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Augmentative and Alternative Communication: the role of Communication Partners

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INTRODUCTION

Augmentative and Alternative Communication (AAC) can be defined as an area of research, clinical, and educational practice that aims at studying and compensating temporary or permanent impairments, activity limitations, and participation restrictions of individuals with severe disorders of speech-language production and/ or comprehension (ASHA, 2005). AAC is a strengths based approach that focuses on "Augmenting" the communication skills and capabilities that an individual already has through modalities or devices, "Alternative" to speech, that will allow individuals to convey the content of their communication. **The ultimate goal of AAC** is allowing the individual to actively **participate** in society. As Beukelman and Mirenda (2013) stated, the goal of AAC is to allow individuals with communication disabilities to efficiently and effectively participate in all the activities they choose by enabling the AAC user to communicate needs and wants, to transfer information, to achieve social closeness and to use the social etiquette (Light, 1988).

The focus of this thesis will be on the role that communication partners play in supporting AAC users' participation. The term communication partner refers to family members, friends, acquaintances, professionals and unfamiliar persons that interact with the AAC users. Communication partners share responsibilities in the success of AAC intervention by providing communication opportunities to individuals who use AAC. Our focus will be indeed, on the language learning opportunities and interaction opportunities that communication partners may provide through AAC interventions.

Two research questions will lead the development of this thesis. The first one relates with language learning opportunities and the role of AAC devices in supporting communication partners' language modeling strategies and vocabulary expansion. The second one relates with interactions opportunities and the role of communication partners' attitudes toward individuals who use AAC.

Regarding the **first research question**, we decided to investigate the role of mobile technologies, iPad in particular, as they have been found to affect communication partners modeling strategies and vocabulary expansion. Indeed, mobile technologies allowed to overcome some of the barriers related to AAC devices (costs, availability, etc…). However, they tend to replicate in their design the same barriers (programming procedures and operational demands) that can be found in more traditional AAC devices. The design of AAC systems have been proved to affect communication outcomes (Light & McNaughton, 2012) therefore we wondered if an AAC app, based on an innovative AAC design and reduced operational demands, could affect the communication partners programming and use of the device when interacting with children who use AAC. We hypothesized that a different design and the reduced operational demands could support communication partners' modeling strategies and vocabulary expansion better that traditionally designed AAC app.

Regarding the **second research question**, we decided to investigate communication partners' attitudes toward an individual who use AAC as they have been found to affect people's willingness to interact with individual who uses AAC (Kim et al., 2015) especially when the individual is a member of a group that holds the same attitude (Beck et al., 2010). This statement is particularly true for school classrooms. School classrooms are "social communities in their own right" (Nowicki & Sandieson, 2002, pp. 244) in which attitudes, if negative, "are generally recognized as being a major barrier to full social inclusion at school for children and youth with disabilities" (McDougall et al., 2004, p. 288). In particular, we focused on two of the variables that are related with communication partners' attitudes at school: a) we wondered if the AAC device used to communicate may impact teen-agers students' attitudes toward a peer using AAC and b) we wondered if the experience in working with individuals who use AAC may impact teachers' attitudes toward children who use AAC in class.
We hypothesized that the AAC device used, the iPad in particular, would impact on teenagers' attitudes. In the same way, we hypothesized a difference in the teachers' attitudes when they never had experience working with children who use AAC in class.

To address these research questions, we will dedicate the first four chapters of this thesis to the AAC **background** that describes and explains AAC and the role of communication partners in AAC interventions. Specifically, we dedicate:

- ***Chapter 1***, to account for how AAC has evolved in a period of time that rages from 1950 to 2009;
- ***Chapter 2***, to account for the framework on which AAC is currently based;
- ***Chapter 3***, to account for language learning opportunities and interaction opportunities;
- ***Chapter 4,*** to account for the current AAC systems.

This background description will allow to put emphasis on the aspects of our research questions that inspired the **research studies** described in the last four chapters (**Fig. 1**). Specifically, Chapter 5 and Chapter 6 will primarily investigate communication partners' language learning opportunities through AAC systems modeling and programming, whereas Chapter 7 and Chapter 8 will investigate interaction opportunities through communication partners' attitudes towards individuals who use AAC. More in detail:

- ***Chapter 5*** describes the design and development of a Just-in-Time (JIT) based AAC App;
- ***Chapter 6*** describes the comparison of the JIT based AAC App developed with a more traditional AAC App;
- ***Chapter 7*** describes teenagers' attitudes toward a peer who uses AAC;
- ***Chapter 8*** describes elementary school teachers' attitudes toward children who use AAC in class.

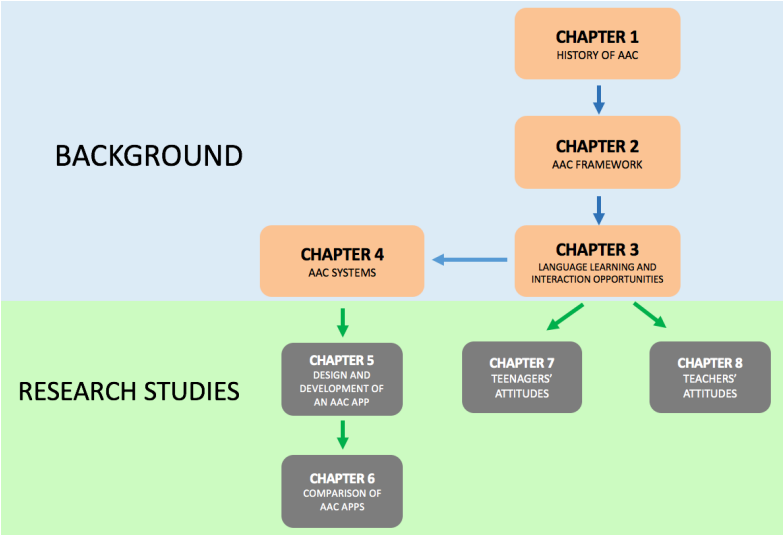


*Figure **Error! Style not defined.**.1. Thesis structure*

AAC BACKGROUND

Chapter 1 describes how AAC evolved from being considered in 1950 as the last resort to use with individuals with intact cognition to be recognized in the 1990s as a promoter of the Human Right for Communication for every individual with communication disabilities, regardless their type of disabilities. Although the history of the field of AAC has been brief, many challenges have been confronted, many myths have been debunked and many steps forward have been made to provide individual with significant communication needs the Right to communicate. As Light and McNaughton (2012) highlighted, by looking at the changes in the AAC users, in the scope of communication, in the assessment and intervention procedures and in the AAC systems we are able to account for the impressive accomplishments that AAC has made (C. Zangari, Lloyd, & Vicker, 1994).

We will go through this evolution by highlighting the main aspects that changed over time and contributed to make AAC as we know it today. First of all, we will consider the evolution of AAC a decade at the time, from the 1950 to present. For each decade we are going to analyze each of the following aspects: the historic factors related to disability, that allowed changes in the AAC field, such as the Education for All Handicapped Children Act that mandate the provision of school-based services to all school-aged students with disabilities; the AAC users, that were considered to benefit from AAC, thanks to this historic changes. Along decades AAC users moved from a restricted group of people with intact cognition to a wide and heterogeneous group of individuals with disabilities, no matter their diagnosis or the extent of their disability; the AAC scope of communication, that changed accordingly to historic changes and users that were considered to benefit from it. AAC aimed originally to speech development and acquisition of oral language. Along decades, its goal became allowing individuals to participate in the society by augmenting their communication skills through alternatives modalities other than speech; the assessment and intervention procedures, that changed accordingly to the scope of AAC. Assessments were based on the Candidacy Model that aimed at identifying the prerequisites required to benefit from AAC, whereas intervention aimed at speech development or language training. Nowadays, assessments are based on the Participation Model that aims at identifying communication

access and opportunities that are enhanced and increased through the intervention; the AAC systems, that reflected the changes occurred in all the above mentioned aspects. AAC systems relied originally on spelling, whereas nowadays they rely on every natural or aided modality of communication that allows individuals to express themselves.

Chapter 2 further explores the theoretical framework on which AAC is based with a specific focus on AAC users, AAC scope of communication and AAC assessment. In the last decade the number and type of AAC users have largely increase. Indeed, not only AAC is provided to all individuals with communication disabilities regardless their diagnosis, their cognitive skills, their chronological age or the entity of their communication disability (temporary or permanent communication disabilities, little or partial speech), but it is also extended to all the possible communication partners with whom the individuals may interact with. The term communication partner refers to family members, friends, acquaintances, unfamiliar persons that interact with the AAC user either on a daily basis or occasionally. The reason of such extension relies the ultimate scope of AAC which is allowing AAC users to fully participate in the society. As described in the Participation Model, which is the framework on which AAC assessments and interventions are based on, a full participation occurs only when the AAC users are provided with both Access to Communication and Opportunities for communication. Communication Access relies on the users whereas communication Opportunities rely on the communication partners. Between communication access and opportunities our focus will be on the communication opportunities, and therefore on the communication partners' strategies, knowledge, skills and attitudes.

Chapter 3 further explores AAC interventions and the role that communication partners play in it. Our focus will be on the role that communication partners play in providing language learning opportunities such as supporting communicative competence development, language comprehension development and vocabulary expansion, and communication opportunities through interactions. Regarding language learning opportunities, one of the most important strategy they can use is language modeling, which is an approach through which AAC users are provided with an AAC component (e.g. a symbols) together with an opportunity for the child to use it. Language modeling support communicative competence development as it provides a model of how an AAC component may be used linguistically, operationally, strategically and socially. It supports language comprehension by augmenting the relationship between referent and reference, and finally it supports vocabulary expansion by introducing and using new concept during interactions within contexts. Language modeling rely on different techniques, all of which however share the need for communication partners to use the AAC device along with the AAC users. This is particularly true when considering vocabulary expansion. In order for professionals to model new concepts, they have to be implemented in the device in order to be used.
Regarding interaction opportunities, one of the barriers that may affect them are attitudes. Negative attitudes have been found to affect people's willingness to interact with individual who uses AAC that result in an interaction that is less likely to be successful (Kim, Kim, Lee, & Park, 2015). Moreover,

negative attitudes may result in reduced expectations toward the individual which results in limited communication opportunities (Popich & Alant, 1997). If negative attitudes are considered to be a barrier to communication opportunities and participation in society, literature studies demonstrate that positive attitudes toward individual who use AAC can help to eliminate these barriers and biases with supports and appropriate expectations (Beukelman & Mirenda, 2013). Therefore, according to literature studies, understanding communication partners' attitudes toward individuals who use AAC, and the variables that affect them, is very important (Beck, Thompson, Kosuwan, & Prochnow, 2010; Triandis, Adamopoulos, & Brinberg, 1984).

Chapter 4 further explores the AAC systems used nowadays and the challenges that communication partners face when using them to support language learning. Our focus will be on the challenges related to the operational demands that AAC system require in order to be programmed. In addition to that, we will focus on the changes occurred with the advent of mobile technologies, the iPad in particular, and the challenges they posed. Indeed, although mobile technologies allowed to overcome some barriers related to AAC devices (costs, availability, etc…), they still replicate the approaches to representation and organization of vocabulary used in traditional AAC devices together with their operational demands. These apps barriers may be due to the minimal attention directed towards improvement of the design of AAC apps to better support language acquisition even if system design have been proved to affect communication outcomes (Light & McNaughton, 2012). AAC design should account for the skills and needs of its user and for the operational demands of both the users and the communication partners (Blackstone, Williams, & Wilkins, 2007). Therefore, the design of AAC technologies should include the input coming from all relevant stakeholder groups such as the user, family members, clinicians, teachers, educators, researchers, developers, caregivers, friends, and manufacturers. However, there is a lack of attention given to the process of app development and, although research studies are investigating this aspect (Caron et al., 2015; Janice Light, 2012; R. W. Schlosser et al., 2016), they do not yet provide enough data to better meet the operational demands of iPad apps for communication partners.

RESEARCH STUDIES

Chapter 5 describes the process of the design and development of an innovative AAC app. The design and development of the app, named Speech to symbols (StS), is based on both an analysis of the AAC apps available on the App Store, with a focus on their design and features, and a focus group with AAC professionals to account for inputs coming from relevant stakeholders. The analysis of the available apps allowed to create a concept of the app that aimed at overcoming the barriers of AAC apps, in terms of operational demands, that use a speech to symbol feature to program new vocabulary. The speech to symbol feature allows communication partners to say the name of a symbol and have access to it without the need of programming grids and navigating between grids of symbols in order to select it. The focus group with AAC professionals allowed to verify if the concept developed could meet their needs of programming and modeling new words. The AAC apps analysis and the focus group results led

to the development of a beta version of the app that was then tested with two AAC professionals during an AAC session. Result from this pilot investigation allowed to receive important inputs from professionals related to the app functioning. Based on the inputs, a prototype of the StS app was developed.

Chapter 6 describes a research study that aims at comparing the StS app prototype with a traditionally designed AAC app. The purpose of this study is to verify if the reduced operational demands could affect the number of symbols programmed and modeled. We used a single case design to compare the programming procedures of the two apps under investigation during AAC sessions. AAC professionals (n=7) and children with communication disabilities (n=3) participated in this study. In addition to the number of symbols programmed, the comparison took also into consideration the consumer satisfaction of the professionals, their level of anxiety before and after using the AAC apps and their behaviors, together with the children' behavior, during the app programming. Results showed that the StS app was used to program more than the traditionally designed app. Moreover, the reduced operational demands of the StS app resulted to have a positive an impact on the consumer satisfaction as well, whereas the level of anxiety measure, along with the children and professionals' behaviors during the programming procedures opened suggestion for future exploration.

ATTITUDES

Chapter 7 describes a research study that aims to investigating the teenagers' attitudes and communication competence perception toward a peer with communication disabilities. The purpose of this study is to investigate the attitudes and the communication competence perceived from teenagers (13 to 18yo) toward a peer with communication disabilities who uses different AAC devices: an iPad based SGD, a communication board, and the AAC user natural voice. The majority of literature studies investigated the impact of a traditional high tech AAC devices versus low tech AAC devices on children' or adults' attitudes. Only a few studies, so far, investigated the impact of the iPad as high tech AAC device. Therefore, we we wondered the impact that the use of an iPad, as high tech device, compared to a low tech device and the natural speech, could have on teen-agers' attitudes. We targeted teenagers as only a few studies investigated this type of population when exploring attitudes toward individuals who use AAC. We hypothesized that the AAC device used, the iPad in particular, to communicate would impact on teenagers' attitudes.

A 3 x 2 design was used to analyze the type of device and the participants' gender impact on both attitudes and communication competence perception. We used the CATCH questionnaire and the Communicative Competence questionnaire as measure. The results of this study show that females tend to have more positive attitudes toward individuals using AAC than males, as well as the impact that the type of device has on the communication competence perception. Clinical implications are also discussed.

Chapter 8 describes a research study that aims to investigate teachers' attitudes toward children who use AAC in class. The purpose of this study is to analyze the teachers' attitudes towards children using AAC in primary schools in Italy and their perceptions of the barriers and the benefits of using AAC. Teachers have important responsibilities in facilitating effective and efficient communication for children who use AAC during classroom interactions (Kent-Walsh & Light, 2003). Research studies on teachers' attitudes demonstrated that they impact the inclusion of children with special needs in the classroom (Avramidis, 2000) and the implementation of AAC intervention (Patel, 2005). The majority of research studies on teachers' attitudes included teacher that had already had experience working with children who use AAC. However, considering a teacher experience, or lack thereof, may be important. Moreover, no research studies have analyzed Italian teachers' attitudes toward children who use AAC yet. Therefore, we wondered if teacher experience in working with children using AAC may impact teachers' attitudes toward them. We hypothesized a difference in the teachers' attitudes when they never had experience working with children who use AAC in class.

Two groups of teachers, those with and without AAC experience, responded to an online survey. The five scales of the Teacher Attitude Scale (TAS) questionnaire and two open ended questions were used to compare the attitudes and the perceptions among the groups of teachers. Results showed that there is a significant difference among the two groups for two of the five scales of the TAS questionnaire. Both groups reported similar barriers and benefits and indicated the use of AAC as being the main barrier. In conclusion, having experience with children who use AAC in class impacts the teachers' perceptions of their own abilities and the teachers' perceptions of the abilities of the children.

CHAPTER 1

HISTORY OF AAC

1.1 HISTORY OF AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

Augmentative and Alternative Communication (AAC) can be defined as an area of research, clinical, and educational practice that aims at studying and compensating temporary or permanent impairments, activity limitations, and participation restrictions of individuals with severe disorders of speech-language production and/ or comprehension (ASHA, 2005).
Since its emerging in the 50s, AAC has widely evolved in many aspects. Although the history of the field of AAC has been brief, many challenges have been confronted, many myths have been debunked and many steps forward have been made to provide individual with significant communication needs the Right to communicate. As Light and McNaughton (2012) highlighted, by looking at the changes in the AAC users, in the scope of communication, in the assessment and intervention procedures and in the AAC systems we are able to account for the impressive accomplishments that AAC has made in the last 60 years (C. Zangari et al., 1994). Therefore, starting from the 50s, we are going to analyze the main changes and accomplishments occurred in each of these aspects (**Tab.1**).

1.2 AAC BETWEEN 1950–1960

Between the 50s and the 60s the American society developed a higher awareness of the rights of minority backgrounds such as individuals with disabilities. Historic and demographic factors helped in developing this awareness. First of all, medical technology and pharmacology advancements, the introduction of antibiotics in particular, allow to decrease neonatal, infancy and early childhood deaths as well as adults' strokes, diseases and trauma deaths. Second, the number of individual with acquired disabilities increased significantly as a consequence of the World War II. Thus, new demands were asked to service delivery systems and professionals that increased the provision of rehabilitation and therapeutic services, including communication assistance (Hardy, 1983), to meet this wide variety of needs.
It was during the 50s that the AAC approaches emerged. Professionals and researchers in the allied health and educational fields started to provide alternative oral communication to individuals with unintelligible or non existent speech due to laryngectomy or glossectomy. These individuals were taught to use artificial larynx devices to allow them to communicate (**Fig. 1**). Until the late 50s, however, no one considered using AAC with individual with an intact oral anatomy.

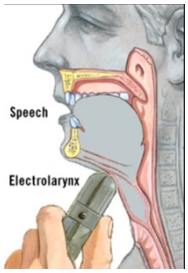


Figure 1. Artificial larynx device

Table 1. Summary of the main changes in the AAC development as a clinical and research based field

	Historic factors	AAC users	Scope of AAC	Assessment	Intervention	AAC system	Trends and myths
1950 - 1960	Increased awareness of the rights of minority backgrounds and medical technology and pharmacology advancements	Individuals with unintelligible or non existent speech due to laryngectomy or glossectomy	Alternative to oral communication	Damaged oral anatomy	Rehabilitation and therapeutic services, including communication assistance	Artificial larynx devices	AAC was not provided to individuals with intact oral anatomy
1961 - 1970	Kennedy's Panel on Mental Retardation	Individuals with mental retardation or cognitive disabilities	Speech development and acquisition of oral language	Prerequisites such as the ability to make or imitate sound, the cognitive ability to comprehend and learn verbal language or "readiness" programs	Speech therapy	None	AAC considered as a last resort as professionals feared it may hinder speech. AAC was not provided to any individual who was believed to have the possibility to develop verbal speech until the age of 8 years old
	Education of individuals with hearing impairment in residential setting	Individuals with hearing impairment and/or cognitive disability	Elicit speech	Hearing impairment or cognitive disability associated with communication disability	Teaching strategies to learn manual signs	Unaided systems of communication such as gestures or facial expression and nonsymbolic vocalizations	
	Advancement in technology	Individuals with severe neurologic involvement of the articulatory system or cerebral palsy	Alternative to oral communication	Neurologic involvement of the articulatory, respiratory or phonatory systems or insufficient manual dexterity to write or manipulate a keyboard	Communication rehabilitation	Aided devices, such as the POSM, based on a typewriter and a switch scanning device	
1971 - 1980	Research about the use of nonspeech symbols and manual signs with nonhuman primates and a focus on the pragmatic function of language.	Individual with cognitive disabilities and physical disabilities	Development and acquisition of the pragmatic function of language	Candidacy Model	Functional language-training in isolated situations	Either unaided or aided systems (such as Blissymbols and electronic devices) but not a combination of the two	Requirement of having certain prerequisites in order to benefit from AAC interventions.
	Microcomputer technology became commercially available	Individuals with communication disabilities	Alternative to oral communication	Individuals who could either read and write or posses the fine-motor and cognitive skills require to type a message	teaching strategies to use the device to produce messages	aided devices such as the Talking Brooch and AutoCom	The use of AAC aided devices was only provided to individuals with intact cognition.
1981 - 1990	Education of the Handicapped Act Amendments (P.L. 99-457) in 1986 and the Technology-Related Assistance for Individuals with Disabilities Act (P.L. 100-407) in 1989. Foundation of the International Society for Augmentative and Alternative Communication (ISAAC) in May 1983	Citizens with disabilities, regardless of their age, type of disability and location of residence	Development of functional communication skills	Communication Needs Model based on prerequisites such as based the individual's cognitive ability, chronological age, oral-motor abilities, and current speech production	Naturalistic teaching techniques within natural routines and settings	combination of and unaided AAC devices (e.g., picture communication symbols combined with manual signs) and aided AAC dynamic systems such as IntroTalker by Prentke- Romich and the McCaw by Zygo	Requirement of having certain prerequisites in order to benefit from AAC interventions.
1990 - 2009	The Individuals with Disabilities Education Act (IDEA) in 1991 and the Communication Bill of Rights in 1992	Every individual with temporary or permanent disorders of speech-language production and/ or comprehension	A full participation in the society	Participation Model based on the universal abandonment of prerequisites and on providing communication opportunities and communication access	Naturalist teaching procedures based on the opportunity of repeated practice within natural routines and environments	A combination of unaded systems such as natural modalities of communication (gestures, facial expression and vocalization) and aided systems such as the DynaVox	AAC Myths debunked by the available AAC research studies results

1.3 AAC BETWEEN 1961 – 1970

During the early 60s another historic factor contributed to increase awareness toward individual with disabilities. President John F. Kennedy older sister was diagnosed with mental retardation and this personal closeness with disability helped to promote public and government awareness of mental retardation specifically and disability in general. In 1961, President Kennedy's Panel on Mental Retardation addressed the need of people with mental retardation to be part of everyday life in America. The increased public and government awareness toward disabilities increased the habilitation of individuals with disabilities and facilitated a transition from the idea that these individuals' primary need was physical care toward a more humanitarian model (Scheerenberger, 1987). In the early 60s the rehabilitation and the therapeutic services began to be applied to individual with cognitive impairment to help them learn and develop skills that would increase their independence.

