CHAPTER 4

DATABASE SYSTEMS

IN EARLY COMMUNICATION INTERVENTION

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Aim: The aim of the chapter is to discuss the research applications of information technology in early intervention in order to provide the underpinnings for a database system in second-generation research in early communication intervention.

4.1 INTRODUCTION

The developing field of early communication intervention (ECI) in South Africa requires research generating activities in order to accelerate the process of establishing the discipline in all contexts and demonstrate effective and relevant services. As research is the way to increase understanding about unresolved problems (Leedy, 1997), the need for data to guide the development of the field of ECI in South Africa is imperative. Rossetti (1996) urges not only researchers, but also early intervention (EI) professionals to become involved in the process of research in order to provide documentation, data, comparative information and empirical comparisons to demonstrate the effectiveness of early communication intervention (ECI).

Although ECI is still in its infancy in South Africa, it is well established in certain centres and developing nationwide (Louw, 1997; Haasbroek, 1999). However, ECI in South Africa is still facing first-generation research issues such as proving its effectiveness to health and education service providers and to reach consensus, as stated by Guralnick (1997), about society's responsibility to provide ECI services. In the South African Speech Language and Hearing Association's (SASLHA) Guidelines for Speech-Language Therapists and Audiologists regarding ECI, Louw (1997) indicates that the identification and prediction of which infants and toddlers are likely to need ECI is the starting point

of the provision of effective services. ECI in South Africa is therefore still engaged in first-generation research issues, but needs to accelerate the development of the local field to participate in second-generation EI research activities. According to Guralnick (1997) second-generation research in EI must strive to provide empirical data about strategies and processes to design individualized programmes to meet the unique needs of young children and their families in all contexts. The application of information technology to stimulate research generating activities needs to be investigated as it offers certain benefits which exceeds those of conventional research methodologies. The greatest impact of information technology is demonstrated in the functions of data capturing, data structuring, analysis, reporting, retrieval and generating queries (Nieuwoudt, 2000).

Rapid advances in information technology have been proven to greatly benefit research activities across disciplinary fields. An example of the importance the field of education affords to information technology in the 21st century is the establishment of the Twenty-first Century Conceptual Tools Center at Purdue University (TCCT Center, 1999). Since the central mission of the TCCT Center is to identify the most important concepts and abilities necessary for success in the technology-based age of information, it is clear that information technology is envisaged as the driving force of advances in research and all its applications.

The application of information technology in ECI research appears a pertinent and logical collaborative effort to equip the field for the 21st century and specifically address the problem stated by Guralnick (1997) of collecting information to more effectively match programme features with child and family characteristics and desired ECI outcomes. It appears, however, that the collecting of client data in a database system and using it for research purposes is not widely applied in the field of speech-language pathology or ECI. The aim of the chapter is to investigate the application of information technology in EI in

order to provide background knowledge for the design of a customized database system to be used in ECI research.

4.2 INFORMATION TECHNOLOGY IN SPEECH-LANGUAGE PATHOLOGY RESEARCH

The application of information technology in speech-language pathology research currently extends far beyond the use of computer packages for the statistical analysis of data. The use of information technology in speech-language pathology research is well-established and ranges from providing the researcher access to information retrieval systems via the Internet (Kuster & Poburka, 1998; Robinson, Cole & Kellum, 1996) to computerized language sample analysis tools such as the CHILDES project (MacWhinney, 1996) and the Language Sample Analysis (LSA) (Miller, Freiberg, Rolland & Reeves, 1992), various software programmes for speech and voice analysis and recognition, the extensive research based on computer technology in the field of augmentative communication (Curtis, 1987) and database systems to support longitudinal research (García-Sánchez, 1999; Mandeville, Raymond & Anderson, 1988).

The two editions of *Seminars in Speech and Language* (Volume 20, Numbers 2 & 3, 1999) devoted to technological applications for speech and language assessments and interventions indicate the extent of information technology–based research supporting clinicians in assessing and treating clients representing the whole spectrum of communication disorders. Despite the vast number of software programs available to enhance clinical interventions, it appears that information technology is underutilized in speech-language pathology (Nelson & Masterson, 1999). As indicated by a 1997 ASHA survey, clinicians appear to be reluctant to venture beyond the word processing functions of their computers and the use of information technology for clinical purposes is currently limited (Nelson & Masterson, 1999).

This situation is likely to change as information technology is rapidly developing and becoming more accessible to the user and the user becoming more accessible for information technology. Current reasons for the limited use of information technology in speech-language pathology appear to be twofold.

According to Nelson and Masterson (1999) the potential benefits of information technology in speech-language pathology service delivery must still be demonstrated in research. There is a dearth of evidence indicating that clients make greater gains and progress more rapidly when computer technology is used. Although research demonstrating the advantages of information technology is still limited, the same authors indicate that there is already evidence that the use of information technology in speech-language intervention is consistent with the criteria for effective intervention as it allows for improved collecting, maintaining and reporting of client data (Nelson & Masterson, 1999).

