance and a report of new findings. *American Annals of the Deaf*, 158(3), 292-310.

Davenport, C. A., Alber-Morgan, S. R., Clancy, S. M., & Kranak, M. P. (2017). Effects of a Picture Racetrack Game on the Expressive Vocabulary of Deaf Preschoolers. *Journal of Deaf Studies and Deaf Education*, 22(3), 326-335. doi:10.1093/deafed/enx015

Encinas, D., & Plante, E. (2016). Feasibility of a Recasting and Auditory Bombardment Treatment With Young Cochlear Implant Users. *Language, Speech & Hearing Services in Schools*, 47(2), 157-170. doi:10.1044/2016_LSHSS-15-0060

Gilliver, M., Cupples, L., Ching, T. Y. C., Leigh, G., & Gunnourie, M. (2016). Developing Sound Skills for Reading: Teaching Phonological Awareness to Preschoolers With Hearing Loss. *Journal of Deaf Studies & Deaf Education*, 21(3), 268-279. doi:10.1093/deafed/enw004

Haptonstall-Nykaza, T. S., & Schick, B. (2007). The Transition From Fingerspelling to English Print: Facilitating English Decoding. *Journal of Deaf Studies & Deaf Education, 12*(2), 172-183. doi:10.1093/deafed/enm003

Hermans, D., Wauters, L., Willemsen, M., & Knoors, H. (2015). 11 Vocabulary Acquisition in Deaf and Hard-of-Hearing Children: Research and Interventions. *The Oxford handbook of deaf studies in language*, 161.

Herrera-Fernandez, V., Puente-Ferreras, A., & Alvarado-Izquierdo, J. M. (2014). Visual Learning strategies to Promote Literacy Skills in Prelingually Deaf Readers, *Revista Mexicana De Psicologia,* 31(1), 1-10.

Lederberg, A., Miller, E. M., Easterbrooks, S. R., & McDonald Connor, C. (2014). Foundations for Literacy: An Early Literacy Intervention for Deaf and Hard-of-Hearing

Children. *Journal of Deaf Studies & Deaf Education,* 19(4), 438-455. doi:10.1093/deafed/enu022

Massaro, D. W., & Light, J. (2004). Improving the Vocabulary of Children with Hearing Loss. *Language Wizard/Player with Baldi*, 104(3), 141-174.

Miller, E. M., Lederberg, A. R., & Easterbrooks, S. R. (2013). Phonological Awareness: Explicit Instruction for Young Deaf and Hard-of-Hearing Children. *Journal of Deaf Studies and Deaf Education, 18*(2), 206-227. doi:10.1093/deafed/ens067

Moog, J., & Geers, A. (1985). EPIC: A program to accelerate academic progress in profoundly hearing-impaired children. *The Volta Review, 87*(6), 259-277.

Pakulski, L., & Kaderavek, J. (2012). Reading Intervention to Improve Narrative Production, Narrative Comprehension, and Motivation and Interest of Children with Hearing Loss. *The Volta Review, 112*(2), 87-112.

Paatsch, L. E., Blamey, P. J., Sarant, J. Z., & Bow, C. P. (2005). The effects of speech production and vocabulary training on different components of spoken language performance. *Journal of Deaf Studies and Deaf Education*, *11*(1), 39-55.

Pataki, K. W., Metz, A. E., & Pakulski, L. (2014). The effect of thematically related play on engagement in storybook reading in children with hearing loss*. Journal of Early Childhood Literacy, 14*(2), 240-264. doi:10.1177/1468798413480516

Richels, C. G., Schwartz, K. S., Bobzien, J. L., & Raver, S. A. (2016). Structured instruction with modified storybooks to teach morphosyntax and vocabulary to preschoolers who are deaf/hard of hearing. *Journal of deaf studies and deaf education*, *21*(4), 352-361.

Robertson, L., Gina Annunziato, D., & Hainzinger, S. L. (2006). Story Retelling Patterns Among Children with and Without Hearing Loss: Effects of Repeated Practice and Parent-Child Attunement. *The Volta Review, 106*(2), 147-170.

Trezek, B. J. (2005). The Efficacy of Utilizing a Phonics Treatment Package with Middle School Deaf and Hard-of-Hearing Students*. Journal of Deaf Studies and Deaf Education, 10*(3), 256.

Wilson, T., & Hyde, M. (1997). The use of signed English pictures to facilitate reading comprehension by deaf students. *American Annals of the Deaf, 142*(4), 333-341.

Wolbers, K. A., Dostal, H. M., Graham, S., Cihak, D., Kilpatrick, J. R., & Saulsburry, R. (2015). The Writing Performance of Elementary Students Receiving Strategic and Interactive Writing Instruction. *Journal of Deaf Studies and Deaf Education, 20*(4), 385-398. doi:10.1093/deafed/env022

Mathematics

Burley, S., Gutkin, T., & Naumann, W. (1994). Assessing the Efficacy of an Academic Hearing Peer Tutor for a Profoundly Deaf Student. *American Annals of the Deaf, 139*(4), 415-419.

Kritzer, K. L. k. k. e., & Pagliaro, C. M. (2013). An Intervention for Early Mathematical Success: Outcomes from the Hybrid Version of the Building Math Readiness Parents as Partners (MRPP) Project. *Journal of Deaf Studies & Deaf Education, 18*(1), 30-46. doi:10.1093/deafed/ens033

Mousley, K., & Kelly, R. R. (1998). Problem-solving strategies foe teaching mathematics to deaf students. *American Annals of the Deaf, 143*(4), 325-336.

Nunes, T., & Moreno, C. (2002). An intervention program for promoting deaf pupils' achievement in mathematics. *Journal of Deaf Studies and Deaf Education, 7*(2), 120-133. doi:http://dx.doi.org/10.1093/deafed/7.2.120

Nunes, T., Bryant, P., Burman, D., Bell, D., Evans, D., & Hallett, D. (2009). Deaf Children's Informal Knowledge of Multiplicative Reasoning. *Journal of Deaf Studies and Deaf Education, 14*(2), 260-277. doi:http://dx.doi.org/10.1093/deafed/enn040

Access to examinations

No references

Mobility and independence

Tzanetakos, N., Papastergiou, M., Vernadakis, N., & Antoniou, P. (2017). Utilizing physically interactive videogames for the balance training of adolescents with deafness within a physical education course. *Journal of Physical Education and Sport, 17*(2), 614-623. doi:http://dx.doi.org/10.7752/jpes.2017.02093

Wu, P.-F., Wheaton, J. E., & Cannella-Malone, H. I. (2016). Effects of video prompting and activity schedules on the acquisition of independent living skills of students who are deaf and have developmental disabilities. *Education and Training in Autism and Developmental Disabilities, 51*(4), 366-378.