Early AAC intervention assessments were based on the assumption that communication development of individuals with cognitive disabilities take place with the same succession as linguistically typical individual but at a slower rate (Bryen & Joyce, 1985; Guess, Sailor, & Baer, 1977; Miller & Yoder, 1974; Bricker, 1972). Therefore, individuals that did not have such prerequisites were kept in "**readiness**" programs before, if ever, progressing to language programs (D. R. Beukelman & Mirenda, 1998).

Moreover, early interventions for individuals with cognitive disabilities and communication needs made little distinction between speech and language (Bryen & Joyce, 1985) and focused primarily on speech development and acquisition of oral language. As a consequence, communication interventions were provided only to those individual whose prerequisites led to believe they could benefit from speech therapy. These prerequisites were the ability to make or imitate sound, the cognitive ability to comprehend and learn verbal language (Bricker, 1972; Stark, Rosenbaum, Schwartz, & Wisan, 1973).

In that very period changes were also occurring in the educational field where more and more individuals with hearing impairment were to be educated in residential settings rather then in their home. This inclusion permitted to shift from an exclusive oralist approach to a less restrictive and supportive approach of signed communication (Jordan, Gustason, & Rosen, 1976).

Manual signs were than legitimated as a mean of communication for individuals with hearing impairments education and interaction. Manual signs and other forms of communication such as gestures or facial expression and vocalizations were considered as unaided systems of communication (Bryen & Joyce, 1985; Miller & Allaire, 1987). They have been called unaided because they did not require any sort of external communication device for production of expressive communications.

This acceptance foreshadowed the use of manual signs with individuals with hearing impaired and cognitive impairment first, and for individual with normal hearing and cognitive impairment after. Although manual signs had a number of advantages such as speeding communication compared to speech development (Stremel- Campbell et al., 1977), it also had several disadvantages. Individuals with cognitive disabilities tended to use signs approximations that became even more approximated when the cognitive disability was concomitant with limitation in their fine motor abilities (Stremel-Campbell

et al., 1977). Moreover, quite few people in the community could understand manual signs. Nevertheless, the main goal of manual signs was to elicit speech (Larson, 1971; J. F. Miller & Allaire, 1987; Stremel-Campbell, Cantrell, & Halle, 1977; Carole Zangari, Lloyd, & Vicker, 1994).

During the 60s the new advancements in technology allowed professional to start considering devices such as typewriter controls, electromechanical devices and voice-output devices, that is devices that use a synthetic voice to speak out aloud the message, as tools for communication rehabilitation. These devices were called aided systems of communication because they required an external communication device for the production of expressive communications (D. R. Beukelman & Mirenda, 1998; J. F. Miller & Allaire, 1987).

In Goldberg and Fenton book, published in 1960 we find the first published reference to aided AAC systems for individuals with little or no functional speech and/or insufficient manual dexterity to write or manipulate a keyboard (Shane et al., 2012). Aided systems of communication were, at the beginning, primarily used with individuals with severe neurologic involvement of the articulatory system which posed them at risk of not developing sufficiently intelligible speech to meet general communication needs (Hixon & Hardy, 1964; Kladde, 1974). Some clinical programs started, initially, to experiment with aided systems of communication with those selected individuals (e.g., Kladde, 1974). Then, the use of aided systems of communication was extended with individual with physical disabilities such as cerebral palsy. The first AAC device, specifically designed for individuals with physical disability, was developed in 1963 by Maling and Clarkson and it was called Patient Operated Selector Mechanism (POSM) (**Fig 2**). This device it is considered to be the beginning of the development of other AAC devices, and it combined together the use of a typewriter with a switch scanning device. Scanning devices allowed for selecting letters without the need to press them with a finger. The scanning highlighted every letter on the keyboard one-by-one. When the letter desired to use was highlighted, the user had to press an external switch, or button, which would be converted as a selection input to the machine.

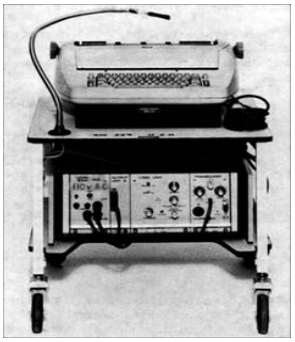


Figure 2. The Patient Operated Selector Mechanism (POSM)

Aided systems of communication such as the POSM device showed promises for improving the quality of life for individuals with physical disabilities (Boulton, 1969; Fox, 1969; Jones, 1961; Miller & Carpenter, 1964; Newell & Nabaui, 1969; Perron, 1965; Roy, 1965). However, the first AAC devices relied on spelling and mainly include typewriters as a mean of communication. Therefore, at their origin, AAC devices could only be used from nonspeaking literate individuals.

Although AAC became more mainstream, professionals implemented it only as a last resort after all other forms of speech therapy had failed and they were certain that the individual would not acquire natural speech. Many professionals were concerned that individuals using these unaided and aided systems of communication would take the easy option instead of pushing themselves to learn speech (Zangari, Lloyd, & Vicker, 1994). Therefore, AAC was not provided to any individual who was believed to have the possibility to develop verbal speech (Beukelman & Mirenda, 1998). As a consequence, many individuals were denied a possibility of communication (D. R. Beukelman & Mirenda, 1998; Kangas &

Lloyd, 1988; Mary Ann Romski & Sevcik, 1988).

1.4 AAC BETWEEN 1971–1980

In 1975 the Education for All Handicapped Children Act (P.L. 94-142) and the new insights provided from base research on communication that led to important changes in the acceptance and use of AAC (Vanderheiden & Yoder, 1986).

P.L. 94-142 (1975) was the first federal legislation that mandate the provision of school-based services to all school-aged students with disabilities requiring appropriate education and services in the least restrictive environment. This legislation allowed an entire generation of students to enter the nation's public schools and it required teachers and therapists to look for and develop new programs to facilitate these students' education (Vanderheiden & Yoder, 1986).

In addition to that, important findings were found in the basic research of communication about the use of symbols and manual signs with nonhuman primates. These research studies demonstrate that chimpanzees could be taught to use manual signs and other abstract symbols for communication purposes (Gardner & Gardner, 1979; Premack, 1971; Premack & Premack, 1974; D. Rumbaugh, Gill, & von Glasserfield, 1973; D. M. Rumbaugh, 1977). From this body of research started to evolve a widened perspective of language, language acquisition, communicative symbol learning and different possible applications of it (Mayberry, 1976). These research studies results generated increased interest among professionals in providing similar symbols training to individual with cognitive impairments that may allow to overcome the disadvantages of manual signs (Carrier, 1974; Deich & Hodges, 1977). Moreover, researchers started to increase attention toward the function of communicative acts rather than their forms, and the language development literature begin to put its interest in pragmatics, semantic relations, and communicative intent developed (Bates, 1976; Bloom, 1970). The focus of communication research studies moved from the structure of language to the pragmatic function of language. The pragmatic function of language was defined as the relationship between communication and the contexts in which it occurs (J Reichle, 1997). This shift in the focus of communication was also propagated in popular media (e.g., Fast, 1971) and this echo may have drawn the attention of professionals toward less conventional communicative signals. Indeed, speech was no longer considered the ultimate goal of language intervention and augmentative communication techniques, such picture symbols, begin to be viewed as acceptable alternatives to speech (Bryen & Joyce, 1985). Professionals started to use symbols with individuals with cognitive impairment that could not access the alphabetical code (Dixon & Curry, 1973) and shifted from teaching grammar and syntax to focus on the function of language as a social behavior (Bryen & Joyce, 1985). Symbols, as a matter of fact, were was based on pragmatics instead of on phonetics. In these years several aided symbols systems started to be developed and implemented. Among them, Blissymbolics (**Fig. 3**) was the first and foremost set of symbols used for individual with communication disabilities.

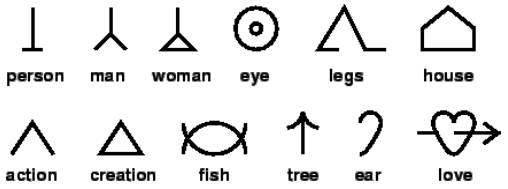


Figure 3. Example of Bliss symbols

Although the changes in the focus communication, AAC assessment were still based on the presence of prerequisites to determine if an individual would benefit from AAC intervention. The Candidacy Model guided professionals to make decision about who could or could not be considered a candidate for AAC and therefore starting to using it (Beukelman & Mirenda, 1998; Musselwhite & St. Louis, 1988). Individuals whose level of cognitive development and receptive or expressive skills did not reach particular level of development on formal tests were not considered candidate for AAC interventions (Chapman & Miller, 1980; Kangas & Lloyd, 1988; Mary Ann Romski & Sevcik, 1988). As a consequence, many individuals with severe and/or profound cognitive disabilities and communication needs were denied AAC services. Moreover, AAC interventions were behaviorally based (e.g., Guess, Sailor, & Baer, 1976; Swetlik & Brown, 1977) and occurred in isolated situations (Bryen & Joyce, 1985) since the generalized use of communication was not yet a goal (Bryen & Joyce, 1985). Communication routines were task-analyzed and segmented into small teachable units that with behavioral techniques were used to reinforce emerging communication skills (Musselwhite & St. Louis, 1988).

Figure 4. The Talking Brooch

By the end of the 70s devices based on microcomputer technology became commercially available. These advances in technology and the attraction to technological developments in computer based displays intrigued AAC professionals to try these devices with individuals with communication disabilities. One example of such devices was the Talking Brooch (A. F. Newell, 1974) (**Fig. 4**). The Brooch used a keyboard that allowed the user to type a message that was then displayed on a light-emitting diode (LED) display pinned to the shoulder of the AAC user.


Figure 5. The Auto Monitoring Communication Board

Another innovative AAC devices was the Auto Monitoring Communication Board (AutoCom) developed at the at the University of Wisconsin (**Fig. 5**). AutoCom allowed an individual to select a message that could then be displayed on a LED screen or printed on a strip of paper. AutoCom was considered a portable device, although it weighted 7.5 Kg, and it gave the advantage to be programmable on the individual's needs. Moreover, it allowed to print the output of the communication, which is the message produced by the individual.

Although innovative, these aided systems were not widely used. The use of keyboards to produce messages allowed them to be use only from individuals who could either read and write or posses the fine-motor and cognitive skills require to type a message (Hagen, Porter, & Brink, 1973; Stremel-Campbell et al., 1977).

During this time, both unaided and aided low tech systems, such as picture symbols, or high tech systems, such as the new electronic devices, were used in AAC interventions. However, at that time the majority of professionals believed that the communication system should be either unaided or aided but not both. Individuals with severe physical disabilities were considered to benefit more from aided systems of communication, whereas individuals with severe cognitive disabilities were considered to benefit more from unaided systems although they would have lesser levels of physical disability.

1.5 AAC BETWEEN 1981–1990

During the 80s, The Education of the Handicapped Act Amendments (P.L. 99-457) that passed in 1986 and the Technology-Related Assistance for Individuals with Disabilities Act (P.L. 100-407) that passed in 1989 entailed great changes in the educational system and in the provision of assistive technologies to individuals with disabilities. The P.L. 99-457 legislation required public school districts to provide technological services and technologies and promote the use of them with children with disabilities (Dugan, 1986), whereas the P.L. 100-407 legislation required every state in America to provide assistive technology to citizens with disabilities, regardless of their age, type of disability and location of residence (Beukelman & Mirenda, 1998; Zangari et al., 1994).

Another important milestone of the 80s was the foundation of the International Society for Augmentative and Alternative Communication (ISAAC) in May 1983. The foundation of the ISAAC witnessed the joining together of professionals from various disciplines and it stated the importance of promoting consumer involvement, improving service delivery and research in the growing field of AAC. The term itself, Augmentative and Alternative Communication, was established in 1983. Previously, terms such as “nonoral,” “nonvocal,” “nonverbal” or “non- speech/nonspeaking” were widely used although all of them failed in adequately and accurately describe the skills possessed by many individuals with speech impairment that however were able to use some sort of speech or vocalization for communicative purposes (Zangari et al., 1994).

The term Augmentative and Alternative Communication shifted the focus from the lack of an ability, such as an intact speech to communicate, to the presence of abilities, such as strategies or modalities that these individuals used or could use to communicate. The term “Augmentative” highlights the possibility to augment the communication skills and capabilities that the individual already has. The term “Alternative” highlights the possibility to use any type of modality or device, other then the speech, that will allow the individual to convey the content of the communication.

As a consequence, changes occurred in both the AAC assessment practices and in the intervention procedures. The Candidacy Model was replaced by the Communication Needs Model (Beukelman & Mirenda, 1998) that although shared several considerations with the previous model, it was less restrictive. The primary goal of the Communication Needs Models was to identify the individual’s current communication needs, the degree to which they were met and selecting the appropriate AAC system to meet these needs. The first step of the assessment was still the determination of candidacy for an AAC system (Musselwhite & St. Louis, 1988) based the individual’s cognitive ability, chronological age, oral-motor abilities, and current speech production. The second step consisted in selecting the appropriate aided or unaided AAC system. The final step consisted in selecting the goals for the system’s implementation. The assessment practices of the Communication Needs Model, although less restrictive, still failed to adequately include individuals with severe developmental disabilities.

Related to the intervention procedures, the traditional therapy based on behavioral teaching techniques, used to pull out and reinforce emerging communication skills in isolated language training,

were gradually substituted with more naturalistic teaching techniques strategies (Miller & Allaire, 1987). Naturalistic teaching techniques were defined as "the use of naturally occurring opportunities to teach communication during the course of an individual's daily routines" (Schepis, Reid, Behrmann, & Sutton, 1998, p.562) and they were found to lead to higher acquisition and generalization of functional communication skills (Bryen & Joyce, 1985). AAC language interventions started to identify and focus on functional communication skills within natural routines and settings (Bryen & Joyce, 1985; Romski & Sevcik, 1988). Functional communication skills refer to the skills required to initiate and maintain daily interactions within the natural environment (Janice Light, 1989) that allow AAC users to express needs and wants, exchange information, develop social closeness, and participate respecting the social etiquette routines (Janice Light, 1988).

Along with the the shift in the focus of AAC interventions, the use of a combination of aided and unaided AAC devices (e.g., picture communication symbols combined with manual signs) started to be recognized as increasing the user communication (Romski & Sevcik, 1988). Therefore, the choice of the type of AAC device was not based anymore on the type of disability of the AAC user. Teachers and therapists came to the conclusion that the gain in functional communication was not depending from the system chosen to communicate but on how it was implemented within the natural routines and environments of the user (Romski & Sevcik, 1988). Indeed, there was the need to consider the users' communication needs based on the interaction processes and the communication demands of their environments (S. N. Calculator, 1988; Janice Light, 1988).

The increased awareness of the power of assistive technology, AAC included, in enhancing the life of individual with disabilities, prompted several progress in the quality of the available devices.

Development in computer memory, voice synthesis and computer graphics led to more user-friendly, and graphic in nature, AAC devices that could be than used from individual who were unable to read or write (Zangari et al., 1994). The IntroTalker by Prentke-Romich and the McCaw by Zygo (**Fig. 6**) are some example of these innovative devices that were based on the selection of symbols and the use of speech output to communicate. The commercial availability of these devices allowed families to have more access and choices on communication devices.

Figure 6. McCaw by Zygo

The advancements in technologies occurring during the 80s allowed for development in both the access to AAC devices and the type of display of AAC devices. Starting from the 80s individual with extremely severe motor impairments were able to access AAC devices not only through scanning systems but also through eye pointing systems. Scanning systems used scanning options to select the desired symbol (e.g., Flexcom, ScanPAC, ScanWOLF) whereas eye pointing system allow users to select the desired symbol using their eye gaze (e.g., EyeTyper and Light Talker) (**Fig. 7**).

Figure 7. Light Talker eye-gaze device

Technology improvement allowed also for changes in the type of display. So far, AAC device were based on static display, meaning that the individual could have access only to the symbols included in the device. During the 80s dynamic displays of symbols started to become available. Dynamic displays allowed to change the display of symbols based on the user's communication needs (**Fig. 8**). Therefore, the symbols that the individual could have access to was not limited anymore.

Figure 8, ZYGO Talara dynamic display

Moreover, the availability of symbols increased significantly during this time frame. Blissymbolics extended the initial vocabulary and published a dictionary of 1400 Blissymbols in 1980, and different symbols set and systems started to be developed (e.g., Carlson, 1984; Cregan, 1982; Johnson, 1981, 1985).

From the 80s on the advancements on AAC devices paralleled the changes and innovations occurring in mainstream computer and technology. Moreover, as the progress in technology were made, the interest and discussion of researchers and developers on the specific requirement of AAC devices (type of displays and access options) led to important changes in how AAC devices were designed (Vanderheiden, 1978).

The changed view in the importance of how AAC technologies were implemented and the shift in the AAC interventions in more naturalistic environments changed the role that families have in AAC. Before the 80s, AAC assessments and interventions were mainly centered on individuals with communication disabilities and on their needs (H. P. Parette & Marr, 1997). In this time frame, professionals started to recognize the responsibilities of families in providing information, supporting the assessment and intervention efforts with inputs of a variety of issues such as for example, vocabulary selection (Musselwhite & St. Louis, 1988). Indeed, families were primarily seen as a crucial source of information. Not yet however, families could plan or driven the intervention strategies in the individual's routines or environments along with professionals and therapists (Musselwhite & St. Louis, 1988).

1.6 AAC BETWEEN 1991–2009

In 1991, the 1975 Education for All Handicapped Children Act was renamed the Individuals with Disabilities Education Act (IDEA). As a consequence, words such as "inclusion" and "empowerment" appeared in many system plans and the Communication Bill of Rights (National Joint Committee for the Communication Needs of Persons with Severe Disabilities (NJC), 1992), stating that communication was not a gift but a Right of all individuals with communication disabilities, was endorsed by a committee composed of several professional organizations.

In 1997 IDEA amendments specifically targeted AAC as students' education occurred more frequently in general education classrooms rather than in "pullout" settings (e.g., Sailor, Gee, & Karasoff, 2000; Westling & Fox, 2004). Professionals and teachers were required to provide (a) individual assessment of assistive technology needs, including AAC, and (b) consideration of these needs on each student's Individualized Education Program (Beukelman & Mirenda, 1998; Zangari et al., 1994). Consequently, the provision of AAC services greatly increased as teachers were looking for ways to allow children with

severe disabilities comprehensively and successfully participate within inclusive environments (Zangari et al., 1994).

Empirical research studies (Kangas & Lloyd, 1988; Romski & Sevcik, 1988), once again, allowed for another great change in the AAC field. Research studies indeed, demonstrated that there was no need for cognitive prerequisites prior to beginning of AAC interventions (Kangas & Lloyd, 1988; Romski & Sevcik, 1988). As Pat Mirenda (1993) stated individuals with disabilities do not have to learn to communicate. Communication is something inevitable since, although non intentionally, people cannot not communicate. These results led to the universal abandonment of prerequisites for AAC services which opened the possibility to AAC services provision to all individuals regardless of the severity of their disabilities. Consequently, a change in the assessment procedures occurred. A new assessment model, the Participation Model was developed and established. The Participation Model consider all individuals with severe disabilities to be able to achieve enhanced communication abilities. It is a strengths based model (Kroth & Bolson, 1996) in which the two major underpinnings are communication opportunities and communication access (P. Mirenda & Iacono, 1990).

The first step of the Participation Model is the assessment of the current communication needs, communication opportunities and access barriers of individuals based on the analysis of their daily routines and environments. The second step is a detailed assessment of the future needs that the individual may have in a variety of environments (schools, home, community). The third and last step is the planning of the intervention that aimed at meeting the current and future communication needs of the individual (Beukelman & Mirenda, 1998).

The focus of communication interventions changed accordingly. AAC interventions goal was the acquisition of functional communication skills which can be defined as "the actual use of language to achieve predetermined purposes". In order to be functional, language must influence others' behaviors and bring about effects that are appropriate and natural in a given social context" (Calculator & Jorgensen, 1991, p. 204). Therefore, a greater emphasis was given to communication interventions within natural daily routines and environments (Beukelman & Mirenda, 1998; Calculator & Jorgensen, 1991) where functional communication skills could be taught by using both materials and activities that were commonly accessible and greatly reinforcing for the individual (Schepis et al., 1998). As a consequence, naturalistic teaching strategies became the best practices for AAC interventions (Reichle, 1997). Naturalist teaching procedures incorporated frequent models of appropriate communication within natural routines through the use of prompting strategies of child communication, the use of natural consequences based on the choices of the individuals and an ongoing interaction between the child and the professional (Warren & Reichle, 1992). Naturalist teaching strategies also relied on the opportunity of repeated practice through which the children have the opportunity to observe and perform the desired communication skill (Kaczmarek, Hepting, & Dzubak, 1996; Kozloff & Rice, 1998). Critical to these interventions is providing communication opportunities and teachers and professionals' role is to be a facilitator, that is altering children' environments to promote communication opportunities (Kuder, 2003). In addition to that, ecological inventories (Brown et al., 1979) became very helpful in recognizing the specific vocabulary that meet children' needs and that

children can acquire and generalize in their natural environments. These instructional strategies have been proven to led to significant acquisitions of functional communication skills in a variety of areas such as requesting the desired objects, refusal of items or events and access to activities (Cipani, 1990; Drasgow, Halle, Ostrosky, & Harbers, 1996).