Secondly, Robinson, *et al.* (1996) point out that the application of information technology is curtailed by the fact that undergraduate courses teach computerized information seeking skills and literature retrieval strategies only to a limited extent. It appears that clinicians in the field of speech-language pathology do not yet fully realize that conventional information retrieval methods and the exclusive use of low-technical procedures and techniques in assessment and treatment are no longer sufficient in clinical practice.

It is clear that a large variety of clinical and research tools based on information technology is available, but professional training programmes, planning, a change of mind and further research is necessary to increase the use of information technology in speech-language pathology. One such a tool is database systems which contain vast possibilities for speech-language pathology and can bridge the gap between clinicians and researchers and enhance information technology utilization in the field. Clinical data entered in a personal

computer equipped with a database can be linked to a wide network of databases nationally and internationally and may greatly enhance research and clinical applications in speech-language pathology and specifically in ECI (Niewoudt, 1999).

A brief explanation of the concept of database systems will serve to illustrate its importance to a profession facing the challenges of the information technology age.

4.3 FEATURES OF RELATIONAL DATABASE SYSTEMS

In its most basic form, a database is a computerized record-keeping system with the purpose of maintaining information and making that information available on demand (Aitken, *et al.,* 1997; Curtis, 1987; Date, 1990). A relational database is a collection of relations and supports a fixed collection of data types (Ramakrishnan, 1998). The most common relational database system for limited use is *Microsoft® Access.*

A computerized relational database has certain advantages over a conventional paper-based filing system, as it stores sets of data in database files which can be manipulated by sorting it, changing it or finding items within it. The most salient advantages of a computer database relate to the ability to manage large volumes of data and to manipulate the data at a high operating speed. A database is also efficient as there is no need for voluminous paper files, the tedious task of maintaining files by hand is eliminated and, if regularly updated, accurate information is available on demand at any given time (Date, 1990). A relational database system can create baselines, chronological sets and provide time slices of development (Nieuwoudt, 2000). The features of a computer database therefore demonstrate its suitability for data processing for research purposes as

the systematization and categorization of data are the first steps in the process of research (De Vos, 1998).

Rapid advances in the field of database systems research have resulted in the wide spread application of databases in all disciplines, linked via the Internet (Connolly, *et al.,* 1996; http://hera.eecs.berkeley.edu/Research/Summaries/1995-99). According to Connolly, *et al.* (1996) and Bowers (1993) the exceptional productivity in database research over the past thirty years has led database systems to be viewed as the most important development in the field of software engineering. The database provides the underlying framework of the entire global information system and has radically changed the way organizations operate and research is conducted.

As databases became more powerful and flexible to use, their apparent simplicity conceals the highly complex and sophisticated structure of the system which created a whole new way of thinking about data processing (Bowers, 1993). The approach taken with relational database systems is to separate the definition of data from the application programs. This approach, known as data abstraction, results in an internal and external definition of objects so that the user only sees the external definition and is unaware of how the object is defined and how it functions (Connolly, *et al*., 1996). As a result of the complex structure of a database system, it has numerous advantages.

4.3.1 Advantages of Relational Database Systems

In contrast with spreadsheets, database systems are much faster to operate and data manipulation is more flexible. According to Date (1990) the centralized control of data in a database system is the overriding advantage to the user or institution. Based on a literature review the benefits of centralized control in relational databases are as follows:

- *Redundancy can be reduced*. When non-database systems are used, such as spreadsheets or electronic file-based storage systems, there tends to be redundancy and waste of storage space as data are stored in separate files which are difficult to integrate.
- *Inconsistency can be avoided to some extent*. Centralized control implies that inconsistent data can be identified, therefore avoiding the supply of incorrect or contradictory information to database users.
- *The data can be shared*. The fact that the database is integrated and relational-based implies that different users can share the same information concurrently or for different purposes. Existing applications can share the data in the database, but new applications can also be developed to operate against the same stored data without having to create any additional stored data. It is the sharing of data, linked via information networks, that distinguishes database systems from traditional filing systems and spreadsheets.
- *Standards can be enforced*. As the database is centrally controlled desirable standards can be observed, thereby increasing the value of data and making it more suitable for research and for national and international data exchange.
- *Security restrictions can be applied*. Central control requires a security system and ensures that access to the database is through proper channels and that sensitive data is protected. Anonymity of subjects participating in a research project can therefore be guaranteed.
- *Integrity of data*, i.e. ensuring that data in the database is accurate, *can be maintained.* Even if redundancy is controlled, data can still be inaccurate if integrity checks are not controlled centrally. Integrity controls are most important when data is shared and utilized for research purposes.
- *Conflicting requirements can be balanced*. The database can be designed and operated to serve the best interests of an institution rather than the requirements of individuals.

(Benyon, 1990; Bowers, 1993; Connolly, *et al*., 1996; Date, 1990).

As a database is a shared collection of logically related data, which also provides a description of this data, it can be designed to meet the information needs of a particular organization (Connolly, *et al*., 1996). Databases can therefore be customized to be used in diverse contexts, from production companies to research laboratories. The seven benefits of centralized control of databases can be used as guidelines and operating criteria when designing a database system for the specific research needs of the present study.