Cognitive skills

Benedict, K. M., Rivera, M. C., & Antia, S. D. (2015). Instruction in Metacognitive Strategies to Increase Deaf and Hard-of-Hearing Students' Reading Comprehension. *Journal of Deaf Studies & Deaf Education, 20*(1), 1-15.

Marshall, M., Carrano, A. L., & Dannels, W. A. (2016). Adapting Experiential Learning to Develop Problem-Solving Skills in Deaf and Hard-of-Hearing Engineering Students. *Journal of Deaf Studies & Deaf Education, 21(*4), 403-415. doi:10.1093/deafed/enw050

Passig, D., & Eden, S. (2003). Cognitive Intervention Through Virtual Environments Among Deaf and Hard-of-Hearing Children. *European Journal of Special Needs Education, 18*(2), 173-182. doi:10.1080/0885625032000078961

Peterson, C. C. and J. L. Peterson (1989). Positive Justice Reasoning in Deaf and Hearing Children Before and After Exposure to Cognitive Conflict. American Annals of the Deaf. *American Annals of the Deaf 134*(4): 277-282.

Rochette, F., Moussard, A., & Bigand, E. (2014). Music Lessons Improve Auditory Perceptual and Cognitive Performance in Deaf Children. *Frontiers in Human Neuroscience, 8*. doi:10.3389/fnhum.2014.00488

Wellman, H. M., & Peterson, C. C. (2013). Deafness, Thought Bubbles, and Theory-of-Mind Development. *Developmental Psychology, 49*(12), 2357-2367. doi:10.1037/a0032419

Social and emotional functioning

Antia, S. D., & Kreimeyer, K. H. (1996). Social Interaction and Acceptance of Deaf or Hard-of-Hearing Children and their Peers: A Comparison of Social-skills and Familiarity-Based Interventions. *Volta Review, 98*(4), 157-180.

Antia, S. D., & Kreimeyer, K. H. (1997). The Generalization and Maintenance of the Peer Social Behaviors of Young Children who are Deaf or Hard of Hearing. *Language, Speech & Hearing Services in Schools, 28*, 59-69.

Avcioglu, H. (2007). Examining the Effectiveness of a Program Developed for Teaching Social Skills to Hearing Impaired Students Based on Cooperative Learning. *Kuram ve Uygulamada Egitim Bilimleri, 7(*1), 340-347.

Ducharme, D. E., & Holborn, S. W. (1997). Programming Generalization of Social Skills in Preschool children with hearing impairments. *Journal of Applied Behavior Analysis, 30(4),* 639-651. doi:10.1901/jaba.1997.30-639

Dyck, M. J., & Drew, E. (2003). Can the Emotion Recognition Ability of Deaf Children be Enhanced? A Pilot Study. *Journal of Deaf Studies and Deaf Education, 8*(3), 348.

Greenberg, M. T., & Kusche, C. A. (1998). Preventive interventions for school-age deaf children: The PATHS curriculum. *Journal of Deaf Studies and Deaf Education, 3*(1), 49-63. doi:http://dx.doi.org/10.1093/oxfordjournals.deafed.a014340

Good, A., Gordon, K. A., Papsin, B. C., Nespoli, G., Hopyan, T., Peretz, I., & Russo, F. A. (2017). Benefits of Music Training for Perception of Emotional Speech Prosody in Deaf Children with Cochlear Implants. *Ear and hearing*, *38*(4), 455.

Holt, C. M., & Dowell, R. C. (2011). Actor Vocal Training for the Habilitation of Speech in Adolescent Users of Cochlear Implants. *Journal of Deaf Studies & Deaf Education, 16*(1), 140-151. doi:10.1093/deafed/enq033

Raver, S. A., Bobzien, J., Richels, C., Hester, P., & Anthony, N. (2014). Using Dyad-Specific Social Stories to Increase Communicative and Social Skills of Preschoolers with Hearing Loss in Self-Contained and Inclusive Settings. *International Journal of Inclusive Education, 18*(1), 18-35. doi:10.1080/13603116.2012.756543

Richels (2014). Teaching Emotion Words Using Social Stories and Created Experiences in Group Instruction with Preschoolers who are Deaf or Hard of Hearing: An Exploratory Study. *Deafness & Education International 16*(1): 37-58.

Vandell, D. L., Anderson, L. D., Ehehardt, G., & Wilson, K. S. (1982). Integrating Hearing and Deaf Preschoolers: An Attempt to Enhance Hearing Children's Interactions with Deaf Peers. *Child Development, 53*(5), 1354-1363. doi:10.1111/1467-8624.ep8588336

Use of technology

Bailey, J., & Weippert, H. (1992). Using Computers to Improve the Language Competence and Attending Behaviour of Deaf Aboriginal Children. *Journal of Computer Assisted Learning, 8*(2), 118-127.

Bloor, C., Curran, D. A. S., Fowler, J., Manktelow, K., Middleton, W., Moscardini, A. O., & Wildig, S. (1995). The Implementation and Evaluation of a Hypertext System for Teaching Employment-Related Language to Hearing-Impaired School Leavers. *Journal of Microcomputer Applications, 18*(4), 319-325.

Constantinescu, G., Waite, M., Dornan, D., Rushbrooke, E., Brown, J., McGovern, J., . . . Hill, A. (2014). A pilot study of telepractice delivery for teaching listening and spoken language to children with hearing loss. *Journal of Telemedicine and Telecare, 20*(3), 135-140. doi.

Elliot, L. B., M. S. Stinson, B. G. McKee, V. S. Everhart and P. J. Francis (2001). College Students' Perceptions of the C-Print Speech-to-Text Transcription System. *Journal of Deaf Studies and Deaf Education 6*(4): 285.

Laine, C. J., & Follansbee, R. (1994). Using Word-Prediction Technology to Improve the Writing of Low-Functioning Hearing-Impaired Students. *Child Language Teaching and Therapy, 10(3*), 283-297.

Messier, J., & Wood, C. (2015). Facilitating Vocabulary Acquisition of Children With Cochlear Implants Using Electronic Storybooks. *Journal of Deaf Studies & Deaf Education, 20*(4), 356-373. doi:10.1093/deafed/env031

Mich, O., Pianta, E., & Mana, N. (2013). Interactive Stories and Exercises with Dynamic Feedback for Improving Reading Comprehension Skills in Deaf Children. *Computers & Education, 65*, 34-44. doi:10.1016/j.compedu.2013.01.016

Parton, B. S. (2017). Glass Vision 3D: Digital Discovery for the Deaf. *TechTrends, 61*(2), 141-146. doi:http://dx.doi.org/10.1007/s11528-016-0090-z

Vogel, J. J., Greenwood-Ericksen, A., & Cannon-Bowers, J. (2006). Using Virtual Reality with and without Gaming Attributes for Academic Achievement. Journal of *Research on Technology in Education, 39*(1), 105-118.