Figure 9. DynaVox device

Greater advancements were also made in technological research and development in aided communication devices. An improvement was made in the design and access of aided AAC devices. New software such as the Board Maker developed by Mayer & Johnson were developed to allow professional to create communication boards based on the communication needs of multiple individuals. These boards could be saved on the computer and later modified to add new vocabulary and printed.

A new generation of dynamic devices was also developed. These innovative devices were based on dynamic picture symbols touch screen displays that allowed for a larger retention of vocabulary storage. The DynaVox (**Fig. 9**) is an example of such advanced AAC devices.

The changes in technologies and in the assessment and intervention procedures led to changes in the role of families as well. Professionals began to recognize that the use of AAC system affect both the individuals and their families (Parette, Brotherson, & Huer, 2000; VanBiervliet & Parette, 1999). More specifically, professional started to understand that the introduction and use of an AAC systems was a source of potential stress for families (Hourcade, Parette, & Huer, 1997) as it may result in limitations and disruptions to the families' routines or environments (Parette & Angelo, 1996; Parette, Brotherson, Hourcade, & Bradley, 1996). Transportation, training and use of the AAC system were the main cause of rejection of the AAC device (Hourcade et al., 1997).

These barriers were the main reason why the design and development of AAC devices began to take into consideration the feedback of families. Not only the user had to be able to access it but also the families or other communication partner that had to implement it, needed to know how to program it and use it.

By the end of this time frame, AAC research studies results allowed for debunking a series of myths that delayed or obstruct AAC development. Although it does not claim to be and exhaustive list of AAC myths, Romski and Sevcik provide evidences both in their paper "Augmentative Communication and Early Intervention Myths and Realities" (2005) and in their preconference session at the 17th Biannual ISAAC International Conference in 2016 entitled "Debunking the Myths about Using AAC with Children and Adults", of 6 major myths that have been debunked since the first appearance of AAC.

The first myth in AAC was considering AAC as the ''last resort'' in speech-language interventions. When first emerging, AAC could only be employed when every other type of language interventions has failed and the child had not developed speech by the age of 8 yo (Chapman & Miller, 1980). The roots of this myth can be found in the assumptions claimed in two other myths.

Prior to the 80s, professionals and parents feared that AAC would hinder speech development. They believed that children would take the easiest way to communicate instead of pushing themselves trying to develop speech. For this reason, professionals asserted that children have to be a certain age in order

to benefit from AAC interventions. Chronological age was often use as a matter against the provision of AAC to young children especially because professionals and parents feared that AAC could hinder the development of speech. Along with this belief, Miller and Chapman argued a series of rules based on which AAC should be considered only if children had not been developed speech by the age of 8 yo (Miller & Chapman, 1980). As a result, AAC intervention were only delivered to children from a certain age on that did not developed speech although many language interventions were provided.

These myths have been debunked by many research studies carried out from the 80s on. First of all, the available empirical data on AAC interventions proved and still proves that AAC interventions do no hinder speech (Romski, Sevcik, & Hyatt, 2003) but on the contrary led to exactly the opposite outcome, that is, the enhancement of spoken communication (Adamson & Dunbar, 1991; Beukelman & Mirenda, 1998; Beukelman & Mirenda, 2013; Cress, 2003; Millar, Light, & Schlosser, 2006; Mary Ann Romski, Sevcik, & Adamson, 1997; Mary Ann Romski & Sevcik, 1996; Schlosser & Wendt, 2008; Sedey, Rosin, & Miller, 1991). Moreover, there were no empirical data supporting the requirement of being a certain age in order to benefit from AAC. On the contrary, research studies demonstrated and demonstrates the efficacy of communication interventions with infants, toddlers, and preschoolers with a variety of severe disabilities (Light et al., 2012; Romski et al., 2010) as well as adults (Snell et al., 2010). Finally, a large body of research studies (David R Beukelman, Fager, Ball, & Dietz, 2007; Bopp, Brown, & Mirenda, 2004; Branson & Demchak, 2009; Fried-Oken, Beukelman, & Hux, 2012; J. B. Ganz et al., 2011; Machalicek et al., 2010; R. Schlosser, Sigafoos, & Koul, 2009; Wendt, 2009) demonstrated and demonstrates the positive outcomes of AAC intervention. This body of research led to debunking the myth that AAC should be the last resort of other language interventions. Research proved and still proves that AAC intervention should be provided prior to speech development failure in order to provide children who are at risk for non developing speech with the communication and language skills they need to communicate (CJ Cress & Marvin, 2003; J. Reichle, Beukelman, & Light, 2002).

A fourth myth refers to the requirement of having certain prerequisites in order to benefit from AAC interventions. Children with cognitive disabilities and/or physical impairments were excluded from AAC because their level of intelligence and/or sensorimotor development was not commensurate with the level required for early language development (Miller & Chapman, 1980; Mirenda & Locke, 1989; Romski & Sevcik, 1988). However, research studies demonstrated that language have a great impact on cognitive development and, although research results agreed that basic cognitive skills are essential for language development (Rice, 1983; Rice & Kemper, 1984), they did not provide a clear relationship between language and cognition. Moreover, the assumption that individuals with physical impairments cannot demonstrate their cognitive abilities without a way by which to communicate led to the conclusion that AAC could not be denied based on the evidence of those abilities (Kangas & Lloyd, 1988; Reichle & Karlan, 1988; Romski & Sevcik, 1988; Rice & Kemper, 1984).

A fifth myth about AAC intervention relates with the use of AAC aided devices only for individuals with intact cognition. Aided systems of communication were often used with individual with no cognitive disabilities for two reasons. The first one relates with the costs of such devices. Aided AAC devices were very expensive (thousands of dollars) and since the available fund for these devices was limited (Patson,

1993) they were required to be given only to individual who could “truly benefit” from it (Turner, 1986). Second, early aided AAC devices required fairly sophisticated level of cognitive skills to be operated and therefore they were provided only to individuals with such level of skills. These two reasons do not apply nowadays anymore. The range of AAC options available is much broader and it includes low costs devices (a few tens of dollars) as well as high cost devices (a few thousands of dollars). Moreover, the improvement of AAC design and access make them very easy to use also for individual with little cognitive skills.

A sixth myth relies with the assumption that children can only learn symbols in a representational hierarchy from objects, to photographs, to line drawing, to written words. The empirical evidence coming from the literature of typically developing children indicates that representational hierarchy as symbols learning strategy is not based on any evidence about how children learn (Namy, Campbell, & Tomasello, 2004). These research studies suggest that iconicity do not impact the ability to learn symbol-referent relationships since this relationship may change throughout the children development.

1.7 AAC BETWEEN 2010 - TO PRESENT

The AAC evolution still witnessed very important changes in the demographic of the population who use AAC, in the scope of communication needs, assessments and intervention practices, and in the AAC systems devices used to communicate (Janice Light & McNaughton, 2012). All these aspects are going to be further analyzed in the next chapters with a wider focus on today’s best practices.

CHAPTER 2

THE THEORETICAL FRAMEWORK OF AAC

2.1 AAC USERS AND COMMUNICATION PARTNERS

The type and number of AAC users has greatly changed and paralleled the growth and evolution of the AAC as a field. Regarding the type of users, we can identify different trends that determine changes.

The first one relies on the **presence of cognitive prerequisites** in order to be candidates for AAC. Individuals who did not possess those prerequisite were not considered to benefit from AAC interventions. Therefore, initially AAC was only used with individuals who had little or no functional speech, due to the surgical removal of their vocal cords (laryngectomy), or with individuals with cognitive disabilities and/or hearing losses with the cognitive prerequisites required. It was not until the late 80s that research results (Kangas & Lloyd, 1988; Reichle & Karlan, 1988; Romski & Sevcik, 1988) proved that no evidences supported the assumption about the cognitive prerequisites, which led to the recognition that it was inappropriate to exclude individuals with severe or profound cognitive disabilities. From the 90s on all the individuals with communication disabilities were provided with AAC intervention regardless their cognitive skills.

A second trend relies on **level of speech development**. Initially, AAC intervention were provided only to individuals with little or no intelligible speech. Moreover, individual with no functional speech who were believed to develop speech were excluded from AAC intervention because professionals feared that these individuals, more often children, would take the easy way instead of pushing themselves to speak. AAC intervention were provided as a last resort after all other interventions had failed (Romski & Sevcik, 2005). Research studies results demonstrated again that there were no evidences about AAC hindering the speech, on the contrary AAC was proved to enhance it. This results opened AAC interventions not only to young children with communication disabilities (e.g. Branson & Demchak, 2009; Light & McNaughton, 2012; Snell et al., 2010) but also to children who have some spoken language skills (Baumgart, Johnson, & Helmstetter, 1990; Bodine & Beukelman, 1991) and to children who are at risk for speech development such as children with Autism Spectrum Disorder (ASD), Down syndrome, developmental apraxia, or children who have speech that is difficult to understand (e.g. Calculator & Black, 2010; Light et al., 2012; Romski et al., 2010).

Moreover, the increased awareness and acceptance of AAC during its development, led to an extension of AAC interventions to **adults with acquired disabilities**, including individuals with aphasia, Alzheimer's disease, dementia, amyotrophic lateral sclerosis (ALS), Guillain-Barré syndrome, multiple sclerosis,

Parkinson's disease, brainstem stroke, closed head injury, and individuals in intensive care units (ICU) who may have temporary conditions of communication disabilities (e.g. Beukelman, Fager, Ball, & Dietz, 2007; Bourgeois, Dijkstra, Burgio, & Allen-Burge, 2001; Cress & King, 1999; Downey & Hurtig, 2006; Fried-Oken et al., 2012).

The number of AAC users increased as a consequence of an increase in the type of AAC users. However, two other factors contributed to this increase. First, the incidence of certain types of disabilities, such as autism and cerebral palsy, increased due to advancements in medical interventions. Second the life expectancy of older adults (65 years old or older) has increased which led to an increase of adults AAC users with acquired conditions of communication disabilities (Segalman, 2011).

Nowadays then, AAC interventions is provided to **all individuals with communication disabilities** regardless their diagnosis, their cognitive skills, their chronological age or the entity of their communication disability (temporary or permanent communication disabilities, little or partial speech). Moreover, AAC interventions do not only include the AAC users but it is also **extended to all the possible communication partners** with whom the individuals may interact with. The term communication partner refers to family members, friends, acquaintances, unfamiliar persons that interact with the AAC user either on a daily basis or occasionally. AAC professionals such as facilitators, specialists, educators, clinicians, finders and experts are also considered communication partners. Indeed, in the 90s the users' communication partners started to have a role in AAC intervention, not only as provider of information about the user but also as an active help in the implementation of the intervention itself. AAC started to be carried out in natural environments and therefore not only the family members but all the different communication partners started to play an important role for the efficacy of AAC interventions. Research studies demonstrated that communication partners share the responsibility to support the person who relies on AAC to effectively communicate as independently as possible (Beukelman, Ball, & Fager, 2008; Beukelman & Ray, 2010).

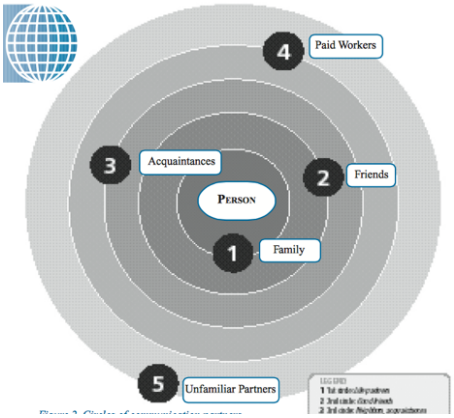


Figure 1. Circles of Communication Partners (CCP)

The different types of communication partners are well explained in the "Circles of Communication Partners" (CCP) (**Fig. 1**) proposed from Sarah Blackstone and Hunt Berg (2003). The CCP includes five concentric circles and the person with communication disability right in their center.

The **first circle** includes the users' life long communication partners. For children the first circle typically includes family members and siblings whereas for adults it usually includes parents or guardians, spouse and children and domestic partners.

The **second circle** includes friends and/or relatives with whom the AAC users has a degree of closeness and familiarity. It usually includes the individuals with whom the users spend their leisure time or share their interests with. For children it usually includes friends such as schoolmates or neighbors and relatives who live nearby. For adults it includes relatives and friends from their past.

The **third circle** includes individuals with whom the AAC user is acquainted but does not interact with on a daily basis. It includes bus drivers, storekeepers, community helpers, colleagues or co-workers. The fourth circle includes all the individuals who are being paid when interacting with the AAC users. It includes therapists, physicians, teachers, instructional assistants, personal assistants, babysitters as well as AAC professionals such as facilitators, specialists, educators and experts. These professionals, as communication partners, differ from the role they have in the AAC interventions (David R Beukelman et al., 2008).

- Facilitators are individuals that provide assistance to people who rely on AAC on a daily basis by supporting the implementation of interventions, preparing and maintaining low-tech and/or high tech materials and serve as a connection with other communication partners;
- Specialists are professionals who regularly provide AAC interventions to individuals who rely on AAC. Their major role is to design and implement the intervention, monitor the impact of AAC interventions, obtain funding for interventions, support AAC research, support facilitators and instruct the other communication partners about AAC;
- Clinicians and educators include professionals that work in the education, health care and assisted living settings, such as speech-language pathologists, occupational therapists and teachers. Their role is to support and implement AAC interventions in collaboration with an AAC specialists. In general, they monitor the impact of AAC interventions, implement appropriate AAC systems, prepare and support AAC facilitators and instruct the other communication partners;
- Finders are professionals that recognize an unmet communication need and recommend AAC interventions. Finders usually include family physicians, pediatricians, speech-language pathologists, physiatrists and and teachers. Although these professionals are not expert of AAC they are aware that AAC interventions may provide benefits for children, youth or adults with communication needs;
- Experts are professionals focused on developing services, policies, technical and knowledge bases of the AAC field, such as researchers, administrators and university faculties. Their role is to promote, sustain and enhance AAC services providing specialists, clinicians and educators with continuing education, develop AAC policies and execute AAC research.

The **fifth and last circle** includes unfamiliar partners who may potentially interact with the AAC user. It includes "every one else" that do not fit in any of the other four circles.

2.2 SCOPE OF COMMUNICATION

The field of AAC went through a transition related to the goals of AAC interventions provided to individuals with communication disabilities. Initially, communication interventions focused on remediating speech and/or language impairment in an attempt to ***"repair broken parts"*** (Lyon, 1998, pp. 204). AAC interventions put emphasis on the technical aspect of communication, such as the access to devices and correct production of manual signs, without considering the communicative needs of the AAC users in their interactional contexts. Starting from the 70s however, professionals begin to put **emphasis on the needs** arising from the AAC users in interaction with their environments. Professional realized that to impact the functioning of AAC users they should meet their needs in their home, educational, vocational, and community environments, rather than in clinical or educational settings because they recognize that the mere provision of instructions on how to operate a device or on how to sign was not enough to ensure an effective use of the system for communication purposes (Calculator, 1988; Light, 1988).

Nowadays, the ultimate goal of AAC became allowing the individual to **actively participate** in society. As Beukelman and Mirenda (2013) stated, the goal of AAC is to allow individuals with communication disabilities to efficiently and effectively participate in all the activities they choose. Light (1988) structured participation in four main sub-goals that can be described through specific characteristics: aim of communication, focus of communication and emphasis:

- the first AAC sub-goal is to enable the user to communicate needs and wants. The communication of needs and/or wants aims at regulating the listener's behavior in order to fulfill the need or the want expressed by the AAC user. An example of needs and wants expression is asking for help or ordering food in a restaurant. The focus of the communication is the user's desired object or action and the emphasis is on providing the user with means to independently initiate the interaction;
- the second AAC sub-goal is to enable the user to transfer information. Information transfer aims at sharing information with the listeners. An example of information transfer is telling a friend about the activities carried out during the day. The focus of the communication is the information to be transferred and the emphasis is on providing the user with means to develop the interaction;
- the third AAC sub-goal is to enable the user to achieve social closeness. Social closeness aims at establishing, maintaining or developing personal relationship with the listener. Examples of social closeness are greetings, cheering and feelings expression. The focus of the communication is the interpersonal relationship and the emphasis is on the feelings of connectedness achieved through the interaction;
- the fourth AAC sub-goal is to enable the user to use the social etiquette. Social etiquette aims at conforming to social conventions of politeness. Examples of social etiquette are expressing appreciation by saying "please" and "thank you". The focus of the communication is the social convention itself and the emphasis is on providing the user with means to conform to it.

2.3 ASSESSMENTS AND THE PARTICIPATION MODEL

During the evolution of AAC as a field, AAC assessment and interventions went through significant changes as well. During its emerging, the focus of AAC assessments and interventions was on addressing traditional language goals based on vocabulary acquisition and mean length of utterances. Then, AAC interventions started to focus on the technical aspects of communication such as a proper access to the assistive devices and/or a correct production of manual signs. Starting from the late 70s, AAC interventions began to address the expression of needs and wants through AAC systems. AAC assessment and interventions were based on the Candidacy Model which required the presence of a set of prerequisites in order to qualify for AAC interventions. These prerequisites included a list of cognitive and linguistic skills without which the individuals could not be considered candidates for AAC interventions. The individuals who did not possess the prerequisites required were considered "not ready for" AAC and, in order to "become ready", they usually had to work on a series of activities specifically designed to teach them the prerequisites they were lacking of (Beukelman & Mirenda, 2013). An example of such activities were learning about object permanence by finding toys that were hidden under a towel and learning about visual tracking by following stuffed animals moved from left to right. These activities usually failed to lead to the "readiness" they were supposed to. Therefore, individuals who were not considered candidates for AAC interventions were often denied access to the possibility of communicating needs, wants, preferences and feelings. During the 80s, professionals become interested in functional communication and started to consider AAC users in interaction with their environments. Professionals carried out interventions in their home, educational and community environments in order to be able to support their functioning and participation within these environments. Therefore, the interventions were extended beyond the individual to include also the communication partners with whom the user interact with (e.g. Broberg, Ferm, & Thunberg, 2012; Thirumanickam, Raghavendra, & Olsson, 2011). The focus of intervention was not just meeting the users' needs and wants but also allow information transfer, social closeness and social etiquette (Light, 1997). The outcomes of the interventions began to be measured in terms of enhanced communication effectiveness and participation's support in the society (David R Beukelman, 1991). Participation became the ultimate goal of AAC interventions.

In 2004 the American Speech-Language-Hearing Association (ASHA) endorsed a framework to carry out AAC assessments and interventions called the Participation Model (**Fig. 2**). The Participation Model is a dynamic and systematic process for AAC assessment and intervention's design based on the functional participation requirements of individuals without disabilities that have the same chronological age as the AAC user. The functional participation requirements take into consideration the interactions, the activity to be completed and the contexts in which the activities or interactions are performed from an individual without disability. Those requirements are used to make a participation inventory that aims at identifying the key activities and interactions that the AAC user carries out in different environments. Once the activities and interactions are identified, the first step of the Participation Model is to determine how a peers with no disability, who have the same age and gender of the user, successfully participate and complete the key activities or interaction selected. The peers' performances and

participations will determine the criteria against which to compare the performances and participations of the AAC user during the same activity or interaction. This comparison will underline which steps required to complete the activity present gaps between the AAC user and the peer. These gaps will constitute the participation inventory of the AAC user on which the intervention, and its desired outcomes, will be based. For example, if elementary children participate to the roll call by saying "I am here", children with communication disability may not participate to it. Therefore, providing children with AAC strategies to participate to the roll call may be a step of the intervention to allow them to fully participate at school in the same way their classmates participate.

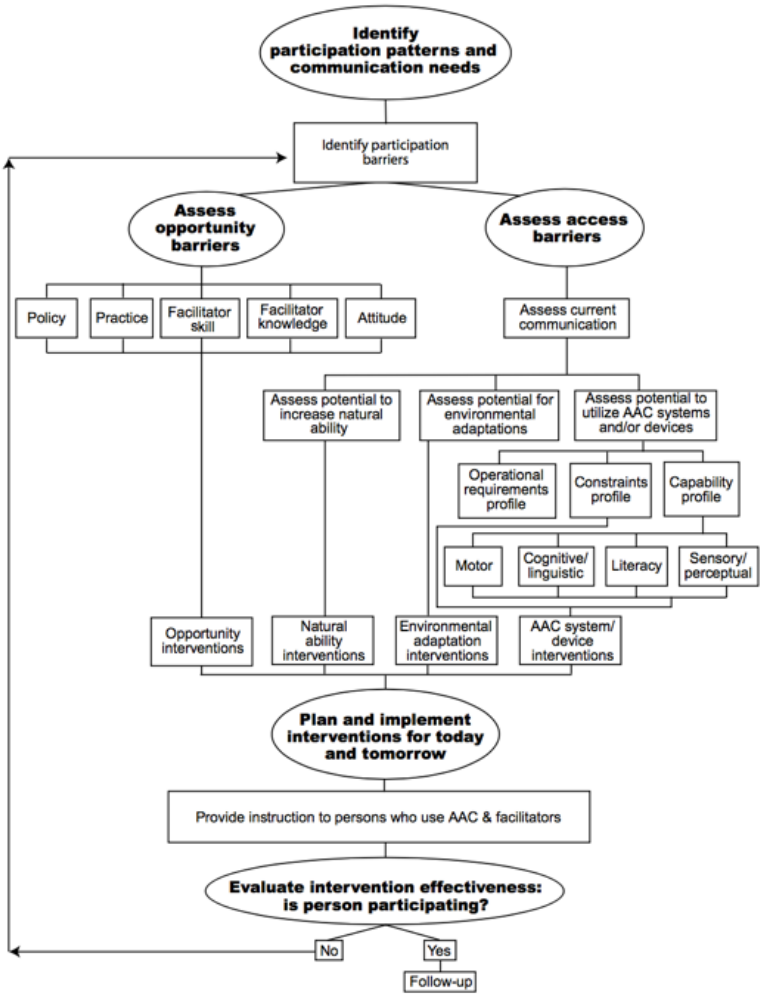


Figure 2. Participation Model flow chart (Beukelman & Mirenda, 2013)

In addition to a participation inventory it is also important to assess the communication partners with whom the AAC user is likely to communicate. This assessment will help the AAC team to identify areas of potential strengths and weaknesses for the communication process. Communication partners are crucial in providing the AAC user with communication opportunities. However, in order for that to happen, communication partners should be informed and acknowledge how to support the user's communication.