In order to demonstrate the diverse application possibilities of database systems and provide guidelines for the requirements and features of the intended database system of the current study, some selected examples of existing databases in EI will be discussed.

4.4 DATABASE SYSTEMS AS MANAGEMENT TOOLS IN EI

An overview of literature revealed that database systems are used extensively in EI in the USA, but since the databases are mostly used as management information systems and not as research tools, it appears that descriptive articles about them are not published. The USA law mandating EI to all infants and toddlers with disabilities, Part H of the Individuals with Disabilities Education Act (IDEA) of 1990 (PL 101-476), prescribes 14 components of an EI system to be implemented in each State. The last of these components is an information management database system (Hebbeler, 1993; Stayton & Karnes, 1994).

In order to fulfill the requirements of the Program for Infants and Toddlers with Disabilities, Part H of IDEA (1990), the data system of each state must at least be able to provide information regarding the numbers of all who require EI, the numbers of clients served and the types of EI services provided by the particular State. Apart from these basic requirements of an EI data system, States are encouraged to design a useful tool to build and improve their EI programmes and

to benefit the EI service provision by creating an information culture. The result is that no two data systems are alike as they are designed to meet the needs of a particular State and make provision for different approaches to data collection. In the beginning stages of the implementation of the data system, States were encouraged to maintain a balanced perspective on the degree of error that will be involved in such multi-user data systems. The establishment of a data system was to be viewed as a process which must be improved over time. The importance of data collection from the initiation of a programme was stressed as uniform record keeping is the only way to effectively monitor and evaluate the programmes in a State (Hebbeler, 1993).

In paying so much attention to the establishment of data management systems for EI, the USA legislators demonstrated their understanding of the long-term and short-term advantages of database systems for the implementation of the act. It is clear that the operational needs of any programme, whether designed for management or research purposes, require that information must be recorded, analyzed and interpreted and database systems are the most effective and accurate tools with which to do it.

In a survey of the different management information systems of the various States, Hebbeler (1993) found that all the States implemented data systems which vary greatly, but has the core function of overseeing the local programmes. The State data system therefore provides a means of bridging the gap between the State and the local level of EI service provision in the USA. According to Hebbeler (1993) the S*tate level* client-based data systems are able to perform comprehensive functions to answer questions concerning local services and assist in:

- *Describing the population* being served in the State, how it changes over time and the kind of services individuals are receiving. The information on clients

is used to generate annual reports, plan services, determine staff requirements and estimate budgets.

- *Identifying weaknesses* in the State service delivery system so that targeted assistance can be provided to local programmes. For example, data on referrals and referral sources revealed that mass screening clinics conducted at the local level were not an efficient way of using resources, as few children requiring EI were detected this way. Other useful data revealing weak points were the number of children on waiting lists.
- *Monitoring of the Federal regulations* for specified timelines for certain events in the service delivery process, such as the review of Individual Family Plans.
- *Planning for the future*. If data has been collected over several years, valuable information regarding programme changes over time is revealed. Projections about the nature and size of the population to be served can be made.
- *Facilitating linkages* between agencies and institutions and ensure the immediate follow-up of infants requiring further EI after they have been discharged from the NICU.
- *Compiling reports* to be used to convince the State's legislators and sponsors about the importance and need for EI (Hebbeler, 1993).

It is clear that a large number of questions can be answered by the State database systems as the information output is only limited by the type and quality of the data which was entered. As data systems are able to link data sets the different States also use their databases to operate an automatic process of payment for EI services (Hebbeler, 1993).

The local EI programmes of the different States also benefit from the same information the State management data systems releases, but according to Hebbeler (1993) these local programmes face greater information management challenges than the State level databases. The local level information systems must be able to track information on hundreds of children while the State

manages information of 25 to 75 programmes only. In order to demonstrate the capabilities and flexibility of the database approach to information management, the following functions of the local EI databases in the USA are presented (Hebbeler, 1993). In utilizing their data systems, the clinicians in local EI programmes can do the following:

- Generate statistical reports on clients for evaluation and intervention planning purposes.
- Review data and produce various lists or sub-sets of children.
- Monitor the status of EI services to individual children and their families and remind the clinicians about upcoming appointments.
- Produce legible and complete copies of a child's record to share with the family and interdisciplinary team.
- Access information about other resources available in the community.
- Generate individual transition reports for school districts when children continue with intervention after three of years age.
- Easily and quickly transmit required data to the state level database.
- Although not a function of databases, word processing and producing of labels for mailing or file folders are possible as the data is derived from the database.

(Hebbeler, 1993)

The overview of the varied and innovative functions of a database management system for the local EI programmes in the USA points to the careful planning necessary before designing such a data system. Another necessity is the high level of technical expertise required from clinicians to realize the full potential of their information system. Since it is *people* who convert data to information and *not machines* (Hebbeler, 1993), a lack of training and resistance against the use of computer technology can therefore negatively impact on the vast possibilities of database systems.