Teaching support

No references

Strategies

No references

Minority Language

No references

Inclusion

Fisher, A., Monsen, J., Moore, D. W., & Twiss, D. (1989). Increasing the Social Integration of Hearing-Impaired Children in a Mainstream School Setting. *New Zealand Journal of Educational Studies, 24(*2), 189-204.

Guardino, C., & Antia, S. D. (2012). Modifying the Classroom Environment to Increase Engagement and Decrease Disruption with Students Who Are Deaf or Hard of Hearing. *Journal of Deaf Studies & Deaf Education, 17*(4), 518-533.

References - General

Additional Learning Needs and Educational Tribunal (Wales) Act (2018).

Allen, S., Mulla, I., YenNg, Archbold, S., & Gregory, M. (2017). *Using radio aids with preschool deaf children.* Research report commissioned by the NDCS and conducted by the Ear foundation.

Ansell E, Pagliaro C; (2006) The Relative Difficulty of Signed Arithmetic Story Problems for Primary Level Deaf and Hard-of-Hearing Students, *The Journal of Deaf Studies and Deaf Education*, Volume 11, Issue 2, 1 March 2006, Pages 153–170.

Antia, S. D. (2002). Developing Membership in the Education of Deaf and Hard-of-Hearing Students in Inclusive Settings. *Journal of Deaf Studies and Deaf Education 7*(3): 214.

Antia, S. D., Jones, P., Luckner, J., Kreimeyer, K. H., & Reed, S. (2011). Social Outcomes of Students who are Deaf and Hard of Hearing in General Education Classrooms. *Exceptional Children*, *77*(4), 489-504.

Antia, S. D., Reed, S., & Shaw, L. (2011). Risk and Resilience for Social Competence: Deaf Students in General Education Classrooms. In *Resilience in Deaf Children* (pp. 139-167). Springer, New York, NY.

Antia, S.D., (2015) Balancing Individual, Family and, and School Assets and Risks for Deaf and Hard-of-Hearing Students in Deaf Education. In Knoors H., Marschark M., (Eds) *Educating Deaf Learners Creating a Global Evidence Base* pp. 527-546 Oxford University Press.

Antia, S.D., and Jones, P. (2010) *Development of risk Scale to determine services to deaf and heard of hearing students in public schools.* Paper presented at the American Education Research Association, Denver, CO.

Antia, S.D., Kreimeyer, K.H., Metz, K.K., and Spolsky, S (2011) 'Peer interactions of deaf and hard-of-hearing children'. In M. Marschark & P. E. Spencer (Eds) *Oxford handbook of deaf studies, language and education* (Vol 1, 2nd ed., pp.173-187) New York: Oxford University Press.

Antia, Shirin D., Sabers, D., & Stinson, M. (2007) 'Validity and Reliability of the Classroom Participation Questionnaire With Deaf and Hard of Hearing Students in Public Schools.' *Journal of Deaf Studies and Deaf Education*, vol. 12, no. 2, 2007, pp. 158–171. *JSTOR*.

Archbold, S. M., Nikolopoulos, T. P., Tait, M., O'Donoghue, G. M., Lutman, M. E., & Gregory, S. (2000). Approach to Communication, Speech Perception and Intelligibility After Paediatric Cochlear Implantation. *British Journal of Audiology*, *34*(4), 257-264.

Archbold, S., (2015) 'Being a Deaf student: Changes in Characteristics and Needs'. In Knoors H., Marschark M., (Eds) *Educating Deaf Learners Creating a Global Evidence Base* (2015) pp. 23-46 Oxford University Press.

Archbold, S., Ng, Z. Y., Harrigan, S., Gregory, S., Wakefield, T., Holland, L., & Mulla, I. (2015). Experiences of Young People with Mild to Moderate Hearing Loss: Views of Parents and Teachers. *The Ear Foundation Report to National Deaf Children's Society (UK)*, 1-47.

Arends, N., D.-J. Povel, E. Van Os, S. Michielsen, J. Claassen and I. Feiter (1991). An Evaluation of the Visual Speech Apparatus. *Speech Communication 10*(4): 405-414

Asher, S.R. and Macdonald, K.L. (2009) The behavioural Basis of Acceptance , Rejection, and Perceived Popularity. In K.H. Rubin, W.M. Bukowski and B. Laursen (Eds) *Handbook of peer interactions, relationships, and groups.* New York: Guilford.

Bat-Chava, Y. (1993). Antecedents of Self-Esteem in Deaf People: A Meta-Analytic Review. *Rehabilitation Psychology*, *38*(4), 221.

Bavelier, D., Dye, M. W. G., & Hauser, P. C. (2006). Do Deaf Individuals See Better? *Trends in Cognitive Sciences*, *10*, 512–528.

Bloom, L., and Lahey, M. (1978) *Language Development and Language Disorders.* New York: John Wiley.

Booth, T. and Ainscow, M. (1998). *From them to us: An International Study of Inclusion in Education*. Psychology Press.

Brereton, A. E. (2010). Is Teaching Sign Language in Early Childhood Classrooms Feasible for Busy Teachers and Beneficial for Children? *YC Young Children 65*(4): 92-97.

BSA (2011) Recommended Procedure.Pure-Tone Air-Conduction and Bone-Conduction Threshold Audiometry with and without Masking.

Caselli M.C., Rinaldi P., Onofrio D., Tomasuolo E. (2015) 'Language Skills and Literacy of Deaf Children in the Era of Cochlear Implementation' in (in Eds Knoors H., and Marschark M.) *Educating Deaf Learners: Creating a global evidence base* Oxford University Press

Cawthon, S. W., Winton, S. M., Garberoglio, C. L., & Gobble, M. E. (2010). The effects of American Sign Language as an Assessment Accommodation for Students who are Deaf or Hard of Hearing. *Journal of Deaf Studies and Deaf Education*, *16*(2), 198-211.

Collins, A., Coughlin, D., Miller, J. & Kirk, S. (2016). *The Production of Quick Scoping Reviews and Rapid Evidence Assessments: A How to Guide*. Department for Environment Food and Rural Affairs.

Constantinescu, G., Phillips, R. L., Davis, A., Dornan, D., & Hogan, A. (2015). Exploring the Impact of Spoken Language on social Inclusion for Children with Hearing Loss in Listening and Spoken Language Early Intervention. *The Volta Review*, *115*(2), 153-181.