2.3.1 AAC ASSESSMENT FOR "TODAY" AND "TOMORROW"

AAC assessment is important because it allows to make decision to support the AAC user's communication needs. AAC interventions are usually a long-term ongoing process in which communication needs and capabilities often change with AAC user's age and impairment evolving. Some users increase capabilities and communication opportunities whereas some others experience less participation opportunities as they age or as their impairments become more severe.
Beukelman and Mirenda (2013) reported as a good practice during the assessment process the consideration of the goals set for meeting the "today" communication needs together with the goals set for the "tomorrow" communication needs. The decisions taken for "today" aim to meet the user's immediate communication needs and should match the current user's capabilities and constraints that have been identified during the assessment. The decisions taken for "tomorrow" aim to meet the needs, capabilities, constraints and opportunities that are likely to result from the intervention of "today". For example, decisions for AAC users with degenerative conditions such as ALS, should take into consideration the loss of motor and communication skills. If the communication system for users with ALS is activated with their fingers, it is important that the system will also allow another type of activation, for example an activation through external switch, to supports users' communication when they will not be able to use their hands anymore. Once the system for "tomorrow" has been established it then becomes the system for "today", and the planning for another "tomorrow" may begin. In the example above, the use of eye-gaze technologies may be the next decision to consider for AAC users with ALS. Both the decision for "today" and "tomorrow" are therefore critical for the success of the AAC interventions.

2.3.2 PHASE OF ASSESSMENT OF THE PARTICIPATION MODEL

The Participation Model takes into account the communication goals set for today and for tomorrow and it includes four general phases.

Phase 1: Referral for Augmentative and Alternative Communication Assessment
During this phase the AAC user is usually referred for an AAC assessment from an AAC finder. The AAC finders plays an important role during this phase because after recognizing that an AAC intervention may be appropriate to meet a user's communication needs, they usually initiate a referral of the AAC users and their family to the appropriate resource. Although finders play a short-term role, their awareness and information about AAC interventions is the key for the beginning of an AAC assessment process without which the AAC users would be delayed in meeting their communication needs.

Phase 2: Initial Assessment and Intervention for Today
In this phase, the AAC team assess the AAC users' current communication needs together with their physical, cognitive, language, and sensory skills. The goal of this phase is to design an intervention that

matches the existing skills with the existing needs. Typically, an initial AAC intervention focuses on allowing successful communicative interaction between the AAC users and their familiar communication partners (family, siblings, friends) and it continues to refine itself as the users, their communication partners and the AAC team learn about new AAC skills and needs of the users.

Phase 3: Detailed Assessment for Tomorrow

The goal of this phase is to develop a communication system that will take into account the communication needs that the AAC users may encounter in the future, not only in the environment and with the communication partners they are familiar with, but also in other environments with unfamiliar communication partners. These future environments and communication partners will reflect the users' lifestyle and interests and therefore may include schools, employment, residential and leisure environments. Each of these environments, and the communication partners they include, have specific participation requirements that should be met. For example, an adult AAC user might need to be able to talk on the phone as well as be able to have a conversation with co-workers. Thus, this phase not only requires an assessment of the AAC user's current participation patterns and communication skills, but it should refine the AAC intervention to accommodate future participations. This phase of the assessment takes also into consideration the possible evolution of a specific disability, especially if they are degenerative. For example, for an individual with ALS a possible goal for "today" would be using an amplifier for a better understanding of the natural speech whereas potential goals for "tomorrow" would be using scanning devices or an eye tracking devices to allow the individuals to keep communicating regardless their motor impairment.

Phase 4: Follow-Up Assessment

This phase involves maintaining the AAC system up to date with the user's changing skills, needs and lifestyle. Periodically, the communication device and the user's abilities and capabilities should be assessed in order to detect changes. If a user's lifestyle and capabilities are relatively stable, follow up assessments may not occur frequently. On the contrary, especially for users with degenerative illnesses such as ALS, follow up assessments are essential to accommodate the communication system with the user's skills and needs.

2.4 BARRIERS TO PARTICIPATION

It is important to assess the user's skills, needs and capabilities to participate as well as the user's communication partners in order to design an effective AAC intervention. However, meeting the AAC user needs for "today" and "tomorrow" (Beukelman & Mirenda, 2013) is only one part of the Participation Model assessment. The Participation Model aims also at identifying the barriers that may affect the AAC users' participation. The AAC main barriers refer to access barriers and opportunity barriers. Access barriers relate with AAC users or devices limitations that obstruct communication, whereas opportunity barriers relate with limitations imposed by individuals other than the AAC users.

2.4.1 Access Barriers

Access barriers refer to the limitations of the AAC user capabilities, attitudes, resources and to the limitations of the communication device. Examples of access barriers include the difficulty of an AAC user to use eye gaze constantly and the difficulty in using the device to initiate a conversation. The AAC team should verify that the communication device selected for the users it is not difficult to use and that they use it to effectively engage in communication interactions. In order to identify access barriers there are three types of assessments: the capability profile, the operational requirements profile and the constraints profile.

Regarding the capabilities profile and operational requirements profile, the AAC team needs to identify which of the electronic devices, non electronic devices or a combination of the two, can be appropriate to meet the user's communication needs. In order to do so, this assessment uses in combination both the user capabilities assessment and the operational requirement assessment, through the feature matching approach. The capabilities assessment refers to the process of gathering information about the user's level of performance in areas that are critical for AAC interventions such as the user's motor control, cognition, language and literacy skills (Yorkston & Karlan, 1986). The assessment aims at identifying the capabilities of the user in order to match them with the operational and learning requirements of AAC devices. The feature-matching approach helps the AAC team to select the device whose features best match the user's capabilities (Costello & Shane, 1994; Glennen & DeCoste, 1997). The feature-matching approach uses criterion-referenced tasks to answer questions such as, for example, "are the individuals able to use their fingers to access the device?" "are the individuals able to navigate through multiple levels of symbols? Do the users need large images on the display?". If the answer to the first question is "yes" devices with scanning options are eliminated from consideration, if the answer is "no" devices with scanning option are further explored. And so forth. Based on the answers to this criterion-referenced questions the AAC team will select one or more devices that the users can try for a period of time in order to verify if it/they can support their communication needs.

Regarding the constraints profile, once the AAC device or devices are identified, the AAC team should assess the constraint profile which may impact with the use of it/them. The common constraints to AAC intervention are related to the individual and family preferences, the preferences and attitudes of other communication partners and communication partners and facilitators' skills and abilities.

Of paramount importance when making AAC device decision is the users and their family preferences about the communication device. Users and family members seem to value aspects of AAC devices that go beyond their functionality and that are not considered as high priority by professionals or manufacturers. User and family preference usually relies on some device characteristics which include the portability, durability, quality and the "naturalness" of communication supported by the device (for example the cosmetic appeal). Light and colleagues (2007) asked a group of children without disability to draw a communication device for an invented boy on a wheelchair. Children draw functional features already included in AAC devices such as voice output, multiple levels of vocabulary, but they also added

features like cartoon characters, lights and other popular themes. A common concern of users and family members is indeed that the AAC device will make the users look and sound different from their peers.

Many other factors affect user and family preferences. One of these is related to the attitudes toward technology (David McNaughton et al., 2008; Saito & Turnbull, 2007). Some individuals may have had positive or negative experiences with technology. Some individuals are indeed attracted to it whereas some others are frustrated by it (Bailey, Parette, Stoner, Angell, & Carroll, 2006).

Beukelman and Mirenda (2013) stated that sensitivity and attention to users and family member's preferences for a device is critical for an AAC intervention. Therefore "even if this means that the final assistive device decision is "less than perfect" from the perspective of the AAC professionals on the team" (Beukelman & Mirenda, 2013, pg. 126), users and families' preferences should be seriously taken into consideration during the assessment.

Although less important than the users and family members' preferences, it should also be considered preferences and attitudes of other communication partners, such as friends or relatives, since they may impact the AAC user's communication opportunities. Research studies demonstrate that different AAC devices impact on the communication partners' attitudes toward the user. Research studies have found out that adolescents and adults may have more positive attitudes toward individuals who use electronic devices to communicate compared with individuals who use low tech devices such as communication boards (C. Gorenflo & Gorenflo, 1991; Lasker & Beukelman, 1999; Lilienfeld, Lilienfeld, Alant, & Alant, 2002).

Attitudes and preferences are not the only constraints emerging from the users, family members and other communication partners. The skills of communication partners have a wide impact on both the quality of the communication and the communication system use. Communication partners should know how to interact properly with the user without dominating the interaction. Communication partners tend indeed to direct the communication by asking many questions and do not always respect pauses and silence needed for message construction (Müller & Soto, 2002). Related to the communication system use, communication partners should be operationally competent in programming, using and maintaining the device as well as offering a good model of use. A lack of communication partners' skills or commitment may cause the abandonment of the device and will likely result in AAC implementation failure (Beukelman & Mirenda, 2013).

2.4.2 Opportunity Barriers

Opportunity barriers refer to limitations imposed by individuals, other than the AAC user, that can not be overcome by an AAC intervention. For example, users may not be able to participate to an activity because of the lack of AAC knowledge or skills of communication partners, even though the AAC system is appropriate to meet their communication needs.

There are four types of opportunity barriers. The first one relates with policy barriers which are the result of the legislative and regulatory procedures that govern every agency (schools, hospitals,

rehabilitation centers, etc.). Also less formal situations, like family homes, has policies that need to be respected. These formal and informal policies may act as barriers to participation. For example, there are schools in which the policy is that students with disabilities spend most of their time doing activities in a classes that does not include their peers. This policy severely restricts both communication opportunities and opportunities to make friends.

The second type of barrier relates with practice barriers. Practice barriers includes procedure or conventions that are followed, although they are not actual policies. For example, the teachers may tell to parents that the child can not bring the AAC device home because of the school policy even though no such policy is written.

The third type of barrier relates with knowledge. A lack of communication partners' knowledge regarding AAC interventions, technologies and strategies severely affects communication and participation opportunities of the AAC user.

The fourth type of barrier relates with communication partners' skills. Communication partners may have difficulties in implementing an AAC technique or strategy even though they have knowledge about AAC interventions. This type of barrier highlights the difference between knowledge and practice.

Besides these four types of barriers there is also a fifth barrier that relates with the attitudes and beliefs of the communication partners. Attitudes may be implicit or explicit and it is important to be aware of them as potential opportunity barriers. Examples of attitudes barriers in AAC may be having a reduced expectation of the AAC user as it is described in the statement of two adults with cerebral palsy: "The REAL barrier...[is] people's stagnant and outdated attitudes toward...people with speech disabilities...When people see me, they do not see me. They just see a person in a wheelchair" (McNaughton, Light, & Arnold, 2002, PG. 66).

In the participation model, the effectiveness of an intervention is based on the user's ability to participate successfully in the activities and contexts identified during the assessment. If the desired level of participation is not achieved than the intervention was not effective and a reexamination is required. There are two approaches used to evaluate the outcome of an AAC intervention: the functional limitations approach and the social validity approach.

The functional limitations approach refers to the "limitations in performance at the level of the whole... person" (Nagi, 1991, pg. 322). The effectiveness of the intervention is measured through specific functional skills such as how many times the user responds to a communication partner's request, engages in social interactions, makes choices, initiate a conversation and so forth. These skills can be measured by frequency counts and traditional language sampling procedures through the Universal Language Activity Monitor (U-LAM) which is an automated system that record language samples from users who rely on AAC devices (Romich et al., 2004).

The social validity approach measures factors that are relevant both to the AAC user and the other stakeholders that are persons who are strongly affected by AAC system, technique or the overall intervention (family members, caregivers, teachers, administrators, advocates, case managers, clinicians). Social validity is indeed considered a very important source for obtaining AAC outcome data (Cook & Polgar, 2008; Weiss-Lambrou, 2002). Social Validity in AAC interventions can be defined as a

communication partner's opinion of the impact of a specific AAC device, materials, procedure and changes that are directly related to intervention (Ralf Schlosser, 1999b). Indeed, although AAC team may consider an intervention efficacious, this does not imply that it is perceived as equally efficacious by other stakeholders. For example, if the parents of a boy with autism do not consider that the communication board meets their child's communication need they will be less likely to use it at home (Hamilton & Snell, 1993) although professionals consider it as a good device. Subjective evaluation approaches such as questionnaire or structured interviews are frequently used to measure social validity (Storey & Horner, 1991).

CHAPTER 3

LANGUAGE LEARNING AND INTERACTION OPPORTUNITIES

3.1 COMMUNICATION COMPETENCE

In order to allow a full participation in the society, professionals considered the development of the users' communicative competence as crucial. A growing number of research studies provided evidence that AAC interventions develop and support communicative competence and language skills (Millar et al., 2006). Professionals rethink the concept of communicative competence to to better fit it into the AAC field (Light, 1988) and defined it as "... a relative and dynamic, interpersonal construct based on functionality of communication, adequacy of communication, and sufficiency of knowledge, judgment and skill in four interrelated domains: linguistic competence, operational competence, social competence, and strategic competence" (Light, 1989).

The term functionality of communication, included in the above definition, refers the skills required to initiate and maintain daily interactions within the natural environment (Light, 1989; Williams, Krezman, & McNaughton, 2008) that allow AAC users to express needs and wants, exchange information, develop social closeness, and participate respecting the social etiquette routines (Light, 1988). Indeed, the functionality of a communication skills, that is, the success of it or the lack thereof, is given by the demands coming from the AAC user' environments and not from structured labs, clinical rooms or therapy sessions.

The term adequacy refers to the level of communication skills needed to meet the environmental and communication partners' demands in order for users to meet their communication goals (Light, 1989). Therefore, adequacy is strictly related to the AAC user goal of communication.

The terms sufficient knowledge, judgment and skills rely with the tools and use of them in daily interactions (Light, 1989).

According to Light (1989) definition, the functionality of communication, the adequacy of communication and the sufficiency of knowledge, judgment and skill are to be put in place in four interrelated domains: linguistic, operational, social, and strategic.

3.1.1 LINGUISTIC COMPETENCE

The linguistic competence refers to the user's expressive and receptive language skills in his/her own native language. It includes the semantic, morpho-syntactic, pragmatic skills of the linguistic code required by the native language (Blockberger & Sutton, 2003; Mollica, 2003; Romski & Sevcik, 2003; Smith & Grove, 2003) as well as the augmentative and alternative semantic, morpho-syntactic, pragmatic and linguistic code of the AAC system (symbols, manual signs, words). Developing a linguistic competence may be a challenge for the user due to the asymmetry between the communication input received (spoken language) from communication partners and the communication output required (symbols, manual signs, written word) through which an AAC user communicates. To support a user's linguistic competence development, communication partners play a significant role. Communication partners indeed, may offer ongoing opportunities in natural context for practicing both the native and the augmentative language (M Romski & Sevcik, 1996) through receptive input models. Receptive input models require communication partners to use the spoken language while pointing to the equivalent symbol on the AAC system (communication partners modeling techniques are described in detail in Chapter 2). However, in order to provide sufficient opportunities for practice, communication partners may need to learn themselves how the linguistic code in the AAC system works (Loeding, Zangari, & Lloyd, 1990; Spragale & Micucci, 1990).

3.1.2 Operational competence

The operational competence relies on the technical operation and techniques, such as motor, cognitive, visual/auditory skills, needed to efficiently and accurately use the AAC system whether it has aided means of communication such as low tech systems (communication boards, printed symbols, etc.) and high tech systems (computer, handheld devices or tablets) and whether it has unaided means of communication such as gestures, facial expressions or manual signs (Beukelman & Fager, 2007; Hodge, 2007). Developing the operational competence may be challenged by the significant learning demands posed by the AAC system used (Horton, Horton, & Meyers, 2001) which require the AAC user and the communication partners to manage all the operational and maintenance aspects of it (Lee & Thomas, 1990). These aspects include keep the vocabulary up to date, create symbols display based on the user's communication needs, modify the system to meet future needs, secure and protect the system from damages and other problems, ensure the availability and operation of the system throughout the day. Because of the variety of aspects to consider, the AAC user is not the first person in charge of the operational competence. Usually much of the responsibilities for operational competence is on the communication partners' hands. In general, low tech systems require less operational competence than high tech system that usually pose more significant operational demands.

3.1.3 Social competence

The social competence includes both the sociolinguistic and socio-relational skills and can be defined

as a the “competence as to when to speak, when not [to], and as to what to talk about, with whom, when, where, in what manner” (Hymes, 1972). Sociolinguistic skills rely both on the pragmatic aspects of communication, such as initiating, maintaining and repairing an interaction, and on the expressive aspects of communicative functions such as requesting or rejecting (Brady & Halle, 2002; Iacono, 2003; Light, Parsons, & Drager, 2002; Sigafoos & Mirenda, 2002; Sigafoos, O’Reilly, Drasgow, & Reichle, 2002). On the other hands, socio-relational skills rely on the interpersonal aspects of communication needed to develop effective relationships such as demonstrating interest in partners or actively participate in conversations (Light, Arnold, & Clark, 2003). Having the opportunity to practice social competence in natural context is crucial for AAC users, and once again the role of communication partners is highly significant. There are indeed a consistent number of trainings to help communication partner to communicate with an AAC user (e.g., Light & Binger, 1998; Light, Dattilo, English, Guiterrez, & Hartz, 1992; Pepper & Weitzman, 2004) that aim to inform communication partners about how to adjust their communicative interaction to meet the AAC user’s needs. As Beukelman and Mirenda stated “communication partner interventions … are often as critical as more extensive facilitator training endeavors” (2013).

3.1.4 Strategic competence

The strategic competence includes adaptive and coping strategies that allow AAC users to bypass the limitations in their linguistic, operational, and/or social competence “to make the best of what they do know and can do” in order to effectively communicate (Light, 1996; Mirenda & Bopp, 2003). AAC users may need to be able to repair communication breakdowns or learn how to interact with individuals that are unfamiliar with AAC. This is another competence where the role played by communication partners is very important. Communication partners can meet the AAC users’ need for mentoring or coaching that is what research studies prove to help increase the communicative competence of AAC users (Cohen & Light, 2000; Light, McNaughton, Krezman, Williams, & Gulens, 2007). Indeed, a daunting challenge of AAC users is that the individuals around them typically do not use their AAC system to communicate and therefore, unlike their peers, AAC users can not rely on the observation of others to learn how to communicate with their system.

3.2 INTERVENTION TOWARD COMPREHENSION ENHANCEMENT

Another transition in the goal of AAC refers to the focus of the intervention aimed at enhancing the AAC user comprehension together with the user expression. The process of language learning for children who require AAC focused mainly on the development of expressive communication as the primary skill to learn (Nelson, 1992; Romski & Sevcik, 1993; Wood, Lasker, Siegel-Causey, Beukelman, & Ball, 1998). Research has demonstrated that AAC interventions can serve to enhance comprehension as well as expression (e.g., Bruce, Trief, & Cascella, 2011; Sevcik, 2006; Wood, Lasker, Siegel-Causey, Beukelman, & Ball, 1998). Moreover, research studies provided evidence that the development of language comprehension skills is critical for the acquisition and use of AAC (Hirsh-Pasek & Golinkoff,

1991) and that individuals who exhibit delays in acquiring receptive language will be likely to displays delays in expressive language as well (Hudry et al., 2010). As Sevcik and colleagues (1996) stated: "language comprehension has been the silent partner in augmented language acquisition and use"(p. 132).

3.2.1 COMPREHENSION DEVELOPMENT IN CHILDREN WHO USE AAC

Typically developing children experience spoken language during re-occurring events or situation that provide them with rich and social interactions. These routines provide children with milestones on which they base language comprehension (Bruner, 1985; Nelson, 1985) and production. Language comprehension, or receptive language, can be defined as an individual's ability to understand the communicative messages conveyed by others (Romski & Sevcik, 1993) and even though there is substantial individual variability in language development, comprehension seems always to occur ahead of production (Wetherby, Reichle, & Pierce, 1998). Indeed, by the age of 12 months, children have developed understanding of many words and short phrases (Tager-Flusberg & Caronna, 2007) that will not be able to produce until between 18 and 24 month (Fenson, Dalef, Reznick, & Bates, et al., 1994). However, when a child develops a productive use of language, the role of comprehension recedes in the background and it is only inferred from the child's behavioral response. Thus, the child's spoken word output, that results in an overt behavior than can be observed, had traditionally obscured the crucial role of speech comprehension (Hirsh-Pasek & Golinkoff, 1991; Benedict, 1979; Huttenlocher, 1974) for children who use AAC.

The development of comprehension skills, however, poses significant challenges for children who require AAC. First of all, during their first years, children who need AAC are mainly exposed to spoken language and unfortunately, many of them tend to receive less and poorer language input quality than typically developing children in the same community (Janice Light & Drager, 2007; M Smith, 2006; von Tetzchner, Brekke, Sjøthun, & Grindheim, 2005). Moreover, most children are not introduced to AAC until age 2 or 3 or even later, and even when introduced to AAC, their primary language input is still spoken language. Second, children comprehension is influenced by the capability to establish an arbitrary relationships between the spoken word and the referent (object or event) of the communication and also by the ability to transform this information from auditory to visual (i.e. from words to symbols) (Mary Ann Romski & Sevcik, 1993).