The description of the State and local data management systems portrays them as powerful tools to enhance EI programmes and identifies EI as a leader in the application of database management systems in the field of speech-language pathology. One of the greatest advantages of longitudinal databases in EI is the unique opportunity of tracking individual infants with disabilities and those at risk for developmental delays from birth onwards throughout their lives. When using such an EI database the advantage is that the data is recorded prospectively and the inaccuracies and omissions in information created by retrospective data recording can be avoided. These benefits constitute the most important motivations for the implementation of information management and research database systems in the field of EI which in turn directs the attention to the foremost reason for data collecting. As stated aptly and clearly by Rossetti (1996), effective EI services can only be delivered if we have the data to guide our actions.

Even though the data systems for EI described previously were not designed for research purposes, it is clear that large management databases can be used to identify subjects for research projects, provided that families have given their consent before any data is entered into the system. The *South African Constitution* has a clause in the *Bill of Rights* to protect a person's privacy and states that "everyone has the right to privacy which includes the rights not to have the privacy of their communications infringed" (http://www.polity.org.za.govdocs/constitution/saconst 01.html.). This clause relates directly to research conducted in South Africa and must be adhered to in pursuit of ethical standards in research.

In contrast with management databases it is, however, the customized research databases recently being described in the literature that promise exiting new applications in EI.

4.5 DATABASE SYSTEMS AS RESEARCH TOOLS IN EI

Currently, limited articles are available on the use of databases as research tools in EI. These articles were located in different sources, indicating that research databases, just as data management systems, are utilised and reported in EI, but are not always published. The resources that provided access to reports on databases, were the Internet, where the ISEI (International Society on Early Intervention) (1999) announced a short description of a database by García-Sánchez (1999) on their web site, the ERIC (Educational Resources Information Centre) database, an information network designed to provide access to non-journal resources where unpublished articles were located by Bezruczko and Zell (1993), Bornstein and Casella (1993) Hebbeler (1993) and in professional journals where articles were identified (MacWhinney,1996; Mandeville, *et al*., 1988; Miller, *et al*., 1992). In order to investigate the use of database systems in EI research each of these databases will be described briefly.

4.5.1 The Individual Following Record to Early Intervention (García-Sánchez, 1999)

The announcement on the ISEI web site on the Internet described a Spanish database system designed to be used as an individual following record of infants with cerebral palsy and as an epidemiological research tool in EI. *The Individual Following Record to Early Intervention* (García-Sánchez, 1999) was designed with the purpose to systematize the recording of large amounts of data of children, birth to six years old, with cerebral palsy attending different EI centres of the Región de Murcia, in Spain. The database is able to record data on 185 variables which include information regarding the diagnosis and characteristics of the child's disability, history of the pregnancy, birth and perinatal period, information about the sociocultural and socioeconomic characteristics of the family and information about the EI programme such as treatment modalities and the child's integrative experiences in the kindergarten and primary school. The *Individual Following Record to Early Intervention* (García-Sánchez, 1999) is

capable of recording successive assessment data of 53 different sub-scales of assessment instruments, registering the results according to different age intervals.

The database is intended for use by a team of professionals from different EI centres and is coordinated from a university-based research centre. An operating manual is available in Spanish to ensure effective participation of the different users of the database system.

The description of the database demonstrates that it can be used to track the development of individual children for the monitoring of their EI programmes and for longitudinal studies contributing to the epidemiological data on the population of children and their families participating in the research. The detail in which the author (García-Sánchez, 1999) describes the database provides useful information about the structure of the data system which can be replicated or adapted when designing other databases. Unfortunately this database is currently only available in Spanish which restricts the linking of the data with other databases. The database, however, demonstrates how data can be shared among different EI programmes and assist the transition of subjects from one programme to another. This way data about subjects is not lost and a more comprehensive description of the population can be obtained.

No information about the results of the intended use of the database for epidemiological research was supplied. In order to demonstrate that database systems can be successfully applied in research, the following reports referring to database systems employed for research purposes will be discussed.

4.5.2 Relational Database System to Integrate Early Childhood Assessment Data across Pre-kindergarten, Kindergarten and Grade 1 (Bezruczko & Zell, 1993)

The relational database system described by Bezruczko and Zell (1993), as well as the database described by García-Sánchez (1999), is also a tool designed for longitudinal data collection. This research tool (Bezruczko & Zell, 1993) aims to integrate the continuous assessments of a large group of urban disadvantaged children enrolled in EI programmes in Chicago. In a conference paper the authors describe how a large centralized database stores the data of 22,000 individual clients which can be accessed by teachers via tabletop computers in the local schools. The database was designed to address the data management problem caused by the large numbers of children requiring EI and large volumes of data which increases with each year a child is enrolled in the EI programme.

The structure of this database (Bezruczko & Zell, 1993) was designed to accommodate and systemize multiple assessment resources such as interviews with parents, naturalistic field observations of the child, survey responses and child performance examples without causing redundancy or duplication of the data.