CRIDE. (2017). CRIDE 2017 Survey.

Dammeyer, J. (2009). Psychosocial Development in a Danish Population of Children with Cochlear Implants and Deaf and Hard-of-Hearing Children. *Journal of Deaf Studies and Deaf Education*, *15*(1), 50-58.

Davis, P., & Florian, L. (2004). *Teaching Strategies and Approaches for Pupils with Special Educational Needs*: A scoping study. Nottingham: DfES Publications.

DeLuzio, J., & Girolametto, L. (2011). Peer Interactions of Preschool Children with and without Hearing Loss. J*ournal of Speech, Language, and Hearing Research, 54*(4), 1197-1210.

Dye, P., Hauser, P., & Bavelier, D. (2008). Visual Attention in Deaf Children and Adults: Implications for Learning Environments. In M. Marschark & P. Hauser (Eds.), *Deaf cognition* (pp. 250–263). New York, NY: Oxford University Press.

Ebrahim, F. (2006). Assessing Creative Thinking Abilities of Deaf Children. *International Journal of Special Education,* 21 (1), 153-163.

Eriks-Brophy, A., A. Durieux-Smith, J. Olds, E. Fitzpatrick and et al. (2006). Facilitators and Barriers to the Inclusion of Orally Educated Children and Youth with Hearing Loss in Schools: Promoting Partnerships to Support Inclusion. *The Volta Review 106(*1): 53-88.

Fellinger, J., Holzinger, C. Beitel, M. Laucht & Goldberg, D. (2009). The Impact of Language Skills on Mental Health in Teenagers with Hearing Impairments. *Acta Psychiatrica Scandinavica 120*(2): 153-159.

Ferrell, K. A., Bruce, S., & Luckner, J. L. (2014). *Evidence-Based Practices for Students with Sensory Impairments* (Document No. IC-4). Retrieved from University of Florida, Collaboration for Effective Educator, Development, Accountability, and Reform Center website.

Garberoglio, C. L., Schoffstall, S., Cawthon, S., Bond, M., & Caemmerer, J. M. (2017). The Antecedents and Outcomes of Autonomous Behaviors: Modeling the Role of Autonomy in Achieving Sustainable Employment for Deaf Young Adults. *Journal of Developmental and Physical Disabilities*, *29*(1), 107-129.

Garrison W, Long G, Dowaliby F. (1997). Working Memory Capacity and Comprehension Processes in Deaf Readers. *Journal of Deaf Studies and Deaf Education , 2,* 78-94.

Geers, A. E. (2002). Factors Dffecting the development of Speech, Language, and Literacy in Children with Early Cochlear Implantation. *Language, Speech, and Hearing Services in Schools*, *33*(3), 172-183.

Geers, A. E. (2003). Predictors of Reading Skill Development in Children with Early Cochlear Implantation. *Ear and hearing*, *24*(1), 59S-68S.

Gheysen, F., Loots, G., & Van Waelvelde, H. (2007). Motor development of deaf Children with and without Cochlear Implants. *Journal of deaf studies and deaf education*, *13*(2), 215-224.

Gottardis, L., Nunes, T., & Lunt, I. (2011). A synthesis of Research on Deaf and Hearing Children's Mathematical Achievement. *Deafness & education International*, *13*(3), 131-150.

Gregory S (1998) *Mathematics and Deaf Children*. In S Gregory, P Knight, W McCracken, S Powers, L Watson (eds) Issues in Deaf Education. London: Fulton, pp. 119–128.

Harris, M., Terlektsi, E., & Kyle, F. E. (2017a). Literacy Outcomes for Primary School Dhildren who are deaf and Hard of Hearing: A Cohort comparison Study. *Journal of Speech, Language, and Hearing Research*, *60*(3), 701-711.

Harris, M., Terlektsi, E., & Kyle, F. E. (2017b). Concurrent and Longitudinal Predictors of Reading for Deaf and Hearing Children in Primary School. *The Journal of Deaf Studies and Deaf Education*, *22*(2), 233-242.

Hermans, D., Vugs, B., van Berkel-van Hoof, L., & Knoors, H. (2015). Deaf Children's Executive Functions. *Educating deaf learners: Creating a global evidence base*, p 231-260).

Hoover, W. A., & Gough, P. B. (1990). The Simple View of Reading. *Reading and writing*, *2*(2), 127-160.

Houghton-Carr, H. A., Boorman, D. B., & Heuser, K. (2013). *Land Use, Climate Change and Water Availability: Phase 2a-Development of the Rapid Evidence Assessment protocol*. Wallingford, UK, NERC/Centre for Ecology & Hydrology, 19pp. (UNSPECIFIED) (Unpublished)

Huber, M., B. Pletzer, A. Giourgas, A. Nickisch, S. Kunze and A. Illg (2015). Schooling Relates to Mental Health Problems in Adolescents with Cochlear Implants - Mediation by Hearing and Family Variables. *Frontiers in Psychology 6*.

Hulsing, M. M., B. Luetke-Stahlman and D. F. Loeb (1995). Analysis of Successful Initiations of Three Children with Hearing Loss Mainstreamed in Kindergarten classrooms. *Language, Speech & Hearing Services in Schools 26*: 45-57.

Iowa Department of Education Bureau of Student Family Support Services (2013). *The Expanded Core Curriculum for Students who are Deaf or Hard of Hearing*. Accessed December 2017:

Kafai, Y. (2001). The Educational Potential of Electronic Games: From games-to-Teach to Games-to-Learn. *Playing By The Rules, Cultural Policy Center, University of Chicago, Chicago, IL, 2001*.

Kelly R., Lang H.G., Pagliaro C. (2003). Word Problem Solving for Deaf Students: A Survey of Practices in Grades 6-12' *Journal of Deaf Studies and Deaf Education* 2003; 8 920: 104-119.

Knoors H., Marschark M., (2014) *Teaching Deaf Learners: Psychological and Developmental Foundations* 'Multimedia-enhanced, Computer-assisted Learning for Deaf Students' Oxford University Press

Knoors, H., Marschark M (2014) Teaching Deaf Learners: Psychological and Developmental Foundations Oxford University Press.

Kritzer, K.L. (2009) Family Mediation of Mathematically Based Concepts While Engaged in a Problem-Solving Activity with their Young Deaf Children. *Journal of Deaf Studies and Deaf Education, 13, 503-517.*

Kyle, F. E., & Harris, M. (2010). Predictors of Reading Development in deaf Children: A 3-year Longitudinal Study. *Journal of experimental child psychology*, *107*(3), 229-243.