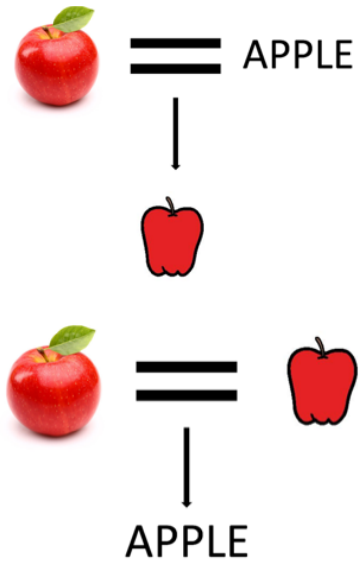


Figure 1. Object and symbol relationship in AAC

Children who use AAC have two different ways on which they can build word, object and symbol relationship (Mary Ann Romski & Sevcik, 1993) (**Fig. 1**).

The first one is through the comprehension of speech. If children communicative interactive experience allowed them to create a relationship between the spoken word and the referent (object or event), then this relationship can pose a foundation on which to link the established understanding of the spoken word with an AAC output mode (symbol or picture). For example, if a child understands that the word "Apple" relates with the fruit he/she eats, he/she will then have to link the word "Apple" with the symbol that represents it in order to use it for communication purposes.
The second way to create a relationship is through the understanding of the AAC symbols. If children do not establish a relationship between the spoken word and referent (object or event), they must then begin their receptive skills development by creating a relationship between the AAC symbol or picture and the referent (object or event) by relying on contextual cues or visual modality to extract meanings (Mary Ann Romski & Sevcik, 1988). For example, if a child does not associate the word "Apple" with the actual fruit, he/she will have to link the symbol that represents the apple and the actual apple with the word in order to understand its meaning.

3.3 AUGMENTED INPUT AND LANGUAGE MODELING

Children may have significantly different receptive language skills ranging from intact receptive language skills to severe comprehension difficulties. Research studies in AAC (Janice Light, Roberts, Dimarco, & Greiner, 1998) have demonstrated that AAC has a great impact on enhancing both comprehension and expression skills (Bruce, Trief, & Cascella, 2011; Mary Ann Romski et al., 2006).
Traditionally, there are two approaches that support language comprehension and symbol-referent relationship**: explicit instruction**, that is based on match-to-sample task in which the child is asked to match the symbol with its referent (Wilkinson & McIlvane, 2002), and **language modeling**.
Language modeling is an approach based on research studies carried out on how typically developing children acquire language (David R. Beukelman & Mirenda, 2013) and it includes two different phases. The first phase requires **augmenting an input**. Romski and Sevcik (1993) defined "augmented input" the incoming communication or language from the communication partner that includes speech and a component of an AAC system. For example, a communication partner augments the input by pointing to a key graphic symbol while saying the name of the word/object the symbol represents. The aim of augmenting an input is to enhance comprehension and assisting the child in the creation of the relationship between the word and the symbol through real-world experiences.
Furthermore, an augmented input gives a model of how an AAC system can be used during communicative exchanges and it makes an implicit statement to the AAC user that AAC is an accepted and encouraged form of communication because of its use by other partners. Literature demonstrated the potential benefits of partners using augmented input in conjunction with their speech (Goossens, 1989; Romski & Sevcik, 1988, 1993).
The second phase of language modeling requires **providing a model**. The communication partner provides the opportunity for the child to use the symbol during a motivating and interactive activity. As Wood et al. (1998) stated ''augmenting the message is not response driven; when partners provide this

input, they do not necessarily expect the user to reply at that time' whereas providing a model focuses more on the expressive component of communication".
For example, during a bubble play activity the communication partner may augment the word "more" by pointing to the equivalent symbol and by saying the word out loud before starting to blow other bubbles. The communication partner may then provide the model by leaving the symbol at reach to allow the child, potentially, to point at it to request more bubble.
Language modeling, indeed, usually occurs during play activities. Play contexts are the primarily source of communication opportunities for children since every child likes to play, is motivated by it, engaged by it and interested in it (Musselwhite, 1986). Through play activities communication partners can provide many opportunities for supporting a child communication skills and capabilities. For example, the play activity aimed at dressing a doll can provide communication opportunities such as choice making, commenting, requesting and turn taking (Brodin, 1991). To foster the development of communication skills, play activities should remain playful, facilitate interactions and do not become vehicles for work. Research studies found out that some types of activities such as blocks, puppets, bubbles and balls facilitate interaction and communication opportunities since they allow for more interaction opportunities between the child and the partner than other activities such as books, play dough and puzzles (Beckman & Kohl, 1984). By observing how symbols are used from communication partners during play activities children can establish a "mental template" of how symbols can be used and combined to mediate communication (Goossens', Crain, & Elder, 1992).

3.4 LANGUAGE MODELING TECHNIQUES

Over the years, many language modeling techniques have been developed for AAC interventions. Language modeling techniques can be defined as strategies that augment the input to a child and simultaneously provide a model to support symbol-referent relationships and vocabulary expansion (Cafiero, 2001; Romski & Sevcik, 1996; Goossens, 1989). The main modeling techniques are: Aided Language Modeling (ALM) (Kathryn Drager et al., 2006), Aided Language Stimulation (ALS) (Elder & Goossens', 1994; Goossens' et al., 1992; Goossens, 1989), and the System for Augmenting Language (SAL) (Romski & Sevcik, 1992,1993, 1996). **Tab. 1** summarizes the main characteristics of the three techniques.

3.4.1 Aided Language Stimulation

Aided Language Stimulation (ALS) can be defined as a strategy in which the communication partner points out a symbol on the child's communication board (e.g. a picture of an *apple)* while simultaneously providing a verbal model (e.g. saying the word *apple)* (Goossens', 1989). The aim of ALS is to provide both speech and symbol input throughout the day. ALS uses specific instructional techniques to model the language: 1) communication partners should index finger pointing, 2) index finger pointing with a small squeaker concealed in the palm of the hand to draw attention to the communication board, 3) point to each symbol with a small flashlight or squeeze light (Goossens', 2010;

Goossens' et al., 1992) and it requires a minimum of 12 graphic symbols on the child's communication board as the minimum number that allow for an interactive exchange with the child (Goossens' et al., 1992). Research studies have documented the effectiveness of interventions incorporating ALS (e.g. Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004; Heine, Wilkerson, & Kennedy, 1996) with preschoolers and school-aged children with communication needs. Despite its benefits, ALS is infrequently used by communication partners because they keep to provide spoken language as the main language input even when the child is introduced to other AAC systems (symbols, boards, devices) (Janice Light, 1997).

3.4.2 Aided Language Modeling (ALM)

Aided Language Modeling (ALM) can be defined as a strategy in which the communication partner points to the referent in the environment (e.g. an *apple)* then points to the symbol of the referent on the child's communication board (e.g. the symbol of an *apple)* while simultaneously saying the related word (e.g. *apple)* (Drager et al., 2006). Drager and colleagues (2006) provide evidence of the effectiveness of Aided Language Modeling on symbols comprehension in two 4 year-old preschool children with autism who used fewer than 30 functional words. Functional words are defined in AAC as the words allow the individual to initiate and maintain daily interactions within the natural environment.

Furthermore, research studies indicate that parents and professionals can learn to use ALM strategies and that children can gain new communication and language skills as a result (Binger, Kent-Walsh, Ewing, & Taylor, 2010; Kent-Walsh, Binger, & Hasham, 2010; Iris Rosa-Lugo & Kent-Walsh, 2008).

3.4.3 System for Augmenting Language (SAL)

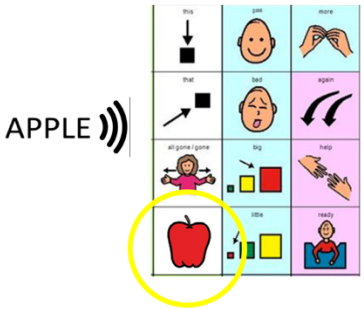
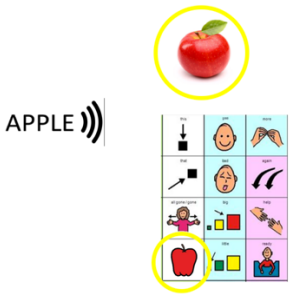
The System for Augmenting Language (SAL) can be defined as a strategy that requires the communication partner to point to an AAC symbols (e.g. an image of an *apple*) while using both the speech (e.g. saying the word *apple*) and the speech output generated by the AAC device when a symbol is activated (e.g. synthetic speech of the word *apple*), during naturally occurring communication interactions. In this way the child would see the communication partner using the symbol on the SGD and, at the same time, he/she hears both the communication partner and the SGD saying the word. The SAL approach has five major components: 1) a speech output communication device for use in natural communicative environments; 2) appropriate symbol vocabularies; 3) encouragement, but not a requirement, that the AAC users use the device; 4) communication partners who have been systematically instructed; and 5) ongoing resource and feedback mechanisms to support the users and their partners in their communication efforts (Mary Ann Romski & Sevcik, 1996).

The SAL strategy is very similar to the ALS strategy with some exceptions: a critical component of the SAL intervention is the use of a speech output communication devices (Romski & Sevcik, 1992, 1993, 1996), the instructional techniques of the SAL strategy are simpler than the ones used for ALS, and the

finally, the SAL strategy uses a gradual introduction of symbols rather than placing all the symbols on the communication board at once. In the SAL strategy symbols are gradually placed on the board based on the needs that arise during naturally occurring communication interactions, a strategy that mirrors a small part of the spoken linguistic input provided to typical language learning children.

Research studies demonstrate that SAL technique is effective for children's comprehension and production. Romski and colleagues (2005) compared 13 participants with and without SAL experience with typically developing youth and found out that the participants with SAL experience communicate better than the participants without SAL experience, although not quite as well as the youth who were able to talk. Moreover, Romski and colleagues (2010) compared three different conditions for improving vocabulary production in 62 toddlers with communication disabilities (ages 21–40 months) that included: augmented communication input (caregivers used SAL), augmented communication output (caregivers used SAL and prompted the child to use the AAC device to communicate), and spoken communication (caregivers used speech only). Compared to the speech only condition, both the augmented input and the augmented output resulted in significant gains in the use of the target symbols on the SGDs and in the production of the target spoken words.

Table 1. Characteristics of language modeling techniques

Aided Language Stimulation (ALS)	Point to the child's communication board (e.g. a picture of an *apple)* while simultaneously providing a verbal model (e.g. saying the word apple)	
Aided Language Modeling (ALM)	Point to the referent in the environment (e.g. an *apple)* then points to the symbol of the referent on the child's communication board (e.g. the symbol of an *apple)* while simultaneously saying the related word (e.g. *apple)*	
System for Augmenting Language (SAL)	Point to an AAC symbols (e.g. an image of an *apple*) while using both the speech (e.g. saying the word *apple*) and the speech output generated by the AAC device when a symbol is activated (e.g. synthetic speech of the word *apple*),	

3.5 MODELING FOR VOCABULARY GROWTH

The efficacy of modeling techniques brings to light the role played by the vocabulary that is modeled. Research studies, indeed, have demonstrated that language modeling not only support comprehension and symbol-referent relationships (Mary Ann Romski, Sevcik, Robinson, Mervis, & Bertrand, 1996) but it also provides support for preschooler (Drager, Postal, Carrolus, Castellano, Gagliano, & Glynn, 2006; Harris & Reichle, 2004) and school-aged children (Shakila Dada & Alant, 2009) expression and vocabulary expansion. Dada and colleagues (2009) examined the effectiveness of a 3-week-long language modeling program aimed at teaching 24 new vocabulary items to four children with little or no functional speech. Results of this study that the program was sufficient to facilitate the comprehension and acquisition of the target vocabulary items.

Through modeling techniques, communication partners can expose children to symbols that they do not already have in the AAC system, whether it is a communication board or an electronic device, in the same way as typically developing children learn new vocabulary when exposed to words that are not yet within their expressive communication.

The modeling of new vocabularies composes what is called the developmental vocabulary that, regardless of the age, should be provided to every AAC user, since it is the major component of language growth (Romski & Sevcik, 1996).

Modeling developmental vocabulary requires the communication partners or the professionals to expose the user to the new symbols when the users are about to experience their needs. For example, if a child is about to experience a birthday party for the first time, then the professionals or communication partners should include on the child device some vocabulary words associated with the new activity such as “birthday cake”, “gifts”, “celebrate”.

During the activity, the communication partners should model the new words in order to give the child the opportunity to learn the new vocabulary through exposure. However, in order for this to happen, the symbols must be readily accessible to the communication partners, which requires them to select in advance what could be the necessary words to model.

3.6 VOCABULARY SELECTION

Having access to a suitable vocabulary selection may determine the success of a social interaction (Alm, Arnott, & Newell, 1992; Higginbotham, Mathy-Laikko, & Yoder, 1988; A. Newell, 1992). However, selecting vocabulary before its need arises is not part of a speaker experience, not even of AAC professionals. Indeed, a research study carried out from Balandin and Iacono (1998) indicate that speech pathologists and professionals lack of ability to predict the most likely vocabulary of conversation occurring in a specific setting. Indeed, participants to this study were more likely to predict vocabulary for nondisabled individuals rather than for individual with communication impairment despite their experience in AAC. This study demonstrates that adult-centered vocabulary selection does not often meet the children’s interests and needs (Light, 1997), but, despite these results, the vocabulary included in the AAC systems, whether it is a communication board or an AAC device,

especially for young children, it is usually selected by the adult that programs the system (parent or AAC professional).

In order for a vocabulary selection to be appropriate for a user's needs, it must reflect the user's individual differences related to the type of disability, age, gender and cultural identity, communication needs, preferences and interests, literacy skills and to the different life experiences the user had. All these differences should be especially taken into consideration when the adult that selects the vocabulary and the user differ from age, gender, and culture.

Another aspect to consider in the process of vocabulary selection is the environment in which the conversation will take place (Banajee, Dicarlo, & Buras Stricklin, 2003). For example, research studies revealed that the communication at home is different from communication at schools (Marvin, Beukelman, & Bilyeu, 1994). Children in school talk primarily with relatively unfamiliar adults and peers which requires them to use a different vocabulary than the one they use to meet immediate needs and achieve social closeness with family members (Westby, 1985). Marvin and colleagues (1994) recorded five typically developing preschool-age children at home and in school and found out that one third of the words produced were used only at school, one third were used only at home and one third were used in both environments. The authors argued that these differences may be due to the different activities, people, and routines children are exposed to in these environments.

Sure enough, vocabulary selection it is considered a complex process that communication partners and AAC users identify as a problematic time-consuming task (Balandin & Iacono, 1993; Beukelman et al., 1991; Fried-oken & Stuart, 1992; Morrow, Mirenda, Beukelman, & Yorkston, 1993).

3.7 RESOURCES FOR VOCABULARY SELECTION

To help the process of vocabulary selection, research studies (Beukelman, McGinnis, & Morrow, 1991; Morrow, Beukelman, & Mirenda, 1989) provide three main resources that relate to three different vocabulary selection approaches: the developmental approach, the environmental approach, and the functional approach.

The **developmental approach** relies on lists of words chosen form developmental language inventories based on language acquisition principles (Reichle, Williams, & Ryan, 1981; Fristoe & Lloyd, 1980; Lahey & Bloom, 1977). The vocabulary for AAC systems can then be determined by the knowledge of the development of word forms, such as nouns and verbs, and by the number of words that typically developing children use at certain developmental level.

The **environmental approach** relies on ecological inventories which comprise lists of words that are appropriate for a specific communication environment (Fried-oken & More, 1992; Beukelman & Garrett, 1988; Mirenda, 1985; Karlan & Lloyd, 1983). For example, the words pencil, paper, and crayon are appropriate for an art activity as well as food and drink are for a snack activity. The vocabulary for AAC systems can then be determined by specific environment words.

The functional approach relies on the pragmatic aspects of the language and it is based on expressed communication functions. The vocabulary for AAC systems is then determined by words used to express

functions such as requesting (e.g., *more, all done*), protesting (e.g., *yes, no, not*), asking (e.g. *what, where, who*), commenting (e.g. *I like it, I don't like it)*, etc.
These approaches can be used as a resource to create the two main categories of AAC vocabulary that research studies demonstrated to increase the frequency of AAC use (e.g., Beukelman et al., 1991; Yorkston, Honsinger, Dowden, & Marriner, 1989). These categories are called core vocabulary and fringe vocabulary.

3.7.1 Core vocabulary and Fringe Vocabulary

Core vocabulary can be defined as a small number of structural words (e.g. *I, no, yes/yeah, want, it, that, my, you, more, mine, the, is, on, in, here, out, off, a, go, who, some, help,* and *all done/finished*) that do not change across environments or between individuals (Sarah W Blackstone, 1988) and occur very frequently. Core vocabularies provide a framework for functional language use although it carries little information (Yorkston, Dowden, Honsinger, Marriner, & Smith, 1988). Researchers have attempted to identify lists of words that could be included in a core vocabulary for a variety of people who use AAC, including adults (Balandin & Iacono, 1998), adolescents (Lauren B Adamson, Romski, Deffenbach, & Sevcik, 1992) and preschoolers (Beukelman, Jones, & Rowan, 1989; Fried-Oken & More, 1992). These lists constitute *the three current types of sources* that professionals can use to create a core vocabulary for an AAC user (Beukelman & Mirenda, 2013).
The first resource professionals can use is **word lists based on the vocabulary-use patterns of other individuals who successfully use AAC systems**. Beukelman and colleagues (1984) collected the words used by five AAC adult users and found out that 80% of the words communicated were included in the 500 most frequently English occurring words (Beukelman et al., 1991). In the same way, Yorkston and colleagues (1990) found out that the words used by 10 AAC adult users were between 27% and 60% of the words included in six different standard word lists in published vocabulary sources.
The second resource that professionals may use to select core vocabulary is the **use of word lists based on the vocabulary-use patterns of specific AAC user**. This requires a professional or a caregiver to track the vocabulary used in the past by the individual and create a list of words based on those performances (Yorkston et al., 1990).
The third resource is the use of word lists based on **vocabulary-use patterns of natural speakers**. Many research studies registered conversation of children or adults related to a specific topics or in a specific context and created list of words based on those conversations (Boenisch & Soto, 2015; Benajee et al., 2003). Beukelman and colleagues (1989) analyzed the frequency of words used by six nondisabled preschoolers (3 years 10 months to 4 years 9 months) in three different classrooms across six sessions. Beukelman et al. identified 25 most frequently occurring words that accounted for the 45.1% of the sample collected. These frequently occurring words included verbs, demonstratives, propositions, adverbs and articles representing different semantic functions, such as affirmation, negation, labeling, interrogation and pragmatic functions, such as requesting actions and establishing or maintaining joint attention. Nouns did not emerge as one of the frequently used words in the sample of this study. In

another study, Banajee and colleagues (2003) identified a list of common words used by 50 toddlers in preschool settings to request, affirm and negate. In this study as well, the use of nouns did not occur frequently.

Although these resources can help to select a core vocabulary for an AAC user, they present several limitations. First of all, the AAC users that helped in creating core vocabulary lists were adults. As mentioned before, age influences the vocabulary use patterns but so far, no research studies investigated the vocabulary use of children or adolescents who rely on AAC. Second, creating a list of words based on the past performance of an individual requires accuracy in note-taking and observations. Although technology can now help in being more accurate, not all AAC devices allow to keep track of all the words or symbols used. Third, the use of word list based on conversations of natural speakers may not be representative of the special needs and wants of a person with disabilities (Banajee et al., 2003) and because the vocabulary was collected across activities in school settings, it may not be representative of core vocabularies used across different environments, such as home, playgrounds, or grocery stores.

Moreover, despite the evidences, professional keep selecting nouns as the first symbols to include in AAC systems (Adamson, et al., 1992) and often leave out words that help to regulate the interaction such as verbs or adverbs (Adamson et al., 1992). In Adamson and colleagues (1992) study, results show that the use of the board of young males with moderate to severe intellectual disabilities increased from 2% to 41% when verbs and adverbs were added.

Fringe vocabulary can be defined as a large number of content words, such as nouns, verbs, and adjectives, that carry the necessary information about a specific topic. For example, the words “big”, “pop” “blow” can be used as fringe vocabulary words for the “bubble” activity. Fringe vocabulary serves as well to customize the vocabulary included in the AAC system on the specific communication needs of the user. Indeed, fringe vocabulary is highly individual and it presents a low degree of similarities across users (Blackstone, 1988). For this reason, fringe vocabulary must be recommended from communication partners that know the communication needs of the user quite well. In their research study Yorkston and colleagues (1988) found out that only half of the fringe vocabulary selected from the communication partners matched the one used by the AAC user whereas the other half was not used at all. Suggestions to initial fringe vocabularies are provided by the research study of Musselwhite and St. Louis (1982). These authors suggest that initial vocabulary items should be of high interest for the AAC user, it should have the potential for frequent use and it should include a range of semantic notions and pragmatic functions.

3.8 INTERACTIONS OPPORTUNITIES

The participation model, on which AAC relies on, specifies that to assess the level of participation of individuals with complex communication needs, their participation should be compared with the participation level of their peers who are typically functioning. In case of discrepancy between the two

levels of participation, the reasons or the barriers that prevent a full participation, must be identified and solutions for their elimination should be put in place (Beukelman & Mirenda, 1998).

Among the barriers listed by Beukelman & Mirenda (1998), attitudes barriers have to be considered carefully since they have been found to significantly "limit opportunity for communication and full participation in society" (McCarthy & Light, 2005, pp. 41). Attitudes barriers, such as having reduced expectations toward the child or reduced expectations towards the use and effectiveness of AAC, may lead to limited participation opportunities (Beukelman & Mirenda, 2005) and AAC outcomes (Lund, Light, 2007).