Apart from the obvious data management advantages gained by the utilization of this database system, the research component of the database also proved to be successful. Instead of employing standardized norm-referenced tests, the recording and analysis of authentic samples of child performance resulted in the identification of a developmental sequence of language related skills. The results indicated patterns of continuity across the annual assessments of the children's language skills and proved to be of clinical value in providing direct guidelines for treatment (Bezruczko & Zell, 1993).

The database described by Bezruczko and Zell (1993) demonstrates the large capacity of databases for data storage as large volumes of text data containing actual samples of children's performances can be entered into the database. This important feature of a database was not evident in the description of the database system described by García-Sánchez (1999) as it appears that children's performances are mostly described in terms of age intervals on different assessment instruments which is then entered into the database as numerical data. Whereas the use of numerical data is a time-saving method for data entry, text data can provide valuable data for qualitative analysis, thereby demonstrating the flexibility of database systems to accommodate different research methodologies, depending on the database design.

The most important feature of the database design described by Bezruczko and Zell (1993) is therefore its applicability for longitudinal research on a group of subjects since their enrollment in EI programmes. This feature is also demonstrated in the following database system to be described.

4.5.3 Developmental Assessment and Instruction for Success in Early Years (DAISEY) Data System (Mandeville, *et al*., 1988)

Another example which proves that databases are immanently suitable for longitudinal research is the DAISEY Data System (Mandeville, *et al*., 1988). This database was developed twelve years ago to support a longitudinal research project tracking the academic performance of disadvantaged students from one and a half years to five years of age as they progress through the South Carolina public school system. The design of the database appears to be similar to the systems described by Bezruczko and Zell (1993) and García-Sánchez (1999), but the research applications are different. The research project initially started without database technology, but a database system was later implemented to manage the large amounts of data required for the project. A data system was designed to collect test scores and other data about the subjects and eventually

link the different data sets to track the children's school progress and describe their long-term development. The authors (Mandeville, *et al*., 1988) concluded that the DAISEY Data System proved to be capable of managing the large amounts of data, that the linking of the different data sets were carried out accurately and that the use of database technology was cost effective. As longitudinal research projects are known to be costly, cost savings as a result of the application of database systems can stimulate longitudinal research.

The description of the DAISEY Data System (Mandeville, *et al*., 1988) emphasizes once more the advantages of database systems as flexible research tools, capable of handling large volumes of data over continuous years of research with cost saving benefits.

4.5.4 A Computerized Classroom Language Management and Recording System for Deaf and Hard of Hearing Children (Bornstein & Casella, 1993)

Cost-effectiveness is also one of the advantages reported by Bornstein and Casella (1993) of the database system used in their report on "A Computerized Classroom Language Management and Recording System for Deaf and Hard of Hearing Children". According to the authors the database is a cost-effective resource to the education system and for research. As data sets can be divided in smaller sets or combined into larger units, a database system can provide data for large research projects as well as smaller studies such as student research projects. Although the database system described by Bornstein and Casella (1993) allows for applications in EI it is used mostly for school aged children with hearing loss. The aim of the database system is to assist class teachers to manage large amounts of information required to teach children with a hearing loss effectively. The functions of the database permits the class teacher to use the electronic mail system to contact other teachers and consult experts, to update data regarding the child and to view and print the data. The database was

designed to store information on 13 different clusters of variables such as the child's hearing loss, additional disabilities, family background, language skills, auditory skills, speech reading, speech, manual communication, reading, writing, instructional strategies, the instructional environment and test scores.

When comparing the database of Bornstein and Casella (1993) with the database described by García-Sánchez (1999) it is clear that both databases are designed for their specific contexts of services to children with communication disorders relating to cerebral palsy and hearing loss respectively. The comparison of the two database systems also emphasizes the differences between the EI approach and school-based services later in a child's life. The clusters of variables of the database for classroom information management (Bornstein & Casella, 1993) concentrate on comprehensive information of the child's communication skills and academic needs, whereas the EI database of García-Sánchez (1999) is clearly based on EI principles as advocated by Guralnick (1997) and Rossetti (1996). The emphasis on the prenatal and perinatal history of the child provides information about biological risk factors impacting on the child's development and the extended information on the family and family characteristics reflects the importance of the family in the EI process.

4.5.5 Child Language Data Exchange System (CHILDES) (MacWhinney, 1996)

MacWhinney (1996) describes the CHILDES Project of which one component consists of a large internationally recognized database of language transcripts, containing normal and disordered language samples, mainly in English, but 20 other languages are now accommodated. The system involves a worldwide network of researchers from a variety of disciplines involved in the study of language. According to MacWhinney (1996) the study of child language has progressed through five phases, from naïve speculation, to diaries and biographies, to transcripts, to computers and now to the current phase of

connectivity. Through the Internet researchers and clinicians can now access the CHILDES database and use it as a resource for language analysis. The emergent connectivity of the Internet holds the potential of establishing the Glossome Database, much like the Human Genome Database (MacWhinney, 1996). The CHILDES database emphasizes research and only recently have some clinical applications been included.

The next database is both a research tool and a clinical tool for the analysis of child language performance.