Langereis, M. and A. Vermeulen (2015). School Performance and wellbeing of Children with CI in different Communicative-Educational Environments." *International Journal of Pediatric Otorhinolaryngology 79*(6): 834-839.

Luckner, J. L., Bruce, S. M., & Ferrell, K. A. (2016). A Summary of the Communication and Literacy Evidence-Based Practices for Students Who Are Deaf or Hard of Hearing, Visually Impaired, and Deafblind. *Communication Disorders Quarterly, 37(4),* 225-241.

Luckner, J.L. and Muir, S. (2001). Successful students who are Deaf in General Education Settings. *American Annals of the Deaf, 146* (5), 450-461.

Mäki, H. S., Voeten, M. J., Vauras, M. M., & Poskiparta, E. H. (2001). Predicting Writing Skill Development with Rord recognition and Preschool Readiness Skills. *Reading and Writing, 14*(7-8), 643-672.

Marchark M., Lang HSG., Albertini J.A. (2002) *Educating Deaf Students: from Research to Practice* New York: Oxford University Press.

Marschark M, Morrison C, Lukomski J, Borgna G, Convertino C (2013) Are Deaf Students Visual :earners? *Learning and Individual Differences,* 25, 156-162.

Marschark, M., & Everhart, V. S. (1999). Problem-Solving by Deaf and Hearing Students: Twenty Questions. *Deafness & Education International*, *1*(2), 65-82.

Marschark, M., & Hauser, P. C. (2011). *How Deaf Children Learn: What Parents and Teachers Need to Know*. OUP USA.

Marschark, M., and Knoors, H. (2012) Educating Deaf Children: Language, Cognition and Learning. *Deafness and Education International, 14, 137-161.*

Marschark, M., Green, V., Hindmarsh, G., & Walker, S. (2000). Understanding Theory of Mind in Children who are Deaf. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *41*(8), 1067-1073.

Marschark, M., Pelz, J., Convertino, C., Sapere, P., Arndt, M. E., & Seewagen, R. (2005). Classroom Interpreting and Visual Information Processing in Mainstream Education for Deaf Students: Live or Memorex®? *American Educational Research Journal*, *42*, 727–762.

Mayer, C., & Trezek, B. J. (2017). Literacy outcomes in deaf students with cochlear implants: current state of the knowledge. *The Journal of Deaf Studies and Deaf Education*, *23*(1), 1-1.

Mayer, R.E. (2003) .The Promise of Multimedia Learning: 'Using the Same Instructional Design Methods across Different Media. *Learning and Instruction, 13, 125-139.*

McLinden, M. and Douglas, G. (2014) *Education of Children with Sensory Needs: Reducing Barriers to Learning for Children with Visual Impairment.* In: A. Holliman (Ed), Educational Psychology: An International Perspective. Routledge. pp246-255.

Minnett, A., Clark, K., & Wilson, G. (1994). Play Behavior and Communication Between Deaf and Hard of Hearing Children and Their Hearing Peers in an Integrated Preschool. *American Annals of the Deaf*, *139*(4), 420-429.

Moores, D., Jatho, J. and Dunn, C. (2001). *Families with Deaf members. American annals of the deaf, 1996 to 2000', American Annals of the Deaf, 146*, 245-304.

NatSIP (2016). *Supporting Deaf Young people Through Transition.*

NDCS (2013). *The Future Delivery of Education Services in Wales*.

NDCS (2015). *Access Arrangements for Your Child's Examinations*.

Nelson, J. et al (2011). *Food Growing Activities in Schools. Report submitted to Defra.* Slough: National Foundation for Educational Research

Nikolaraizi, M., & Hadjikakou, K. (2006). The role of Educational Experiences in the Development of Deaf Identity. *Journal of deaf studies and deaf education*, *11*(4), 477-492.

Northern, J. L., & Downs, M. P. (2002). *Hearing in Children*. Lippincott Williams & Wilkins

Norwich, B. (2007). *Dilemmas of Difference, inclusion and Disability: International Perspectives and Future Directions*. Routledge.

Oliva, G. (2004) *Alone in the Mainstream. A Deaf Woman Remembers Public School.* Washington, DC: Gallaudet University Press.

Oster, A.-M. (1989). Applications and Experiences of Computer-Based Speech Training. *Speech Transmission Laboratory Quarterly Progress and Status Report 4(*Oct-Dec): 37-44.

Oster, A.-M. (1995). Teaching Speech Skills to Deaf Children by Computer-Based Speech Training. *Speech Transmission Laboratory Quarterly Progress and Status Report 4(Oct-Dec)*: 67-75.

Pagliaro, C. M., & Ansell, E. (2012). Deaf and Hard of Hearing students' Problem-Solving Strategies with Signed Arithmetic Story Problems. *American Annals of the Deaf*, *156*(5), 438-458.

Pagliaro, C. M. (1998). Mathematics Preparation and Professional Development of Deaf Education Teachers. *American Annals of the Deaf, 143*(5), 373-9.

Pagliaro, C.M. Ansell E. (2002). Story problems for the Classroom: Frequency and Mode of Presentation' *Journal of Deaf Studies and Deaf Education* 2002: 7 (2): 107-119.

Paul, P. V. (2001). *Language and deafness* (3rd Ed.). San Diego.

Pimperton, H., & Kennedy, C. R. (2012). The Impact of Early Identification of Permanent Childhood Hearing Impairment on Speech and Language Outcomes. *Archives of Disease in Childhood, 97*, 648-653. doi:10.1136/archdischild-648 2011-301501.

Powers, S. (2001). Investigating Good Practice in Supporting Deaf Pupils in Mainstream Schools. *Educational Review*, *53*(2), 181-189.

Qi, S and Mitchell, R.E. (2012) Large-Scaled Academic Achievement Testing of Deaf and Hard-of Hearing Students: Past, Present and Future. *Journal of deaf studies and deaf education,* 17, 1-18.

Qi, S., & Mitchell, R. E. (2011). Large-Scale Academic Achievement Testing of Deaf and Hard-of-hearing Students: Past, Fresent, and future. *Journal of Deaf Studies and Deaf Education*, *17*(1), 1-18.

Rieber, Lloyd P. (1996). Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games. *Educational Technology Research and Development* 44, no. 2 (1996): 43-58.

Salter, J. M., Swanwick, R. A., & Pearson, S. E. (2017). Collaborative Working Practices in Inclusive Mainstream Deaf Education Settings: Teaching Assistant Perspectives. *Deafness & Education International*, *19*(1), 40-49.

Sass-Lehrer M. (2012) Early Intervention for Children Birth to 3: Families, Communities, and Communication. In L.A. Schmeltz (Ed.) *A resource guide for early hearing detection and intervention* pp. 10-1-10-16.