In the AAC fields, the definition and approach toward attitudes as barriers relies either on the "three factor theories" or on the "two factor theories".

Related to the **three factor theory**, attitudes can be defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, pp. 1). The evaluative responding is based on 1) an emotional basis: the feelings that the particular entity elicits, 2) a behavioral basis: how individuals behave, or intend to behave, toward the entity and on 3) a cognitive basis: the thoughts or ideas the individuals have about the entity (Eagly & Chaiken, 1993). Any or all these aspects can cause attitudes to be more or less positive.

Regarding the **two factor theories** attitudes are the result of immediate, automatically activated affective responses (emotions) and of controlled, deliberative, cognitive processes (thoughts or ideas) toward the entity under evaluation (Fazio, 1990; Reeder, 1993). According to these theories, behavioral responses are the outcome of the combination of the affective response with the cognitive process. For example, the attitudinal responses of a child toward another child who uses AAC would involve an immediate emotional response to the child that might then be altered by a controlled cognitive evaluation of the child characteristics such as type and cause of disability, the severity of the disability and how it affects the child's ability to communicate. The combination of emotional and cognitive evaluation would determine the behavioral responses of the peer toward the child who uses AAC.

Attitudes toward individual are then recognized as a predisposing factor for the way in which a person acts toward another individual, in particular when this individual is a member of a group that holds the same attitude (Beck et al., 2010). This statement is particularly true for school classrooms. School classrooms are "social communities in their own right" (Nowicki & Sandieson, 2002, pp. 244) in which attitudes, if negative, "are generally recognized as being a major barrier to full social inclusion at school for children and youth with disabilities" (McDougall et al., 2004, p. 288).

Indeed, AAC interventions are considered fundamental also to the educational process (David R. Beukelman & Mirenda, 2013; Cumley & Beukelman, 1992). The sooner the school implements AAC the better are the learning and communication opportunities for the child. Research studies showed that AAC allows children to interact with peers in the classroom context (Dalton & Bedrosian, 1989), exposes them to learning and communication activities (Downing, Ryndak, & Clark, 2000; Erickson, Koppenhaver, Yoder, & Nance, 1997; Pat Mirenda & Beukelman, 1992), increases access to curricular areas (Ralf Schlosser et al., 2000) and promotes literacy skill development (Alant & Emmett, 1995).

As for attitudes toward individuals with physical and intellectual disabilities, the AAC literature shows that attitudes toward individuals with communication disabilities are not as positive as it would be expected (Burke, 1994; Lallh & Rochet, 2000; Rice, Sell, & Hadley, 1991). As early as in preschool, communication skills are among the type of disabilities that young children are most aware of (Diamond, 1993) and not only children perceive differences between themselves and the other peers based on communication (Gertner, Rice, & Hadley, 1994) but they also discriminate against their peers who have such differences (Gertner et al., 1994).

Negative attitudes have been found to **affect people's willingness to interact** with individual who uses AAC that result in an interaction that is less likely to be successful (Kim et al., 2015). Moreover, negative attitudes may result in reduced expectations toward the individual which results in limited communication opportunities and poor academic outcomes (Popich & Alant, 1997).

If negative attitudes are considered to be a barrier to communication opportunities and participation in society, literature studies demonstrate that positive attitudes toward individual who use AAC can help to eliminate these barriers and biases with supports and appropriate expectations (Beukelman & Mirenda, 2013). Therefore, understanding communication partners' attitudes toward individuals who use AAC is extremely important and necessary (Beck, Thompson, Kosuwan, & Prochnow, 2010) as well as keep gaining knowledge about the variables that affect attitudes (Triandis, Adamopoulos, & Brinberg, 1984).

Chapter 4

AAC Tech and Design

4.1 AAC DEVICES

The changes occurred in the scopes of AAC, in the assessment practices and in AAC interventions implementations led to significant changes in the selection and use of AAC systems.

Initially, AAC devices were developed to provide expressive means of communication to individuals with little or no functional speech and/or insufficient manual dexterity to write or manipulate a keyboard (Shane et al., 2012). At the beginning then, AAC devices relied on spelling and could only be used from nonspeaking literate individuals. In the late 1970s AAC was recognized as a legitimate method for communication, and aided systems of communication, such as picture symbols and communication boards, started to be introduced to and used with individuals who could not use the alphabet for education and communication purposes. However, AAC devices where not used indistinctly with AAC users. It was practice during the 70s to use either an unaided or aided systems of communication based on the cognitive skills and/or type of disability. Moreover, the focus of the intervention was on teaching the AAC users how to efficiently operate the device.

Only in the late 80s, the combination of aided and unaided AAC devices started to be recognized as increasing the user communication (Romski & Sevcik, 1988) and the focus of the intervention shifted from the choice of the AAC system and teaching how to use it, to how it was implemented and used within the natural routines and environments of the user (Romski & Sevcik, 1988).

From that time on, the use of AAC devices kept expanding and paralleled the changes and innovations in mainstream computer and information technology services.

Nowadays there is a large array of aided devices either low tech or high tech (**Tab. 1**) that can be selected, through the Participation Model, to meet the AAC users' communication needs.

Systems	Description	Types	Examples
Unaided	relies on the AAC users' body to convey meanings	gestures	fine and gross motor body movements, facial expressions, eye movements, posture
		vocalizations	ounds aimed at signifying physical or emotional states such as yawning or laughing
		sign language	
Aided	rely on external materials or tools in order to convey meanings	low tech or non-powered systems	communication boards or PECS
		high tech or powered systems	SGDs or VSDs

Table 1. Summary of AAC systems

Low technology devices are non-powered systems such as communication boards, written words on paper, photographs or symbols. The most common form of aided communication are **communication boards** (**Fig. 1**). Communication boards are grid-based format pages that contain symbols. Communication boards can be single page or multiple pages and allow for customization by adding new symbols in free cells. Symbols are usually printed, cut and pasted on the communication board. When the grid of symbols does not have any free cell a new blank page can be added.

Figure 1. Example of a communication board

Figure 2. Example of PECS

Another form of aided communication is the **Picture Exchange Communication System (PECS)** (**Fig. 2**). PECS (Fig. 2) was developed by Bondy and Frost (1994) and it is based on teaching the AAC user to communicate by removing a picture or graphic symbol from a communication board and handing it to a communication partner. The act of exchanging the symbol is indeed considered analogous to a communicative exchanges (Shane et al., 2012). PECS was proven to be effective for facilitating vocal/verbal imitation (Charlop-Christy & Carpenter, 2002), increasing the frequency of communicative initiations, responses and comments (Magiati & Howlin, 2003; Marckel, Neef, & Ferreri, 2006) and decreasing problem behaviors (Cafiero, 2001; Cummings & Williams, 2000).

High-technology devices are powered system that use symbols or photographs together with a recorded or synthesized voice output. **Visual Scenes Displays (VSD)** and **Speech Generating Device (SGD)** are the most commonly used forms of aided communication.

VSDs offer a cohesive, context-rich mode for communicating (Wilkinson & Jagaroo, 2004; Wilkinson, Light, & Drager, 2012) (**Fig. 3**). **VSDs** are real-world scenes photographs in which the language concepts are embedded in the form of hotspots. Each hotspot is associated with a word or a phrase that is activated when the hotspot is tapped (Wilkinson et al., 2012). The use of VSDs have several advantages. VSDs allow to quickly process the concepts within a contextual scene (Wilkinson et al., 2012), reduce the working memory demands (KDR Drager, Light, & Speltz, 2003) and are considered to be a more natural approach to teaching communication because they present concepts in context rather than in isolation (Light, Drager, & McCarthy, 2004).

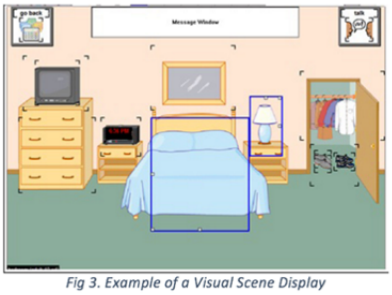


Fig 3. Example of a Visual Scene Display

Figure 4. Example of a Speech Generating Device

SGDs, also called Voice Output Communication Aid (VOCA) (**Fig. 4**), are portable electronic devices that produce a previously recorded or digitized spoken message for each symbol they include (Fig. 4). The use of the voice output allows a larger distance communication without requiring the communication partner to always stand close to the user. Data from research studies suggests that SGDs contributes in receptive and expressive communication improvements (Mary Ann Romski & Sevcik, 1995) and promote vocabulary acquisition and word retention (Bosseler & Massaro, 2003).

Together with the use of aided systems, AAC interventions aim at augmenting also unaided systems of communication, also called natural modalities of communication (Beukelman & Mirenda) since they rely on the user's body to convey meanings. Unaided systems include gestures, gestures, vocalizations and manual signs. Gestures include fine and gross motor body movements, facial expressions, eye movements, and postures. Vocalizations include sounds, produced by the user, aimed at signifying physical or emotional states (e.g. yawning, laughing, crying, moaning and yelling). Some users use vocalizations as substitutes to speech in order to convey a specific meaning. For example, a user may say "M, m, m," as a substitute for the word Mom. To be understood, these type of vocalizations require interpretation by people who are familiar with the user's repertoires of vocal signals (Beukelman & Mirenda, 2013). Manual signs, prior to the 1990s, was the most used form of augmentative communication either used alone or combined with speech. The reasons of its popularity were based on the assumptions that sign language was considered easier to be generalized to non-treatment settings (Bonvillian, Nelson, & Rhyne, 1981), required less symbolic processing because more iconic (Pat Mirenda & Erickson, 2000), and it would allow to bypass the auditory-vocal processing difficulties by using a visual-motor mode of communication (Wong & Wong, 1991).

4.2 OBTAINING AND PROGRAMMING AAC DEVICES

As required in the Participation Model, to select the most appropriate aided device to support an AAC user's communication, professionals should match the existing user skills and needs with the features of devices (feature-matching). However, there are two factors that often intervene and affect the device selection process with important consequences on the AAC user's communication. The first one is the price of the device and the second it the operational demands that it required. Both the high

costs of SGDs and their operational demands have often driven professionals or parents toward a cheaper and low tech solutions in disregard of the matching results.

Related to the **high cost of SGDs** (in terms of thousand of dollars), Rummel-Hudson (2011), father of Schuyler, a child with Bilateral Perisylvian Polymicrogyria, provide an example of the consequences that the high cost of a communication device had on his daughter communication. In order for Schuyler to be eligible for an SGD, the school team evaluated Schuyler's skills and communication needs. After the evaluation, the school team did not consider a high tech device eligible for Schuyler's skills and communication needs and recommended a less sophisticated device. However, parents disagree with this decision considering it as a disbelief towards technology partially based on budgetary reasons and they were right. Schuyler's parents decided to buy, through an online fund raising, an SGD for Schuyler that cost $7500. What turned out was that Schuyler started to successfully use the device for communication purposes and her communication skills increased.

Related to the **operational demands** of high tech devices, research studies provide examples of the consequences they have on AAC users' communication. The main one, as often reported from communication partners, is the lack of use (Baxter, Enderby, Evans, & Judge, 2012a). Research studies highlighted that communication partners play a crucial role in supporting children learning to communicate using AAC (CJ Cress & Marvin, 2003; Douglas, Light, & McNaughton, 2012; Kent-Walsh & McNaughton, 2005), in particular through language modeling. In order to provide effective modeling, communication partners need to use the device together with their users, and therefore they need to know how to program it and use it. Programming an SGD have higher learning costs and operational demands (Caron et al., 2015), compared with low tech devices, which impact communication partners' use of it (Baxter, Enderby, Evans, & Judge, 2012b). both programming and using a high tech device is reported from communication partners (Baxter et al., 2012a) as a significant barrier that affect their modeling strategies. Research studies highlighted three main reasons (**Fig.5**).

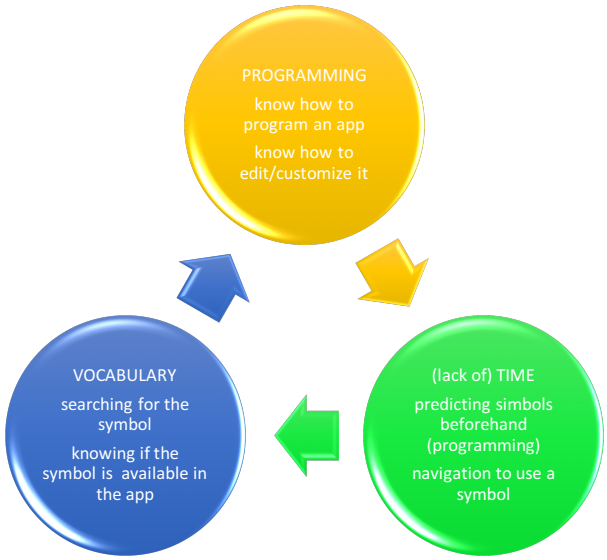


Figure 5. Barriers to programming a high tech AAC device

The first reason is that **high tech devices are not easy to program**. A recent systematic review reported that users and communication partners struggle with the technological aspect of the device itself (Baxter et al., 2012a). McCord & Soto (2004) reported the perceptions of technology as something mysterious and complex to which McNaughton et al. (2008) echoed the feeling of a lack of confidence of communication partners toward technology. Moreover, communication partners struggle with the personalization of symbols' displays that require them to know how to edit the symbols included and how to insert new symbols based on the child's need. Goldbart and Marshall (2004) stated that there is a requirement for parents to build up high levels of specialist or technical information (Goldbart & Marshall, 2004) in order to use an AAC high tech device. Consistent with that, research studies also reported a perception of lack of training from communication partners. A lack of training precludes the use of AAC with the user which impact a successful implementation of systems (Hodge, 2007; Soto, Müller, Hunt, & Goetz, 2001).

The second reason is that high tech devices **require time for programming.** Donato, Shane, and Hemsley, (2014) reported that preparing the symbols is "hard work" and is perceived from communication partners as a barrier to expanding the use of symbols in a wider range of activities.

The third reason is that **the vocabulary included in the device presents limitations** (Donato et al., 2014; Janice Light, 1997; Porter & Cafiero, 2009). Programming an AAC device outside of the contexts in which the vocabulary is to be used requires a communication partner to predict beforehand which of the symbols will be needed in the conversation. Considering the wide variety of topics occurring in natural conversations, and considering the diversity of contexts, it is difficult for partners to predict the required vocabulary prior to interaction. Therefore, an AAC device may not include the appropriate symbol to support the ongoing communication as the child's needs arise. This may limit language learning of children because the device provides access to only a few concepts, usually the ones that the child has already acquired (Light, 1997). Therefore, the degree to which the children can fully participate across contexts and partners is largely determined by adults selecting and programming appropriate vocabulary within their AAC systems (Light, 1997).

4.3 MOBILE TECHNOLOGIES

Mobile technologies, such as tablets or smartphones, impacted the lives of individuals with communication disabilities (Light & McNaughton, 2012) by overcoming some of the high technologies AAC devices barriers. First of all, mobile technologies are easy to obtain. Mobile technologies are readily available, and, compared to traditional AAC devices, their relatively low cost make them accessible to more families, school districts and other agencies with no need of prescription and third party funding. Moreover, mobile technologies are multipurpose devices that can provide Internet access, education, social interaction, entertainment, and information access besides communication (Light & McNaughton, 2012). SGD could only be used for communication purposes, therefore, if the AAC users wanted to access the internet or other mainstream programs, they needed to use (and learn to use) another device.

Second, mobile technologies are easier to use and communication partners with little or no technical background on technology can learn to use them with relative ease (Shane & Laubscher, 2012).
Third, mobile technologies are more socially accepted as AAC devices because they are not "something that tells the world "I have a disability" (Rummel-Hudson, 2011, pp. 22). They don't label a user as possessing a disability, but on the contrary, using mobile devices says "I'm cool…like anyone else" (Hyatt, 2011; Rummel-Hudson, 2011, pp. 22).
Among all the mobile technologies, it was especially the iPad, and the AAC apps in particular, that brought AAC into the mainstream. The iPad apps are relatively cheaper than SGDs. Indeed, an iPad with an AAC app may cost less than a thousand dollars whereas SGDs cost usually more.
The use of an app for AAC purposes was analyzed in several research studies in which the use of either iPod Touch app and an iPad app was compared with traditional AAC devices such as PECS (Kagohara & van der Meer, 2013; Stephenson & Limbrick, 2013). Kagohara et al. (2013) conducted a systematic review of 15 studies that used iOS-based devices apps with children with autism and other developmental disabilities. Seven studies used iPod Touch and one study used the iPad. Eight of the studies, with a total of 25 participants, targeted an improvement in the children's communication skills. This result is encouraging in considering the iOS based device apps effective in improving communication skills of individuals who use AAC. Stephenson et al. (2013) carried out a review of the use of iOS based device apps with people with developmental disabilities and the results are consistent with Kagohara systematic review. Moreover, research studies carried out by Lorah (2013) and Flores (2012) suggest that the iPad and AAC apps can effectively be used as SGD in AAC intervention. Both studies compared the use of an iPad as SGD and the use of PECS on the development of requesting skills in children with developmental disorders. Lorah compared the use of the app Proloquo2go and PECS with five children with autism on requesting for favorite items. Results show that the iPad app produced higher rates of independent requesting compared with PECS (Lorah, Tincani, & Dodge, 2013). Flores compared the use of Pick-a-Word app with PECS on the requesting performance of five children with developmental disorders. Results demonstrate that communication skills increased using the iPad or remained comparable to the level of performance observed with the PECS (Flores et al., 2012).

4.4 AAC APPS PROGRAMMING AND USE

Although mobile technologies allowed communication partners to overcome some of the barriers of AAC devices, such as the price and the operational demands to learn to use them, having an easy access to mobile technologies misplaced the focus from communication to technology. The focus on mobile devices instead of communication enticed developers into reiterating existing features of SGDs in AAC apps, instead of findings new techniques to program them to enhance specific communication needs (Hershberger, 2011). Therefore, although apps are installed on cheaper, easier to use and socially accepted devices, they still require important learning costs to be programmed and use. Indeed, AAC apps replicate the approaches to representation and organization of vocabulary used in traditional AAC devices as they usually reproduce a grid-based format displays of symbols that need to be implemented

and customized. In order to customize the grid of symbols, the app have to be edited. The majority of the AAC apps need to switch from the "Use" mode to the "Edit" mode to program an app. The "Edit" mode usually includes many feature and options like for example creating new cells (which is what constitute the grids of symbols), adding custom pictures or symbols, text (font, color, dimension), audio or synthetic speech voice (speed, pitch, and volume) and link a cell to another cell or to a different board (**Fig. 6**). In addition to that, programming an app requires to have a clear idea of how the grids will look like at the end. Changing a grid layout once created may be problematic since images size and images disposition may change. To be said is that, most AAC app released provide little, if any, technical support for the consumer (D McNaughton & Light, 2013).

Furthermore, AAC apps allow to store a great number of words and messages in the AAC devices. However, as noted previously, vocabulary selection requires communication partners to predict in advance what would be the symbol needed and symbol prediction is not always easy or possible.

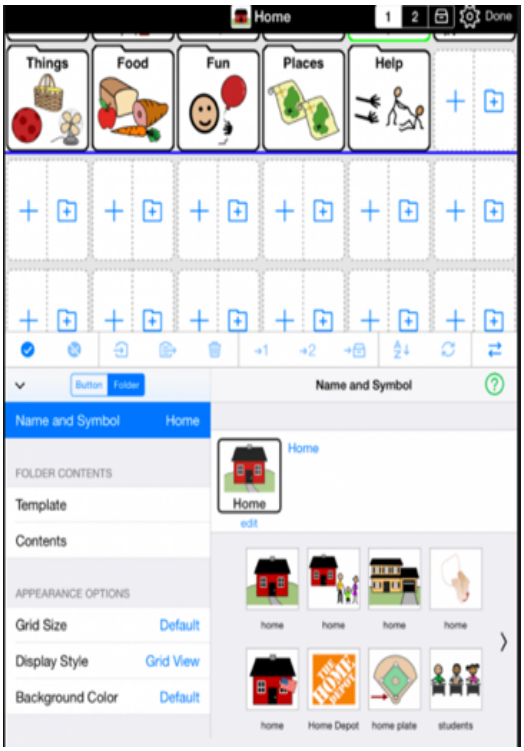


Figure 6. Screen shot of the edit mode of Proloquo2go app

To model language on an app, the communication partner needs to navigate between grids to search for the symbols. Navigation requires the communication partner to know if the symbol is included in the app and where the symbol is located. The more vocabulary an app includes the more a communication partner may need to switch from different grids of symbols. Looking for a symbol may also result in reduced speed of communication which may impact the cognitive resources of the child (Porter & Cafiero, 2009).

Also, it is very frequent that manufacturers and software developers already include a range of different vocabulary and messages in AAC systems that can be readily used by users and communication partners. Pre-stored vocabulary reduces the workload of communication partners and therefore it is attractive to them. However, research studies demonstrate that successful communication with pre-stored vocabularies appears to rely on intact receptive skill of the AAC user (Barton, Sevcik, & Romski, 2006). Individuals with communication impairments in both comprehension and production may not find pre-stored vocabulary useful to meet their communication needs (Todman, 2000). Vocabulary selection should take into consideration different aspect of the AAC user such age, gender, preferences. Pre-stored vocabulary, on the contrary, is typically selected by adults for the "average" user.