4.5.6 Language Sample Analysis (LSA) (Miller, *et al*., 1992)

Miller, *et al*. (1992) describes a reference database of language samples of typically developing children used in public schools in Wisconsin. An earlier version of the LSA as it is currently known, was already published in 1982 as the SALT (Systematic Analysis of Language Transcripts) which indicates that researchers in the field of speech-language pathology realized the value of database systems long before the current popularity and technological advances of the database as described by Connolly, *et al*. (1996).

The LSA (Miller, *et al*., 1992) more so than the CHILDES (MacWhinney, 1996), is a clinical tool designed to be used by speech-language therapists to transcribe, analyze and interpret language samples of children with language disorders. The reference database contains 27 to 30 normal language samples, representing narrative and conversational contexts, for each age interval, from three to 13 years of age.

The advantages of the LSA data system are that the tedious language sampling and analysis of the past is now a much easier process. Miller, *et al*. (1992), however, differ from Mandeville, *et al.* (1988) in stating that the use of database system did not result in time and cost savings, as the use of information

technology involves more processes. The cost-savings come into effect as better quality of data, better interpretations and better programmes result in more effective interventions which results in cost savings only in the long run.

The main achievement of the LSA (Miller, *et al*., 1992) is the contribution to a changed view of language impairment. According to Miller, *et al*. (1992) traditional language tests do not reveal the specific aspects of expressive language difficulties, such as vocabulary diversity which can only be determined through the use of computer technology. The researchers' opinion is that the LSA is crucial to the identification and description of disordered language performance.

It is clear that the use of database technology in the study of child language has brought about much more sophisticated and accurate techniques which resulted in new developments and clinical applications in speech-language pathology. The description of the two database applications also demonstrate that the type of research undertaken is impossible without database technology.

The last two databases which were discussed relate to the very successful application of database technology to research in language analysis and interpretation. These two databases have limited application in EI as the study of child language usually start on the syntax level, implying that the subjects have already reached that developmental level. The aim of the discussion was, however, to indicate how advances in database technology and developments in the study of language mutually stimulate one another.

The discussion on the six databases as research tools with applications in EI has certain implications for further research as well as for the present study.

4.6 APPLICATIONS OF THE USE OF DATABASE SYSTEMS FOR ECI

The use of database systems in ECI research can become a most useful source to describe populations requiring ECI services and guide programme planning. Although limited resources on the applications of database systems in EI are currently available, a literature overview provided useful information and the following implications became clear for applications in ECI:

- Data management systems can be utilized for research purposes as the organization and systemization of data is the first step of the research process (MacWhinney, 1996). Immediate access to data is one of the most valuable advantages to enhance the research process.
- Database systems assist the researcher as well as the clinician to produce better quality observations, recordings, analyses and interpretations (MacWhinney, 1996). These gains will eventually result in more effective interventions.
- Database systems have already made significant contributions in the study of child language (MacWhinney, 1996; Miller, *et al.*, 1992).
- Database systems can successfully manage large amounts of data, link different data sets and can accommodate many users (Bezruczko & Zell, 1993).
- The use of database systems do not necessarily result in cost and time saving benefits (Miller, *et al*., 1992), but gives immediate access to information which would otherwise not be possible.
- The effective way to carry out longitudinal research is to use database technology (García-Sánchez, 1999).
- The effective way to manage an EI programme is to utilize a customized database system (García-Sánchez, 1999) as EI permits the unique opportunity to follow individual children prospectively from birth onwards.

Database systems undoubtedly hold many advantages for ECI research which can subsequently be applied to improve ECI service provision. As advances in database technology are considered one of the most acclaimed achievements of software engineering (Connoly, *et al.,* 1993; Bowers, 1993) data management by means of a customized database system is the way to fully exploit the most valuable resource for research, namely data (Benyon, 1990).

In order to establish a database system complying with the needs of the developing field of ECI in South Africa it is important to determine which information about infants and toddlers requiring ECI is already available. An analysis of the local context regarding ECI research is one of the most important underpinnings for further context relevant research.

4.7 ECI RESEARCH RELATING TO RISK POPULATIONS IN SOUTH AFRICA

A review of the literature revealed that a substantial amount of research regarding various aspects of EI in the field of Communication Pathology has already been carried out. In order to analyze the achievements and areas of needs in local ECI epidemiology, a sample of studies describing different subgroups of children younger than three years old and at risk for communication delays were selected from the general pool of EI research in South Africa. Although an integrated approach to the collection of epidemiological data on the communication profiles of infants and toddlers at risk for delays and their families in South Africa is not available, an overview of the individual descriptive research projects revealed a significant amount of data on different subgroups of the population qualifying for ECI services and presented in Table 4.1. None of these studies employed database technology to obtain data.