Segers E. and Verhoeven L. (2015) Benefits of Technology-Enhanced Learning for Deaf and Heard of Hearing Students. In Knoors H., and Marschark M. (Eds.) *Educating Deaf Learners: Creating a global evidence base* Oxford University Press.

Sharples J, Webster R and Blatchford P (2015) *Making Best Use of Teaching Assistants Guidance Report*, Education Endowment Foundation. https://v1.educationendowmentfoundation.org.uk/uploads/pdf/TA_Guidance_Report_Interactive.pdf

StatsWales (2018a). *Pupils by Local authority, Region and Welsh Medium Type (2017/18)*.

StatsWales (2018b). *Reports of Special Educational Needs (SEN) in Primary, Middle and Secondary Schools by Local Authority, SEN Provision, Welsh/English Medium, and Type of Need (2017/18)*.

Stevenson, J., Kreppner, J., Pimperton, H., Worsfold, S., & Kennedy, C. (2015). Emotional and Behavioural Difficulties in Children and Adolescents with Hearing impairment: A Systematic Review and Meta-Analysis. *European Child & Adolescent Psychiatry*, *24*(5), 477-496.

Stevenson, J., McCann, D., Watkin, P., Worsfold, S., Kennedy, C., & Hearing Outcomes Study Team. (2010). The Relationship Letween language Development and Behaviour Problems in Children with Hearing Loss. *Journal of Child Psychology and Psychiatry*, *51*(1), 77-83.

Stevenson, J., Pimperton, H., Kreppner, J., Worsfold, S., Terlektsi, E., & Kennedy, C. (2017). Emotional and Behaviour Difficulties in Teenagers with Permanent Childhood Hearing Loss. *International journal of pediatric otorhinolaryngology*, *101*, 186-195.

Stinson, M. S. and Y. Liu (1999). Participation of Deaf and Hard-of-Hearing Students in Classes with Hearing Students. *Journal of Deaf Studies and Deaf Education 4*(3): 191.

Swanwick R., Oddy A., and Roper, T. (2005). Mathematics and Deaf Children: An Exploration of Barriers to Success' *Deafness and Education International,* 7:1, 1-21.

Tobey, E. A., D. Rekart, K. Buckley and A. E. Geers (2004). Mode of Communication and Classroom Placement Impact on Speech Intelligibility. *Archives of Otolaryngology-Head & Neck Surgery 130*(5): 639-643.

Valentine, G., & Skelton, T. (2007). Re-defining 'Norms': D/deaf Young People's Transitions to Independence. *The sociological review*, *55*(1), 104-123.

Von Hohendorff, J., Couto, M., & Prati, L. E. (2013). Social Skills in Adolescence: Psychopathology and Sociodemographic Variables. *Estudos de Psicologia (Campinas)*, *30*(2), 151-160.

Webster, R., & Blatchford, P. (2013). The Educational Experiences of Pupils with a Statement for Special Educational Needs in Mainstream Primary Schools: Results from a Systematic Observation Study. *European journal of special needs education*, *28*(4), 463-479.

Webster-Stratton, C., Reid, M. J., & Hammond, M. (2004). Treating Children with Early-Onset Conduct Problems: Intervention Outcomes for Parent, Child, and Teacher Training. *Journal of Clinical Child and Adolescent Psychology*, *33*(1), 105-124.

Wiefferink, C. H., Rieffe, C., Ketelaar, L., De Raeve, L., & Frijns, J. H. (2012). Emotion Understanding in Deaf Children with a Cochlear Implant. *Journal of deaf studies and deaf education*, *18*(2), 175-186.

Wiegersma, P. H., & Velde, A. V. (1983). Motor Development of Deaf Children. *Journal of child Psychology and Psychiatry*, *24*(1), 103-111.

Wolters and Isarin (2015). 'Reciprocity in School Peer Relationships of Deaf and Hard-of-Hearing Early Adolescents'. In Knoors H., Marschark M., (Eds) *Educating Deaf Learners Creating a Global Evidence Base*. Oxford University Press, pp 311-335.

Wood D, Wood H, Griffiths A, Howarth S (1986) *Teaching and Talking with Deaf Children. Chichester*: John Wiley.

Wood D, Wood H, Griffiths A, Howarth S (1986) *Teaching and Talking with Deaf Children. Chichester*: John Wiley.

Xie, Y. H., Potměšil, M., & Peters, B. (2014). Children who are Deaf or Hard of Hearing in Inclusive Educational settings: A Literature Review on Interactions with Peers. *Journal of deaf studies and deaf education*, *19*(4), 423-437.

Annex B - database sources and search terms

Stage 1: literature search and inclusion/exclusion criteria framework

The aim of stage 1 was to carry out searches using the databases and search terms specified below and to apply an inclusion/exclusion criteria framework.

Databases

In the inception report it was stated that seven databases would be searched to identify the literature. Following advice from the subject-specialist librarian at the University of Birmingham and discussion with the funder, it was decided to complete searches within four of those databases. The reasons for inclusion or exclusion of each database are provided in the table below.

Table 97: REA stage 1 databases

Included?	Database	Rationale for inclusion/exclusion
Searched	**EBSCO Education Databases**	Provides a platform on which a search can be undertaken across five important databases in the field of education – British Education Index (BEI; Child Development and Adolescent Studies; Education Administration Abstracts; Education Abstracts and ERIC (an American education database).
Searched	**PsychInfo**	Provides abstracts and citations to the scholarly literature in the psychological, social, behavioural and health sciences.
Searched	**Proquest Social Sciences**	A social sciences database platform which includes databases also contained within EBSCO Education Databases, but also some additional relevant databases.
Searched	**Web of science**	Added following Inception Meeting.

Not searched	**Education Research Abstracts not searched**	This database does not allow sophisticated searches (combination of searches). The subject specialist librarian advised that the sources included in this database would have already been retrieved by the searches within the other comprehensive databases (particularly EBSCO).
Not searched	**Medline (including CINAHL plus) Medline- not searched**	This database is included in the Web of Science database.
Not searched	**Science Direct:- not searched**	The subject specialist librarian advised us that the sources included in this database would have already been retrieved by the searches within the Web of Science database.

A number of other generic databases and known websites were identified in the Inception Report.