4.5 AAC APPS DESIGN

Both the programming and the navigation requires multiple steps which may pose operational demands and learning costs to the communication partner (Light & McNaughton, 2014). These apps barriers may be due to the minimal attention directed towards improvement of the design of AAC apps to better support language acquisition (Light & McNaughton, 2014) even if system design have been proved to affect communication outcomes (Light & McNaughton, 2012). Indeed, research studies suggest that communication partners and AAC system design may inadvertently limit the language development of children with communication needs (Kent-Walsh, Murza, Malani, & Binger, 2015; Janice Light, Drager, Currall, et al., 2012). Indeed, the learning costs, the numerous programming steps, the reduced access to vocabulary and the reduced opportunities for AAC users to participate in the vocabulary selection, that is often selected from the communication partners, may results in the potential abandonment of the AAC device (Meder & Wegner, 2015) with significant consequences on the AAC users' communication. Still in mobile technologies, there is a lack of attention given to the process of app development and, although research studies are investigating this aspect (Caron et al., 2015; Janice Light, 2012; R. W. Schlosser et al., 2016), they do not yet provide enough data to better meet the operational demands of iPad apps for communication partners.

In order to fully realize the potential of mobile technologies it is critical to be guided by what we already know about the design of AAC devices (D McNaughton & Light, 2013). AAC design should account for the skills and needs of its user and for the operational demands of both the users and the communication partners (Blackstone, Williams, & Wilkins, 2007). Therefore, the design of AAC technologies should include the input coming from all relevant stakeholder groups such as the user, family members, clinicians, teachers, educators, researchers, developers, caregivers, friends, and manufacturers.

The success of the user-centered design approach for products' creation, technologies included, may provide well-established guidelines on which to adapt the design of AAC apps. The user-centered design approach is a multi-stage process that envisions the goals that are to be met by users and involves the intended users throughout the entire development process of designing and testing the new product (Andrews et al., 2012; De Leo, Gonzales, Battagiri, & Leroy, 2011; De Leo & Leroy, 2008). The process includes different steps: (a) determine the intended user of the product, (b) interviewing users to create the initial design, (c) creation of the prototype, (d) a multi-stage process of user prototype testing and (e) creation of the final product. This approach has been widely used to develop different types of technological products such as website development (Andrews et al., 2012) and virtual environments (Fidopiastis, 2010). A central component of the user-centered design is the use of prototype creation. Prototypes allow the developers to incorporate the users' feedback into the cognitive and visual aspects of a design as developers create the product (Dolan & Hall, 2001). A conceptual prototype often involves a paper version of the product, or a written description of it (De Leo et al., 2011). This initial prototype is recommended because it allows users to provide their contribute despite their technological capabilities and let the users the freedom to be more critical (Andrews et al., 2012; Klee, 2000). After a conceptual prototype, the product fidelity can be increased through the creation of

“mock-ups” that give a more dynamic visual representation of the final product. Finally, the creation of an operational prototype, that usually follows mock-ups versions of the product, allows the users to test the functionality of the product. All these types of prototypes can be particularly valuable to AAC app development, as they allow the users to provide feedback and input throughout the entire development process.

Another input for improving the AAC app design comes from the creation of just-in-time (JIT) apps technologies (Schlosser & Shane, 2015; Light, 2012). JIT apps require fewer programming steps than traditional AAC apps and research studies provided evidence that JIT tech can reduce the operational demands on communication partners and increase selection and access to vocabulary during meaningful, naturally occurring language learning opportunities as the need and interest of the AAC user arises (Schlosser & Shane, 2015; Caron et al., 2015; Light, 2012). Moreover, JIT technologies have been proven to support the language and communication development of children who use AAC.

For example, Light (2012) compared the programming time of an AAC app (EasyVSD), based on JIT programming, with traditional dedicated AAC technologies with six adults with no prior experience in AAC. The JIT app required the communication partner to draw a hotspot on the screen and press a button, that appears right next to the hotspot drawn, to record the audio in order to add a new vocabulary in the scene. On the contrary, the other app required to go through a list of setting options to add one by one the hotspot and the audio (**Fig. 7**).

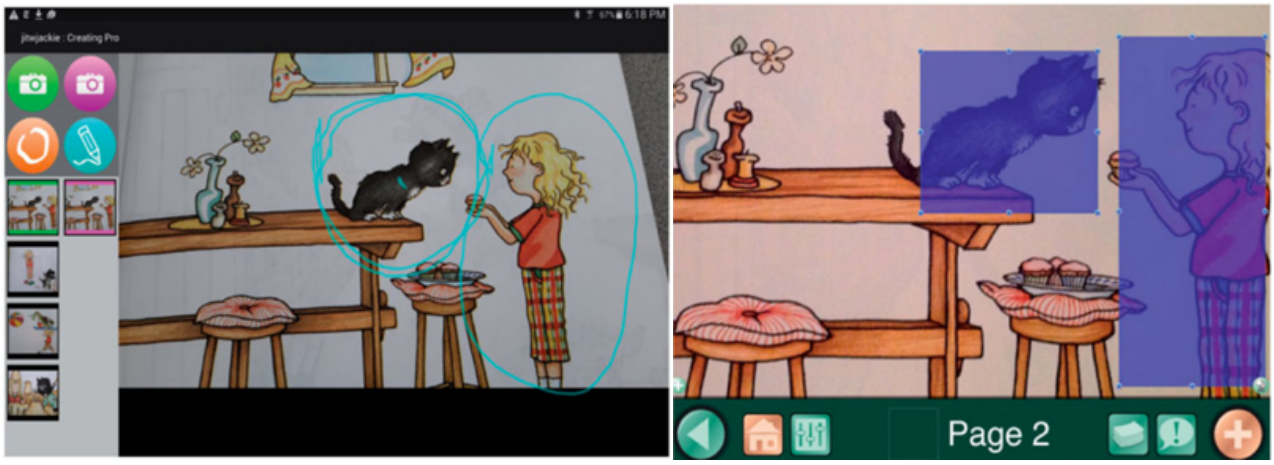


Figure 7 Screenshots of the AAC apps: The one on the left is EasyVSD and the one on the right is GoTalk Now as in “Caron, J., Light, J., & Drager, K. (2016)”

Results showed that the device with fewer programming steps (EasyVSD) was more efficient in adding new vocabulary. Indeed, children had access to more vocabulary and communicate more frequently using the JIT programming app compared to the other traditional devices. Another study (Caron, et al., 2015), compared the programming times of two AAC apps (GoTalk Now5 and AutisMate6) with EasyVSD app based on JIT programming with ten adults with no prior experience in AAC. Again, results showed that participant were fastest programming the application with the fewest programming steps (EasyVSD).

Considering these preliminary results, and the consequences of the operational demands of programming and use AAC, developers and manufacturers should shift the focus again on communication in order to provide AAC apps or AAC devices that effectively support both the users and the communication partners' needs of communication.

CHAPTER 5

DESIGN AND DEVELOPMENT OF A JIT BASED AAC APP

As described in Chapter 4, the learning costs demands imposed from the programming steps and vocabulary access of AAC devices may results in the potential abandonment of them (Kent-Walsh et al., 2015; Janice Light & McNaughton, 2012; Meder & Wegner, 2015) with significant consequences on the AAC users' communication. As research studies claimed, the programming and access to vocabulary are considered to be the strongest limitations for communication partners' use of an AAC device for language modeling purposes (Donato et al., 2014; Janice Light, 1997; Porter & Cafiero, 2009). Indeed, although technology features keep evolving, AAC devices still replicate the same programming steps and vocabulary access that have been reported as significant barriers (Baxter et al., 2012b). This applies to mobile technologies and AAC app as well (Hershberger, 2011).

Literature studies demonstrated that a possible solution to this limitation may be found in rethinking the design of AAC devices. Preliminary successful results are coming indeed from Just-in-time (JIT) technologies in which changes in the design have been applied. JIT devices simplified the learning costs of programming and vocabulary access by reducing the programming steps required to add or edit new contents. In addition to that, Blackstone and colleagues (2007) suggested that the design of AAC devices should take into account the inputs coming from the relevant stakeholders (the user, family members and more in general communication partners) in order to create devices that would meet their skills and needs of programming and access to vocabulary.

Based on these suggestions, this chapter will provide a description of the process that guided the design and development of a new AAC app based on JIT solutions that took into account the inputs provided from communication partners during the entire process.

5.1 PREPARATION PHASE

The preliminary results of the JIT technologies and the need to account for the stakeholders' inputs, may suggest that further investigation in how to improve the design of AAC devices may be required (Caron et al., 2015). The main barriers of AAC devices relies on the operational demands and learning costs of programming and use. As reported in Chapter Four, AAC users and communication partners struggle with three main aspects: learning how to program an AAC device, the time, and lack thereof, required to program it and to navigate through grids of symbols and the access to both the vocabulary

stored in the device and new vocabulary (Baxter et al., 2012a). The end results of these constraints is a lack of use of the AAC devices.
In order to investigate how to overcome these limitations, two sources of information have been used to create a new AAC app (**Tab 1**):

1. an investigation of the programming steps and vocabulary access of AAC apps. This investigation allowed to identify how AAC apps are usually designed and how they can be programmed and used. Based on that investigation, a concept of a new AAC apps have been developed;
2. a focus group with AAC professionals. The focus group allowed to account for inputs coming from relevant stakeholders. The focus group allowed to identify the main needs related to programming and use of AAC devices and it provided preliminary feedback of the design of the new AAC app.

Table 1. Preparation Phase

GOAL: investigate how to improve the design of AAC devices		
Problem	Constrains	Sources of information
Lack of use of AAC devices from both AAC users and communication partners	- operational demands and learning costs; - time required to program and navigate; - access to stored and new vocabulary;	- investigation of the programming steps and vocabulary access of existing AAC apps; - focus group with relevant stakeholders to understand their needs and wants

5.2 INVESTIGATION PHASE

To have a clearer idea of the design of AAC apps and how they can be programmed and used, an investigation of their features and functioning has been done on the App Store.
The criteria used to look for the apps were:

- run a search through keywords (AAC, special education, communication, special needs);
- run a search between the AAC apps from the same developer and the iTunes suggested app;
- list the app features based on the description and screen shots provided in their iTunes page. On that matter, a particular focus has been given to the features that can be used to program the app:
    - how to create or edit grids of symbols/visual scene display;
    - type of navigation between grids of symbols;
    - set of symbols included;
    - images/symbols customization;
    - number of images per display;
    - audio customization;
    - text customization;
    - display feature customization (color background, n° of images displayed, dimension of images);

- accessibility options (the app is or is not usable with external switch).

Results of this investigation show that on January 2016 there were more than 300 hundred apps labeled for AAC purposes. The majority of them have English as primary language, they are either made from AAC device manufacturers or amateurs, such as parents or students.

Related to their design, the majority of them allow for the creation of either grids of symbols or visual scene displays. To January 2016, to create communication contents the AAC apps available on the App Store relied on:

- programming through edit pages or menus. The main features they include are summed in **Tab 2**. The more features an app includes, the longer it takes to program it. However, having a large number of features may guarantee to better meet the needs of an AAC user. For examples, a limitation in the number of images that an app allows to display may entail limited communication opportunities for AAC users that actually needs a large vocabulary.
- vocabulary access through navigation, if more than one grid of symbols is created. Indeed, every symbol displayed in a board can be linked to another grid of symbols. For example, if the communication partner creates a grid of symbols with categories of items such as toys, each category can than be linked with a new grid of symbols in which all the items are included. To access the vocabulary stored in the app the user, or the communication partner, should navigate to the grid that includes the symbol in order to select it. This navigation requires to remember in which grid the symbol is located.

Table2. Description of the main features of AAC apps

Features	Characteristics
type of AAC app	grids of symbols
	visual scene displays
how to create or edit symbols	through separate pages of editing
	directly on the screen
type of navigation	static
	dynamic
set of symbols included;	AAC sets of symbols such as Widgit, Picture Communication Systems (PCS), Symbolstix
	developed specifically for the app
images/symbols customization;	custimizable with images taken from photo library
	custimizable with images taken from symbol library
	custimizable with images taken from the internet
	customizable with images taken from the camera
Number of images per display	unlimited
	limited (max 12, 24, 48, 72)
audio customization;	recording voice
	synthetic voice
text customization;	font
	style
display feature customization	bacground or symbols colors
	width between symbols
	dimension of symbols
accessibility options	scanning options usable with external switch

Three apps have been selected as a prototype to provide an example of both AAC apps design and use. A list of the features they include to program the app are listed in **Tab. 3**.

Table3. Example of the features provided in three AAC apps used as prototype

	Name of the app		
Features	**Talk Tablet**	**Sounding Board**	**Scene & Heard**
type of AAC app	grid of symbols	grids of symbols	visual scenes
how to create or edit symbols;	enter in edit mode	enter in edit mode	enter in edit mode
type of navigation between grids of symbols;	dynamic	dynamic	static
the set of symbols included;	Symbolstix	set created for the app	none
images/symbols customization;	edit image type (from symbols library, photo library or internet)	edit image type (from symbols library, photo library	edit image type (from symbols library, photo library
Number of images per display	unlimited	limited (max 12)	unlimited number of hotspot
audio customization;	voice recording or synthetized voice	voice recording	voice recording or synthetized voice
text customization;	font and style	none	none
display feature customization	background and border of symbols color, n° of images displayed,	background color	none
accessibility options	usable with switch	usable with switc	usable with switch

The first app considered, TalkTablet (**Fig. 1**), is a grid-based symbols type of app and it includes many features to significantly customize the contents of the app. TalkTablet allows for creating grids of symbols by entering in an edit mode. The edit mode is a scrolling dropdown menu displayed on the grid of symbols that lists all the features of the apps that can be edited. These include the number of symbols displayed, the name, sound and type of symbols, the background color and the border of either the grid or the symbols, the format, size and color of the text and the possibility to link a symbol to other grids for a dynamic type of navigation. In order to program the app, the AAC user, or the communication partner, should enter the edit mode, crate a plain grid and customize it using each row of the dropdown menu one by one. The same procedure should be done for all the grids, or symbols, that the user, or the communication partner, may need to add. Indeed, the app allows for a dynamic navigation. Thus, every symbol displayed can be linked to another grid of symbols. To use the vocabulary stored in the app the user, or the communication partner, should navigate to the grid that includes the symbol in order to select it. This navigation requires to remember in which grid the symbol is located.

The second app, SoundingBoard (**Fig. 2**), is a grid-based symbols type of app and it includes features to moderately customize the contents of the app. SoundingBoard allows to create grids of symbols by entering in an edit mode. The edit mode is a separate page in which it is possible to edit the name, sound and type of the symbol as well as linking it to other grids for a dynamic type of navigation. The grids of symbols can display a maximum of 12 symbols per page. In order to program the app, the AAC user, or the communication partner, should enter the edit mode, crate a plain grid and customize it using the edit page. The same procedure should be done for all the grids, or symbols, that the user, or the communication partner, may need to add. Indeed, the app allows for a dynamic navigation. Thus, every symbol displayed can be linked to another grid of symbols. To use the vocabulary stored in the app the user, or the communication partner, should navigate to the grid that includes the symbol in order to select it. This navigation requires to remember in which grid the symbol is located.

The third app, Scene & Heard (**Fig. 3**), is a visual scene display type of app and it includes features to moderately customize the contents of the app. Scene & Heard allows to create visual scene displays by entering in an edit mode. The edit mode is a separate page in which it is possible to edit the scene image and the audio of the hotspot that are visualized with blue rectangles on the scene image. It also allows to add symbols to the scene for a maximum of four. It is possible to edit the name, sound and type of the symbols to display. In order to program the app, the AAC user, or the communication partner, should enter the edit mode, crate a new scene and customize it using the edit page. The same

procedure should be done for all the scenes that the user, or the communication partner, may need to add. The app allows for a dynamic navigation, thus, every symbol displayed or hotspot can be linked to another scene. To use the vocabulary stored in the app the user, or the communication partner, should navigate to the scene that includes the symbol or the hotspot in order to select it.

Fig. 1. TalkTablet app: “User Mode” on the left, “Edit Mode” on the right

Fig.2. SoundingBoard app: “User Mode” on the left, “Edit Mode” on the right

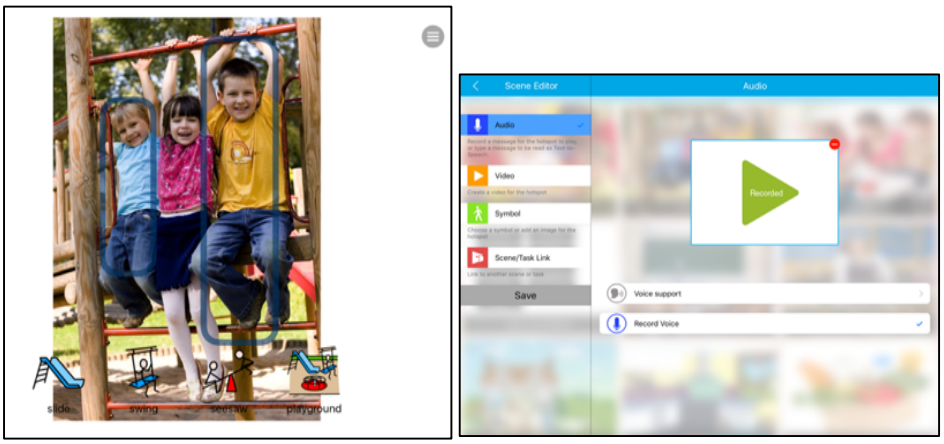


Fig.3. Scene and Heard app: “User Mode” on the left, “Edit Mode” on the right

Based on the information gathered from this investigation, possible alternatives to the programming steps and vocabulary access required from AAC apps have been considered. Among the possibilities that technology offers nowadays (i.e. voice recognitions, cloud storing, conversational agents, etc…) the speech to symbol features have been considered as a possible alternative to programming steps through pages or menus and vocabulary access through navigation. Indeed, the AAC app investigation confirmed that there is no AAC app that is currently using a speech to symbol feature.

The speech to symbols technology consists in saying a word to a device that is able to recognize the speech and display the text or the graphic content, related to it. The speech to symbols has become widely used lately. Both Google, Android and OS devices made this feature available to users to facilitate their searching processes. For example, Google allows a user to run a search on the web without typing. A user can go on Google images and ask for an image and Google will open all the images related without the need of typing any text. Siri, the conversational agent developed by Apple, uses the same technology.

Applied to AAC apps, if an app would be provided with this technology feature built in, it would be possible to say the name of the symbol and have access to it without the need of programming grids and navigating between grids of symbols in order to select it. This feature may provide communication partner with the opportunity to overcome the operational demands of AAC devices. Indeed, although the AAC device should be used by both the AAC user and the communication partners, it is often the communication partners’ responsibility to program and implement it based on the AAC user communication needs (Caron et al., 2015).

5.3 DECISION PHASE

Considering the speech to symbol feature as an alternative to the features usually included in AAC apps, a new JIT programming AAC app concept was developed.

The “concept” of a product or of an idea, was first developed from market and consumer research and it can be defined as a detailed description of a product from the users’ perspective (LaPlaca & Frank, 2011). The development of a concept is usually divided in three stages or phases (**Tab 4**).

Table 4. Stages for product concept development

<table>
<tr><th>Stages</th><th>App concept description</th></tr>
<tr><td>Stage 1:
product premises</td><td>- Eliminate programming steps and navigation;
- Easy access to vocabulary to support the language learning and modeling;</td></tr>
<tr><td>Stage 2:
product description</td><td>- Technical information, benefits and attributes:
<table><tr><th>Technical information</th><th>Benefits</th><th>Attributes</th></tr><tr><td>- Speech to symbol recognition;
- A mic button that allows the speech recognition;
- A pre-stored database of symbols;
- Internet images if symbol is not stored in the app;
- Wi-Fi connection
- free position of the symbols on the screen</td><td>- Easy to use
- No time consuming
- Vocabulary expanding</td><td>- No programming
- No navigation between screens of symbols</td></tr><tr><td></td><td>-</td><td>-</td></tr></table></td></tr>
<tr><td>Stage 3:
product positioning</td><td>- user segment: the app was developed to meet the communication partners’ need of using AAC devices;
- competitive set: so far there are no AAC apps that include the speech to symbol and the use of it for language model purposes</td></tr>
</table>

The initial stage of a concept development is to identify the product premises that address the basic users’ needs. Regarding the new app, the product premise is giving the user, or the communication partners, the symbols they need to support the language learning and modeling without the need of programming and navigating.

The second stage is the product description that provides the technical information, the benefits and the attributes that the product offers. Regarding the new AAC app, it would be provided with a speech to symbols recognition that will retrieve AAC symbols pre-stored in the app database by the activation of a mic. If the app does not find a match between the speech and the symbol in the database, the symbol (or image) will be retrieved from the internet if the device is connected to a Wi-Fi network. While developing the concept and thinking about the symbols disposition on the screen another common feature of the current AAC apps has been taken into consideration. Indeed, the way symbols are displayed may or may not facilitate the comprehension of the meaning conveyed (Gevarter, 2015). All the AAC apps that allow to create communication boards use a grid format in which to insert the symbol. However, a recent study pointed out that the grid might not be ideal to support language learning and modeling (J. Ganz, Hong, & Gilliland, 2015; Janice Light, Drager, & Wilkinson, 2010; Wilkinson et al., 2012). Considering these findings important, another feature was included in the new AAC app. Communication partner will have the possibility of drawing an area on the screen in which he/she wants the symbol to appear. By drawing the area, the communication partner may also have the possibility of choosing the dimension of the symbol.

The third stage is the product positioning. The key factors in this phase are: identify the users segment that will benefits the most from the product and developing the competitive set in which the product

will compete. The users segment identified are the communication partners because they play and important role in programming and using AAC devices. Regarding the competitive set, the app is competitive because so far there are no AAC apps that include the speech to symbol and the use of it for language model purposes.
Among the stages, the second stage is considered to be the most important phase of a concept development because it is the one that generates users' interests by solving a meaningful user need. In this phase, the product description is shared with a group of communication partners that, by providing their feedbacks, allow the producers to understand if the users' needs are associated with the product. Therefore, a group of communication partners was involved in the app development and provided feedbacks in every step.