Table 4.1 (See following pages) provides a summary of studies conducted at the Centre for Early Intervention in Communication Pathology describing young children less than 3 years old requiring ECI. It appears that a steady flow of

Table 4.1 South African studies describing young children mainly under three years old requiring ECI

Author(s)	Population	Subjects	Nature of Study
A. Established risk conditions: Cleft lip and palate, Pierre Robin Sequence, Down syndrome, Sensorineural hearing loss			
1. Louw, 1986	Black infants with cleft lip and palate in the Ga-Rankuwa Hospital	25 subjects; 7-11m old; 9 different African language groups	The proposal of a holistic assessment protocol based on a morpho-functional description of the subjects regarding: - Oro-facial morphology - General development - Mother-child interaction - Communication development
2. Kritzinger, Louw & Hugo, 1996	Young children with cleft lip and palate at the Facial Deformities Clinic, University of Pretoria	44 subjects; 3-31m old; Afrikaans and English	A developmental description of the subjects regarding: - General development - Communication development
3. Fair & Louw, 1998	Young children with Pierre Robin Sequence at the Facial Deformities Clinic, University of Pretoria	4 subjects; 5-28m old; Afrikaans and English	Determined the subjects' progress in ECI in the following areas: - General development - Communication development
4. Louw & Kritzinger, 1991	Infants with Down syndrome receiving ECI at CHRIB	3 subjects; 10-11m old; Afrikaans	Determined the subjects' progress in ECI in the following areas: - General development - Communication development
5. De Freitas, 1997	Young children with Down syndrome at CHRIB	34 subjects; 1-47m old; Afrikaans, English, Tswana, Zulu, German	A description of the subjects regarding: - Pre- and perinatal history - Associated abnormalities - Oro-facial abnormalities - General development - Communication development
6. Swanepoel, 1997	Young children with Down syndrome	5 subjects; 5-24m old; Afrikaans and English	A description of the subjects' communication interaction regarding: - Mother-child communication interaction - Communication functions
7. Roodt, 1994	Young children with sensorineural hearing loss	5 subjects; 10-24m old; Afrikaans and English	A description of the subjects regarding: - Communication skills - Hearing loss - Phonology
B. Biological Risk: Low birth weight and prematurity, chronic otitis media, twins			
8. Smit, Louw & Uys, 1987	Young children who were premature	6 subjects; 30-37m old; Afrikaans	A description of the subjects' expressive language skills regarding: - Mother-child communication interaction - Communication development
9. Kritzinger, 1994	Infants at biological risk, living in Pretoria	19 subjects; Neonates–12m old; Afrikaans and English	A longitudinal study to identify predictors of the subjects' communication development based on: - Mother-child communication interaction - General development - Communication development

Table 4.1 continued

Author(s)	Population	Subjects	Nature of the study
10. Du Preez, 1995	Toddlers at biological risk, living in Pretoria	17 subjects; 18m old; Afrikaans & English	A description of the subjects' communication development at 18m regarding: - General development - Communication development
11. Hugo, Louw & Kritzinger, 2000	Infants and toddlers with various risk conditions at CHRIB	56 subjects; 5-34m old; Mainly Afrikaans and English	The development of a scale for listening behaviour of the subjects
12. Kritzinger & Louw, 1997	Infants at biological risk	25 subjects; 2-26m old; Afrikaans, English Tswana, Zulu	A description of joint book reading practices of the subjects and their mothers
13. Dedekind, 1997.	High risk infants	40 subjects; 1-35m old; Afrikaans and English	A description of the mother-child communication interaction
14. Coetzee, 1991	Twins	3 sets of twins; 24-30m old; Afrikaans	A description of the subjects regarding: - Mother-child-communication interaction - General development - Communication development
C. Environmental Risk			
15. Pieterse, 1998	Infants in a disadvantaged community (Eersterust)	71 subjects; 6-16m old; Afrikaans and English	A description of joint book reading practices of the subjects and their mothers, living in a poor community
16. Van der Merwe, 1999	Infants in a disadvantaged community (Eersterust)	100 subjects; 0-18m old; Afrikaans, English, Zulu, Ndebele, Sotho	A description of the risk factors present in the subjects, living in a poor community

studies was produced the past 15 years, an initiative from this particular centre which is considered as leader in the field of ECI in South Africa (Rossetti, 1998).

The studies described in Table 4.1 are categorized according to the different risk conditions occurring in the subjects and not according to chronology. This way the different populations of high risk infants on which some data is available are emphasized and guidelines for further data collection are provided. The high risk population groups investigated in the studies represented three groups of young

children with *established risk conditions*, i.e. cleft lip and palate and the sub-group Pierre Robin Sequence (Studies 1-3), Down syndrome (Studies 4-6) and sensorineural hearing loss (Study 7), young children at *biological risk* (Studies 8-14) and young children at *environmental risk* (Studies 15 and 16). The choice of these risk categories is contextually relevant as all of these conditions have an increased prevalence in certain South African communities (See Table 1.4, Chapter 1).