Generic databases

- **Google Scholar -** search engine for "scholarly" literature. http://scholar.google.co.uk
- **E-thesis** (PhD and Master thesis)
- **Ingenta Connect Portal** for scholarly publishers. www.ingentaconnect.com

Hand searching of known websites for reports

- Nuffield Foundation www.nuffieldfoundation.org/
- National Deaf Children's Society (NDCS)
- Action on Hearing loss
- British Association of Teachers of the Deaf (BATOD)
- National Sensory Impairment Partnership (NatSIP) https://www.natsip.org.uk/
- Other professional journals or websites for HI, VI and MSI

Search structure

Our broad search involved a series of searches with the following structure (the detailed search terms follows in the next section):

[Age] AND [Sensory Impairment X 3]

AND

[Educational strategy]]

Search terms

An asterisk was used for truncation in some of the databases for quicker searching: for example, "visual* impair*" would found instances of "visual impairment" as well as "visually impaired", and "child*" found articles with "child" and "children" as well as other possible variations of the word.

Age (using Boolean operator OR)
Child* OR student* OR pupil* OR pre-school OR "post school" OR transition OR kindergarten OR youth OR "young people" OR teenagers OR adolescent* OR "early years"

Sensory impairment: Hearing Impairment (using Boolean operator OR)
"Hearing impair*" OR deaf* OR "Deaf and Hard of Hearing" OR "Deaf or Hard of Hearing" OR "hearing loss" OR "Permanent Childhood Hearing Loss" OR PCHL

Educational strategy
The thirteen strategies listed below were be searched for individually (each using Boolean operator OR), and repeated with some adjustment for each sensory impairment group.
1) Communication
Auditory OR Oral OR Sign OR "Sign bilingual" OR "Cued Speech" OR "Visual phonics" OR "Manually coded sign systems" OR "Objects of reference" OR

"Calendar systems" OR "Voice output" OR "Haptics" OR "social haptics" OR "Adapted signing" OR "Smell cues" OR "On body signs"

2) Literacy

Reading OR Writing OR "Metacognition and reading Comprehension" OR "Emergent literacy" OR Phonology OR "Phonological awareness" OR "Phonemic skills" OR "Visual phonics" OR Vocabulary OR "Syntactic Knowledge"

3) Mathematics

Numeracy OR "Math* problems" OR "Math* concepts", "visual spatial abilities" OR quantity

4) Access to examinations

Exam OR Examination OR "Assessment accommodation" OR "Access arrangements"

5) Mobility and Independence

Habilitation OR mobility OR independence OR ILS OR "independent living skills" OR "daily living" OR "activities of daily living" OR orientation OR O&M OR M&I

6) Cognitive skills

Cognition OR Play OR "Theory of Mind" OR "Visual attention" OR Perception

7) Social and emotional functioning

Social OR Emotional OR Assertiveness OR Resilience OR "Self concept" OR "Self-worth" OR "Deaf identity" OR Friendship OR Behaviour OR Interpersonal OR "Well being" OR "Peer training" OR "Peer awareness" Buddy OR "Circle of friends" OR "Self advocacy"

8) Use of technology

"Cochlear implant" OR "Hearing aids" OR "FM systems" OR "Acoustics ICT" OR Computer OR "Mobile technology" OR "Assistive technology" OR "Enabling technology" OR "Access technology"

09) Teaching support

"Learning Support assistant" OR LSA OR "Teaching Assistant" OR TA OR "Communication Support worker" OR Intervenor

10) Strategies

"Co-active movement" OR "Preparation of teaching materials" OR "Audio description" OR "Subtitle" OR "Enlarged print" OR "Simplified language"

11) Minority language

Catalonia OR Catalan OR Basque OR Brittany OR Breton OR Frisian OR Welsh OR Gaelic OR Irish OR "Minority ethnic" OR "Minority language*" OR bilingual OR "dual language"

12) Inclusion

Acceptance OR Rejection OR Modification OR Learning styles OR Pre-teaching OR "post teaching" OR "School environments" OR "Person centred learning"

Hand searches generic databases and relevant websites

deaf OR ’hearing impaired’ child Reading OR Writing

deaf OR ‘hearing impaired’ child Phonology OR "Phonological awareness

deaf OR ‘hearing impaired’ child mathematics OR numeracy

deaf OR ‘hearing impaired’ child exam OR ‘access arrangement

deaf OR ‘hearing impaired’ child independence

deaf OR ‘hearing impaired’ child cognition OR Theory of Mind

deaf OR ‘hearing impaired’ child Social OR Emotional

deaf OR ‘hearing impaired’ child Friendship OR Behaviour

deaf OR ‘hearing impaired’ child Cochlear implant" OR "Hearing aids"

deaf OR ‘hearing impaired’ child Learning Support assistant"

deaf OR ‘hearing impaired’ child OR preparation

Filtering by types of materials and relevance criteria

In each of the four databases the ‘filter’ setting was used to enable us to select only the types of materials under the ‘inclusion criteria’

Table 18: Types of materials – inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Peer reviewed academic journals	Websites not hosted by a recognised organisation as determined by the reviewers. Decision making will be documented.
Professional journals	Personal blogs
Expert opinion*	Personal opinions of interventions (presented online)
Students' work, PhD and Masters dissertations	Newspapers

Note * expert opinion must be written and published by a professional body or reputable publisher, and the author has considerable experience in the field. This will be determined by the reviewers and decision making will be documented.

An additional filter was used to enable us to select the materials under the relevance inclusion criteria.

Table 109: Relevance – inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Date	1980 onwards*	Older than 1980
Language	English or Welsh	Any other language
Geographical location**	International	No exclusion
Population age	0-25	25 onwards

** date 1980* – this date was chosen as an approximate time scale when education practice in relation to disability started to more clearly reflect current practice (e.g. in England and Wales through the 1981 Education Act). The time period also reduces the search results while still including evidence from approximately the last 40 years.

** Location – the focus of the search was agreed to be research undertaken in OECD countries but this was not an available search criteria in. This criteria was therefore applied in stage 2.

Stage 2: Refining the search

The aim of the second stage was to narrow the material down from the initial search by offering a detailed consideration of each source to ensure the most relevant material is selected.

A separate Endnote database for each subject area was created. The sources in each Endnote database were scrutinised based on the inclusion and exclusion criteria regarding the relevance of the study. Although the 'location' filter in each database (stage 1) assisted in selecting sources only from OECD countries, the sources were further scrutinised (reading the abstracts) for geographical location

In terms of relevant to the aim of the study, this is defined as the extent to which educational interventions are effective (or not) for hearing impairment with the purpose of improving targeted outcomes. Where research is related to technology, this technology should be current and has not been superseded by new technology / approaches which means the intervention is no long relevant. Also, to be relevant the intervention should not be *solely* about a medical intervention (e.g. cochlear implant operation), nor solely about the provision of a technical aid (e.g. hearing aid, radio aid), but should be about the educational intervention around this. Furthermore, while interventions should have an education focus they should be additional to or different from those provided as part of, for example, a school's usual differentiated curriculum and strategies.