The variation in age groups of the subjects employed in the studies indicate that the entire EI age range have been studied, from the neonatal period, through infancy to the toddler period. The subjects were drawn from a wide variety of language groups, indicating that infants and toddlers representing different South African languages were included in the studies (See Chapter 3, Table 3.1). This also indicates the unique opportunity of EI to investigate subjects from different language groups characterizing South Africa, as the different aspects of early communication behaviours, such as vocalizations, non-verbal communication skills, communication functions and mother-infant communication interactions are less dependent on language-specific knowledge and can be described by a researcher not sharing the same language as the subjects. The study by Louw (1986) clearly illustrates that a holistic assessment protocol could be successfully applied to a group of infants representing nine different languages.

The 16 different studies were mostly descriptive surveys, but two studies employed an *ex post facto* design to determine treatment progress (Studies 3 and 4), one study was a longitudinal survey to describe the subjects' development and determine predictors of their development (Study 9) and the aim of one study was to develop an assessment scale to describe the subjects' listening skills. According to Table 4.1 it appears that the descriptive studies succeeded in providing comprehensive profiles of the subjects' communication functioning, mother-infant communication interaction patterns and general developmental functioning, but limited descriptions about the characteristics of

the families are provided. The studies of Smit, *et al*. (1987), Pieterse (1998) and Van der Merwe (1999), however, provide extensive detail about the families, such as parental educational levels, their ages, employment and qualifications. It appears that only two of the studies described the subjects' socio-economic status namely Pieterse (1998) and Van der Merwe (1999) mentioning that the research was conducted in a disadvantaged community. This can be attributed to the fact that these populations were not always easily accessible and the emergence of studies such as these reflects the new efforts in providing ECI services to all.

Pieterse (1998) and Van der Merwe (1999) both conducted their research in the mainly disadvantaged community of Eersterust outside Pretoria and succeeded in describing some of the important environmental risk factors negatively impacting on the communication development and school readiness of the subjects. Both studies utilized large samples, i. e. 71 and 100 subjects respectively and can be regarded as valuable contributions to the field of ECI as limited research has been conducted in disadvantaged communities to date. Pieterse (1998) found limited book reading practices in the families investigated and Van der Merwe (1999) found a high prevalence of both biological and environmental risk factors in the subjects. The combination of biological and environmental risk factors evidenced in the subjects corresponds with the leading causes of infant deaths in South Africa (See Chapter 3, Tables 3.2 and 3.3). The results therefore confirm that infants with low birth weight and prematurity and living in poverty constitute the major population requiring ECI services in South Africa.

The two studies cited also demonstrate not only the need for further data collection, but also for a more integrated approach to data collection. The advantages of database technology imply that contributions of various researchers can be entered into a national database, data can be shared and

more comprehensive epidemiological data of the different groups of young children requiring ECI can be obtained.

The discussion of the different studies in Table 4.1 also served to illustrate that most important local research has already been initiated and that further development of the field of ECI depends on the continuation of this research.

4.8 CONCLUSION

In order to stimulate ECI research-generating activities and continue with research to accelerate the process of effective service delivery to all young children and their families requiring ECI, a database system can be utilized as a unique research tool to address the needs arising from the local South African context. Based on a research overview and recent technological developments in the field of database design and application for research, the following conclusions are made regarding the relevancy to ECI:

- As families play such a pivotal role in EI (Rossetti, 1993) there is a need to provide comprehensive descriptions of the families representing the different and diverse communities in South Africa. As proposed by Guralnick (1997) in his conceptual model of early development and risk factors, family characteristics to be described must include the personal characteristics of the parents as well as the characteristics not related to the child's risk status, such as social support, marital relationship and financial resources. This information will assist in the identification of the potential stressors for families, such as information needs, resource needs, confidence threats and interpersonal and family distress created by the child's risk condition.
- There is a need for epidemiological studies employing large numbers of subjects in order to provide clear profiles of the different populations requiring ECI and to design treatment programmes matching these profiles. This will

contribute to second-generation research issues as the improvement of information gathering can facilitate a process to allow improved individualized interventions for children and families. The ideal is to best match ECI programme features to child and family characteristics and treatment outcomes (Guralnick, 1997).

- The large numbers of subjects required for epidemiological research and the voluminous amounts of data of longitudinal projects necessitate the use of a database system with features similar to those described by García-Sánchez (1999). A database system contributing to the national databank on infants and toddlers at risk for communication delays requires to provide a structure with specific features as described by Sokolov & Snow (1994). These features should provide sufficient flexibility to describe individual clients, yet uniform enough to reveal the unique patterns of characteristics of the different populations of young children and their families requiring ECI in South Africa.

The underpinnings and rationale for a uniquely designed database system as a contemporary ECI research tool meeting the needs of the local South African context have now been provided. The next step is to design such as tool and demonstrate its applicability for data management and research purposes in a specific ECI service delivery context.

4.9 SUMMARY

The chapter's vantage point relates to the needs of second-generation research in ECI while first-generation research challenges still prevail in South Africa. The use of database technology is proposed as a way to stimulate research generating activities to improve the gathering of information for epidemiological data to better match programme features with child and family characteristics. The features of database systems and their applications as management and research tools in EI are discussed. Examples of database systems in EI research

and needs in ECI research in South Africa provide the underpinnings for the development of a database system for the present study.