Initial sorting of materials for each sensory field

Following discussions with the funder, it was noted that the commissioned sensory REAs were very broad in focus, rather than focussing upon a specific type of intervention or targeted educational outcome. All three REAs were linked to all educational outcomes, which the team sought to simplify into thirteen areas (see search terms in section '**Annex B - database sources and search terms**

Stage **1: literature search and inclusion/exclusion criteria framework**'). This can be contrasted with other REAs undertaken in other disciplines which might seek evidence of the successful interventions in relation to much narrower target outcomes (for example in relation to ADHD, the focus may be linked to the reduction in particular defining behaviours).

In addition to the point about breadth of the review, there is a related challenge of defining the term 'intervention'. Our working definition of an intervention study was outlined in the proposal as studies which sought to describe the effect of some kind of educational

approach upon a targeted outcome. These studies might be qualitative designs, controlled trials, or single subject designs.

In order to contextualise this definition further, the invitation to tender offers the following definition of the interventions of interest:

“For the purposes of this research, an intervention is defined as SEP [special educational provision] as set out in the Education Act 1996 ‘education provision which is additional to or otherwise different from the education provision made generally for children of their age in maintained schools, other than special schools, in the area. For children aged under two SEP is considered to be education provision of any kind.” (p11)

Our proposal also unpicked special educational provision further and made a distinction between.

(1) **Inclusive practice and differentiation**: ensuring that the child’s environment is structured to promote inclusion and learning throughout their education.

(2) **Additional learning provision:** supporting the child to learn distinctive skills in order to afford more independent learning.

Such a broad and inclusive definition of intervention is helpful in ensuring valuable evidence is included in these REAs which are broad in scope. Nevertheless, such a definition is difficult to operationalise. The working solution was to make a distinction between the following categories of sources: (1) 'excluded/ not relevant'; (2) 'good practice'; and (3) 'intervention'. The table below outlines the criteria for this categorisation.

Table 20: Working definitions of categorisation of sources – (1) 'excluded/not relevant'; (2) 'good practice'; and (3) 'intervention'.

Category	Definition	Example
1. Excluded/not relevant	The source is not linked to a relevant *educational* intervention or outcome (e.g. it is medical in focus), or the source does not provide an analysis of educational practice.	(1) Impact of cochlear implants upon functional hearing. (2) A survey of teacher preparation or parent attitudes not linked to educational practice.
2. Good practice	The source is linked to *educational* practice. While it does not provide evidence of an effect of that practice upon target outcomes, it provides evidence and rationale for the differentiated education provision.	Evidence of the predictors of reading for deaf children
3. Intervention	The source presents evidence of the effect of some kind of educational approach upon a targeted educational outcome(s).	The trial of a reading intervention to measure the effect upon children's reading performance.

Based upon these working definitions all the sources in each Endnote database were categorised into (1) 'excluded/not relevant'; (2) 'good practice'; and (3) 'intervention', and this is reported upon in the sections which follow.

Stage 3: Protocol for inter-rater reliability of robustness scoring

An inter-rater reliability check was performed based on the following protocol:

1. Quality rater 1 (QR1) to identify 25 % of articles from each category (12 categories). If necessary round up the number of papers e.g. 25% = 2.75, rate 3 papers. The selection of the articles to be given to Quality Rater 2 (QR2) is based on the following criteria:

Only one article by author in each category.

A variety of methods when possible. If the category includes interventions with a range of methodology , select a sample different designs of interventions (e.g. trials, case study etc)

A range of scores. If possible the selected articles should reflect the range of scores given (i.e. 1, 2, 3).

2. Quality Rater 2 (QR2) to rate each selected article blindly
3. The total mean scores from each rater are entered in two columns in excel (QR1, QR2)
4. Calculation of inter-rater agreement (percentage)

The scores from the two raters will be entered into columns in excel (QR1 and QR2).

Agreement will be calculated based on the two scoring categories (1- 1.9: impressionistic to moderate evidence, 2-3 moderate to strong evidence)

The agreement of the two raters will be entered in a third column. When the scores of the two raters agree on these two scoring categories (i.e score is anywhere between 1-1.9 or between 2-3) then a score of 1 will be given. If the scores of the two raters are in a different scoring category (e.g the first rater scores 1.6 and the second 2.5) then a score of 0 will be given in the third column.

The number of agreement (i.e the number of 1s) will be added and divided by the number of the articles that were rated by both raters and multiplied by 100.

Example is given below:

A	B	C
QR1	**QR2**	**Agreement (1-1.9 and 2-3)**
1.9	2.3	0
2.1	2.6	1
2.3	2.1	1
2	1.8	0
2.3	2.3	1
1.3	1.4	1
2.4	2.5	1
2.8	2.6	1
	Average (sum divided by the number of articles rated)	**0.75**
	Percentage of agreement 75%	**75%**

5. In the above example 8 articles were rated, for 6/8 articles there was agreement on the scores (in the same category of 1-1.9 or 2-3). The agreement was 75%.

6. Discussion between the two raters where there is no agreement in their scores (a score of 0 was given in the agreement column). In this case, the raters need to discuss and reach a conclusion on the score that will be assigned to each article. This will be discussed by looking at the individual components' score.

7. After rating QR2 to read the 'extracting info' section and to add or amend text as necessary.

Stage 4: Data extraction

A predefined spreadsheet template was developed to facilitate recording of the most important details of each study on intervention to provide a comprehensive overview. This template (record) includes the following details (fields) for each article:

- Title and authors with full reference or web address
- Funder of the research study
- Authors' affiliations
- Welsh specific data
- Theme of the intervention linked to the educational outcomes (12 categories)
- Methodology – including aims, objectives, sample size etc.
- Participants including the following details:
    - Sample size
    - Age group covered
    - Gender
    - Ethnicity
    - Socioeconomic data:
    - Details related to the characteristics of the participants with specific sensory impairment (e.g. degree of sensory loss)
- Design of the research and intervention details:
    - The nature of the intervention / independent variable under investigation.
    - Case study; Action Research; Longitudinal study; Trial; Control trial; Single subject design
- Pre and post measures
- Data Issues – Quality and Limitation
- Key findings summarising the effectiveness of the intervention
- Author's conclusions and recommendations covering the key messages from the article
- Confidence scoring of robustness of the articles (see below).
- OTHER comments – any other reviewer comments which may support the writing upon the report as a whole and/or synthesising the findings (e.g. noting opinions about the applicability – or otherwise – of the findings in the opinion of the reviewer, which were not reported by the original authors),