5.3.1 Focus group

A focus group was chosen as primary method to collect feedbacks about the new app. Focus groups are research techniques that allow data collection through a group interaction on topics determined by the researcher (Morgan, 1996). Focus groups consist of five to eight participants gathered under the guidance of a facilitator who uses interview techniques to lead the participants to reflect on questions related to a specific topic. Focus groups allow the participants to express themselves freely without being forced to closed questions and the interactions between them provides the researcher with data that go beyond the sum of the individuals (Morgan & Krueger, 1993). The assumption behind focus group methodology is that opinions are not always readily available and are apt to be influenced by others. During a focus group, participants are encouraged to talk to one another, share experiences, views, opinion (Kitzinger, 1994) and make additional comments to each other responses. The observation of the circumstances that make opinions to shift enables a researcher to have access to the assumptions that are behind those views and opinions (Robinson, 1999).
For the current research purpose, the aim of the focus group was twofold. First, it was necessary to verify if the limitations about the use of AAC devices were perceived as barriers from the selected group of communication partners. Second, it was crucial to verify if the concept of the new app generated the AAC professionals interest.
In order to explore both the needs arising in the use of AAC devices and receive feedbacks about the new app, a list of topic was developed. The topics selected for focus groups should be clear and include areas such as identification of problems and feedback regarding a specific service or product (Robinson, 1999). The topic chosen for the focus group were: 1) definition and use of AAC devices, 2) how the use of AAC devices has changed through the work experience, 3) how the use of AAC devices affected the work experience, 4) shared reading of the app concept. For each topic a set of questions were developed and are shown in **Tab 5**. Topics and questions served as the guidance of the focus group.

Table 5. Questions asked during the focus group

Topic	Questions

1. Definition and use of AAC devices	1. what do you think if I say AAC devices?
	2. how did you start using them?
	3. Who taught you to use them?
2. How the use of AAC devices has changed through work experience	4. how did the use of AAC devices change during your work experience?
	5. would you change something about the way you learnt to use them?
3. How AAC devices affected the work experience	6. how did the AAC devices enhance your work?
	7. how AAC devices did not enhance your work?
4. Shared reading of the app concept	8. what interested you more about this new app?

5.3.1.1 Focus Group Demographics

Consistent with the focus group methodology, six AAC professionals, who were working in an AAC Centre in Milan (Italy), were asked to participate to a focus group. The participants were five women and one man with a mean age of 42.3 years old. In average, they had 11.1 years of working experience in AAC and they all had a special education background.

The focus group was held in a conference room and lasted about 45 minutes. The facilitator of the focus group had both experience in AAC interventions and AAC apps. Prior to the beginning of the focus group, the facilitator shared with the participants the goals of the focus group. The participants agreed to participate and no benefits were provided. **Tab 6** summarize the demographic characteristics of the AAC professionals who participate to the focus group.

Table 6. Focus group participants' demographics

Subject	**Demographics**			
	Gender	***Age***	***Years of experience***	***Education***
1	F	44	7	Registered Educator
2	M	49	17	Neuro-psychomotor Therapist
3	F	37	14	Registered Educator
4	F	33	3	Registered Educator
5	F	55	18	Special Pedagogy
6	F	36	8	Special Pedagogy

5.3.1.2 Focus Group Results

Topic 1

To define AAC devices, participants were asked to list every tool or device that came into their mind when thinking about AAC device. The participants listed both low technology and high technology AAC devices, iPad included.

Topic 2

Participants were then asked to talk about the way they learn to use AAC devices. As they reported, AAC education introduced them to the use of AAC devices, but it was only through AAC practice that they learn to use them. Indeed, participants pointed out that AAC education about devices served only

as a framework. In order to use the device properly it was essential to customize it on the specific user's communication need. It was then through their work experience that participant agreed they learn to use AAC devices.
Participants also reported that they would have changed the way they learned to use AAC devices. As they commented, learning by doing entails making mistakes, with a great disadvantage for the child. One participant stated "*I wish I did not have to use the child as a learning test*". They then agreed that more practice would have made the use of AAC devices easier.

Topic 3
Regarding how devices enhanced their work, participants mentioned advantages that are consistent with the importance of both expressive and receptive communication. As participants reported, AAC devices allow the "*child to be understood*" and give the "*possibility to the child personality, thoughts and preferences to come to light*".
Participants also highlighted the importance of constantly using the device when communicating with the child. One participant reported that with the AAC device "*I feel sure to have all the tools available to be understood from the child, without which I feel like I have a disability*". Moreover, another participant added that "*AAC device are tools for reality's comprehension. They help to understand the world's dynamics. AAC devices allow to visualize reality*". Therefore, participants considered the AAC devices important because they allow to "*have access to the child, and get in touch with the child*"
Regarding how devices did not enhance their work, participants referred to the difficulties in teaching parents how to use AAC devices. Participants reported that "*parents perceive the device as a limitation that take something away*" and that parents "*struggle in understanding how to use a device because it is not like saying words*". Parents "*see the device like a tangible object and do not perceive it as a tool for communication and contents*".

Topic 4
The concept product of the new app was read to the professionals. The text read follow:
"Nowadays there is not a digital device that allows a communication partner to retrieve the needed symbols in a fast and flexible way without having to search for them. This new app is innovative because it allows to retrieve a symbol by just using the speech. The communication partner can draw an area on the screen, say the name of the symbol and see it displayed in that area. This new app gives the possibility of retrieving the symbols from a pre-stored database of symbols that the new app includes or from the internet if the symbols cannot be found in the database. This new app does not require programming, navigation or a prediction before use of the symbols needed during the conversation. This app is dedicated to communication partners that want to support the child receptive language in a fast and flexible way".
Participants then provided feedbacks on the app concept that was read by the facilitator.
One participants highlighted that "*to reduce the time between the need of a symbol and the availability of the symbol might be useful*" because *"while you take time to look for a symbol you lose the child* ('s

attention)". Furthermore, participants reported positive feedbacks about vocabulary expansion "*having a wide vocabulary available is an incredible enrichment also because the symbol sets we use are not always representative of the children's need*". Participants gave examples of situation in which they found themselves unable to find the symbol to convey the meaning:

> "*the child wanted to tell his dad about the red ball he used to play but I couldn't find a symbol of a red ball, not even on google images because it was too slow and gave me too many options. So I thought that a red ball is something to play with and I modeled the symbol play, but the child left*"

Table 7. Feedback of the focus group participants

Topic	Feedback
Topic 1: Definition and use of AAC devices	Professionals listed both low technology and high technology AAC devices, iPad included
Topic 2: How the use of AAC devices has changed through work experience	Professionals learned to use AAC devices through practice and they had to customize their use based on the AAC user needs. However, they would change the way AAC device use is taught
5. How AAC devices affected the work experience	Professionals describe the efficacy in using AAC devices to support expression and comprehension. However, they reported their difficulty in teaching parents to use the device
6. Shared reading of the app concept	Professionals reported positive feedback about the concept of the new app

After the focus group feedbacks (**Tab. 7**), a Beta version of the app was developed.

5.4 APP DEVELOPMENT

The concept of the new app proposes two innovative features: 1) retrieving symbols through a speech to symbol technology and 2) designing o the screen the area where the communication partner wants the symbol to appear. The beta version of the app was developed thanks to a research collaboration with the Augusta University, (Georgia, USA). An engineer developed the app on iPads using Xcode as programming language, SQLite as database, a Linux based web server with PHP and XML extension to inquiry and retrieve data from the internet (Bing Search, https://developer.yahoo.com/boss/search) and Nuance (Nuance, http://www.nuance.com/index.htm) engine as speech recognition tool. The Nuance engine works if connected to a Wi-Fi connection. The beta version of the app is intended to be used only for language modeling from communication partner. It then focuses only on receptive communication.

5.4.1 Vocabulary

The app comes with a pre-stored customizable dataset of symbols. The symbols included in the app have been designed from Patrick Ecker, a special educator who worked in AAC (http://patrickecker.org/home/) and are already available in an AAC apps used both in the USA and in Italy (I Click I Talk: www.iclickitalk.com; Parla con un Click: www.parlaconunclick.it). We stored in the app database 405 words, 287 of which have a symbol associated. The words with no symbols associated would display a blank spot. More in detail there were:

- 171 Italian verbs conjugated in all tenses, where 53 of these had a symbol associated;
- 187 nouns. All of the nouns had a symbol associated;
- 29 adjectives. All of the adjectives had a symbol associated;
- 11 adverbs. All the adverbs had a symbol associated;
- 7 grammar parts. All of them had an image associated.

In order to make the app as fluent as the natural language, the app recognizes both the singular and plural of words, feminine and masculine and all the tenses of verbs (in Italian).
This feature overcomes a main issue of using AAC apps in Italian. In Italian, adjectives and nouns have to respect the number and gender rule, and the verbs are conjugated differently in accordance with the subject. This feature allows to visualize the symbol “beautiful” (“Bello” in Italian) even if the communication partners says the word “bella” (which is singular and feminine) or “belli” (which is plural and masculine). In the same way, a communication partner may either say “giochiamo” (we play) or “abbiamo giocato” (we played) and the symbol of play will appear in both cases. So far, no AAC app respect verb conjugation, gender and number rules.

5.4.2 Programming and use

As shown in **Fig 4** the interface design of the beta version is very simple and minimal. The main interface includes a Mic button and an Options button. The mic button allows to activate the speech to symbol feature. When the mic button is clicked, the communication partners can say the word of the symbol. If the word is associated with a symbol stored in the app data base, the image will appear on the top left corner of the screen.

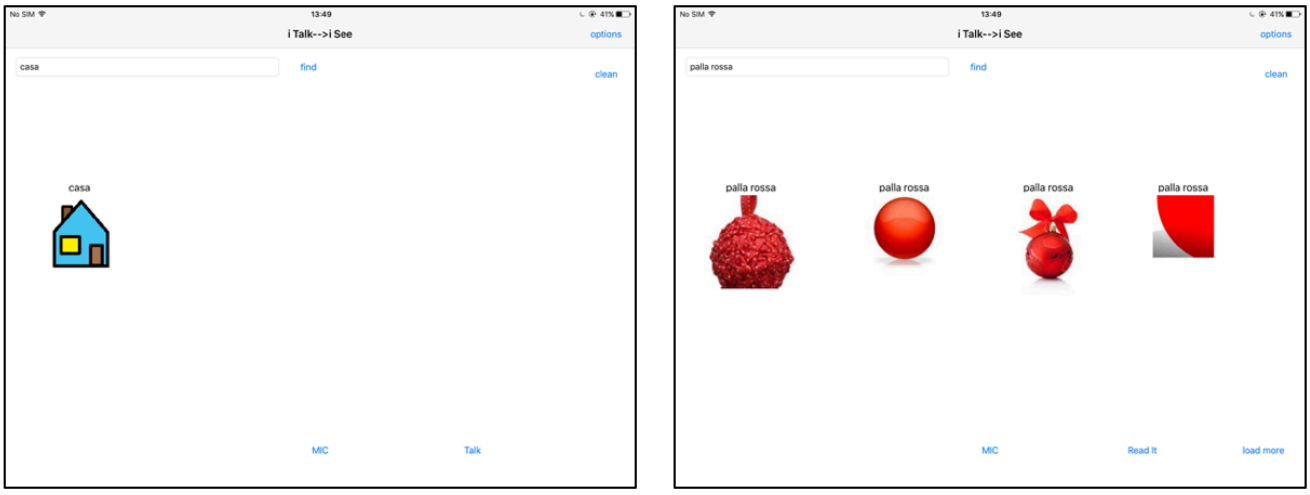


Figure 4. Screenshots of the Beta version of the app. On the left the app displays an image retrieved from the app database, on the right the app displays images retrieved from the internet as the word search was not included in the app database.

If the word is not associated with a stored symbol, the app will automatically retrieve an image from the internet, by using the Bing search engine. The app will retrieve up to 10 different images that are visualized in a banner that scroll from right to left. For example, if a communication partner needs to model the word “red ball” to support the ongoing conversation, the app will retrieve 10 images of a red ball that the communication partner can use to model.

For the beta version of the app, the speech to symbol technology displayed only one symbol at the time.

The option button allows to choose the language of the vocabulary (English or Italian) and choose the background color (black or white). Although we wanted to test the app with Italian communication partners, we decided to have the possibility to use the app also with an English vocabulary.

To be used the app does not require the communication partner to have or developed any technical skills. The communication contents can be visualized in real time, as the language convey thoughts through sentences, without having asynchrony between preparation and use. The possibility of having the right word just in time provides the opportunity to engage in modeling communication.

For the Beta version we decided not to include the drawing symbol area feature.

5.5 PILOT TESTS

The Beta version of the app was tested during two different AAC sessions. In each session an AAC professional and a child who uses AAC engaged in play activity that allow the professional to model the language with the app.

Before the beginning of the session the professionals were instructed to use the app through a demonstration of how it worked. The researcher explained both verbally and by showing it, how to retrieve a symbol. The professionals were then encouraged to try the app for 10 minutes and to ask questions about its use or functioning.

First session

During the first session a special pedagogy professional tested the beta version of the app with B., a 5 years old girl with a diagnosis of cognitive impairment. The professional participated also to the focus group.

During the session B. had her communication board always available. As a normal routine, the professional and the child engaged in play activities: the "Pig Goes Pop" and "Betty Spaghetti". Both activities were held sit on a little table and lasted around 10 minutes each. During the activities the professional used the app to model 18 words, 10 during the first activity and 8 during the second activity. Some words were modeled more than once (n = 2 for the word mouth, and n = 4 for the word big). The words were taken 13 time (72.22%) from database and 5 times (27.77%) from internet. The app displayed all the words said, however 4 (22.22%) of them did not have an image associated. Among the words modeled, 6 (33.33%) were also on B's communication board whereas 12 (66.66%) were not. **Tab 8** describes the order of the words modeled.

Table 8. Word modeled during the first session

Activity	Word	Source	App Results	Was the symbol on the child communication board
the "Pig Goes Pop" activity	Pop	Database	No image associated	No
	Large	Database	No image associated	No
	Big	Database	Image appeared	Yes
	In	Database	No image associated	No
	Mouth	Database	Image appeared	Yes
	Big	Database	Image appeared	Yes
	Mouth	Database	Image appeared	Yes
	Nothing	Internet	Image appeared	No
	Big	Database	Image appeared	Yes
	Belly	Database	Image appeared	Yes
	Big	Database	Image appeared	Yes
	Bang It	Database	No image associated	No
	Stop	Database	Image appeared	Yes
	More	Database	Image appeared	Yes
"Betty Spa	Hair	Database	Image appeared	No
	Blonde	Internet	Image appeared	No

	Long	Database	Image appeared	No
	Blouse	Internet	Image appeared	No
	Skirt	Internet	Image appeared	No
	Blouse	Internet	Image appeared	No
	Hand	Database	Image appeared	Yes
	Little Horse	Database	Image appeared	No

The language modeled in the first session is strongly related to the ongoing activity. However, some of the words used to model were not included neither in the child's communication board nor in the pre-stored vocabulary of the app. This result confirms that it is very difficult to predict before hand what would be the vocabulary needed during a conversation and the internet feature included in the app could really be a solution to it.

Second session

The second session was held by a professional with a background as a special educator, with P. an 8.5 years old boy with a diagnosis of autism spectrum disorder.

During the session P. had his communication board always available. As a normal routine, the professional and the child engaged in play activities: a wooden transportation puzzle and the "Frog Hoppers". Both activities were held sit on a little table and lasted around 10 minutes each. During the activities the professional used the app to model 13 words, 6 during the first activity and 7 during the second activity. Some words were modeled more than once (n = 2 for the word train). The words were taken 12 time (92.31%) from database and 1 times (7.69%) from internet. The app displayed all the words said, however 1 (7.69%) of them did not have an image associated. Among the words modeled, 4 (30.77%) were also on P's communication board whereas 9 (69.23%) were not.

Tab 9 describes the order of the words modeled.

Table 9. Word modeled during the second session

Activity	Word	Source	App Results	Was the symbol on child communication board
Transportation Puzzle Activity	Boat	Database	Image Appeared	No
	Motorcycle	Database	Image Appeared	No
	More	Database	Image Appeared	Yes
	Train	Database	Image Appeared	No
	Train	Database	Image Appeared	No
	Car	Database	Image Appeared	No
	Bicycle	Database	Image Appeared	No
"Frog Hoppers" Activity	Frog	Internet	Image Appeared	No
	Pull	Database	No Image Associated	No
	Toss	Database	Image Appeared	No
	Nice Job	Database	Image Appeared	No
	Red	Database	Image Appeared	Yes
	Orange	Database	Image Appeared	Yes
	Wait	Database	Image Appeared	Yes

The language modeled in the second session is strongly related to the ongoing activity. The app included most of the words needed, however, it is interesting to notice that the child's communication board did not include the majority of the word used. Therefore, without a prediction beforehand the communication partner could not use the words modeled.

Feedbacks

After the sessions, the professionals were encouraged to gave some feedbacks about the use of the app. Two open questions were verbally asked: 1) is there something you would change in the app? 2) is there something you would add to the app? Relating to the first questions, both of them suggested verbally to make the design interface more user friendly, the images bigger and they asked for the possibility to display more than one symbol at the time. The professional of the first session also suggested to associate more symbols to the words included in the data base. She also suggested to give the possibility to select one image displayed between the internet images.

Relating to the second question, they both suggested to link an audio to every symbol. Professionals did not give any suggestion about the location of a symbol on the screen.

Pilot tests Results

The pilot tests showed weaknesses and strengths of the app. The weaknesses are consistent with the feedback reported by the professionals. The graphic interface need to be more user friendly, the symbol display needs to have a larger dimension and the speech to symbol feature should be able to display more than one image at the time. Moreover, all the words included in the database need to be associated with a symbol.

Regarding the strengths of the app, the pilot tests showed that the images can be retrieved from the database very quickly (less then 4 seconds per symbol). The speech to symbol engine did not fail by displaying a symbol that did not match to the word said, and even with background noises, the app was able to recognize the word. Moreover, the professionals learn to use the app very quickly and they were able to carry on the activity while using the app. On the other hand, the children were not distracted by the device and looked engage with it. They consistently look the symbol displayed and in a couple of occasion it has been observed that the app may have served as a support to their comprehension. For example, during the first activity of the first session B. showed to have made a connection between the symbol displaying a belly and the belly of the toy. After that the communication partner said the word "belly", B. looked at the communication partner, she looked at the symbol displayed and then she pointed at the belly of the toy. A similar situation occurred in the second session. The child was asked to toss the frog. He looked at the symbol "toss" displayed on the screen and then tossed the frog.

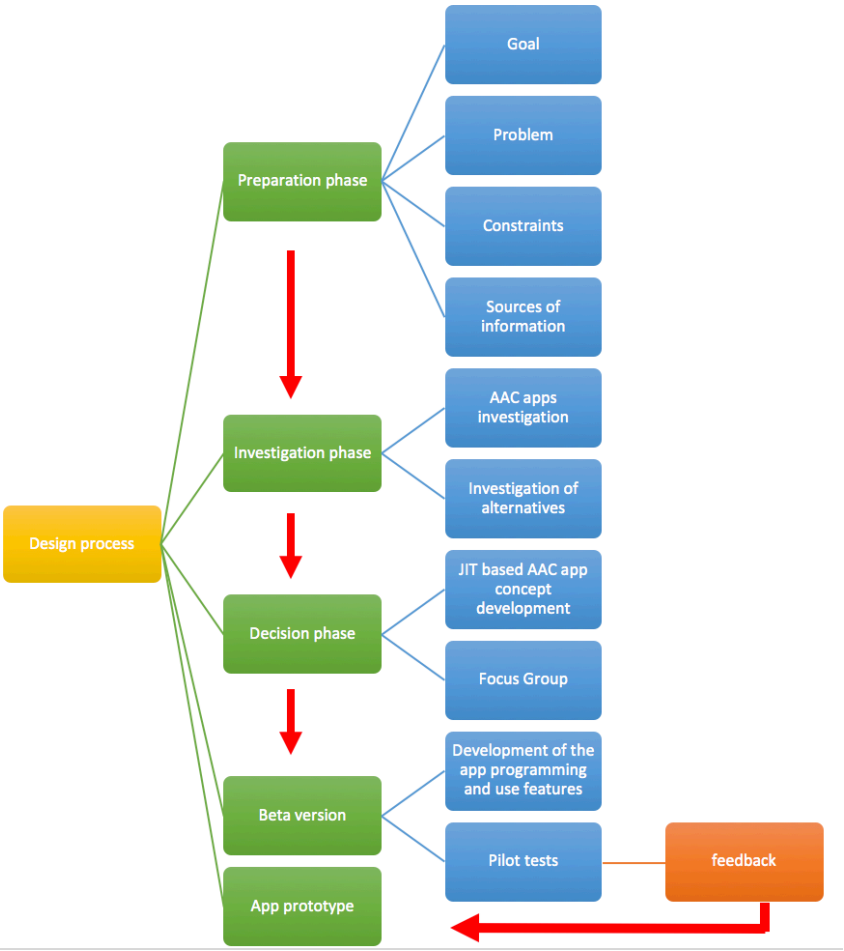


Figure 6. Design process flow

5.6 CHANGES IN THE APP

The pilot tests of the app allowed to test the functioning of the app during two AAC sessions. Considering what has emerged from the pilot some minor changes have been made to the app (**Fig. 6**). The new version of the app has:

- a more user friendly interface;
- it displays more than one symbol at the time;
- the words included in the database have been associated with a symbol and an audio;
- the symbols size can be customized using zooming options;
- images retrieved from the internet open in a new window that allow to select as many images as desired.

Consistent with the pilot and the professionals' feedback, we concluded that having to draw an area on the screen might not be a communication partner's need. Indeed, by watching the professional using the app, we realized that if they were required to draw the area of the symbol, that might have interfered with the rapidity of needing a symbol and seeing it displayed. Therefore, we decided to insert

the possibility of moving the symbols on the screen, if necessary, instead of having to draw the area where they appear (**Fig. 7**).

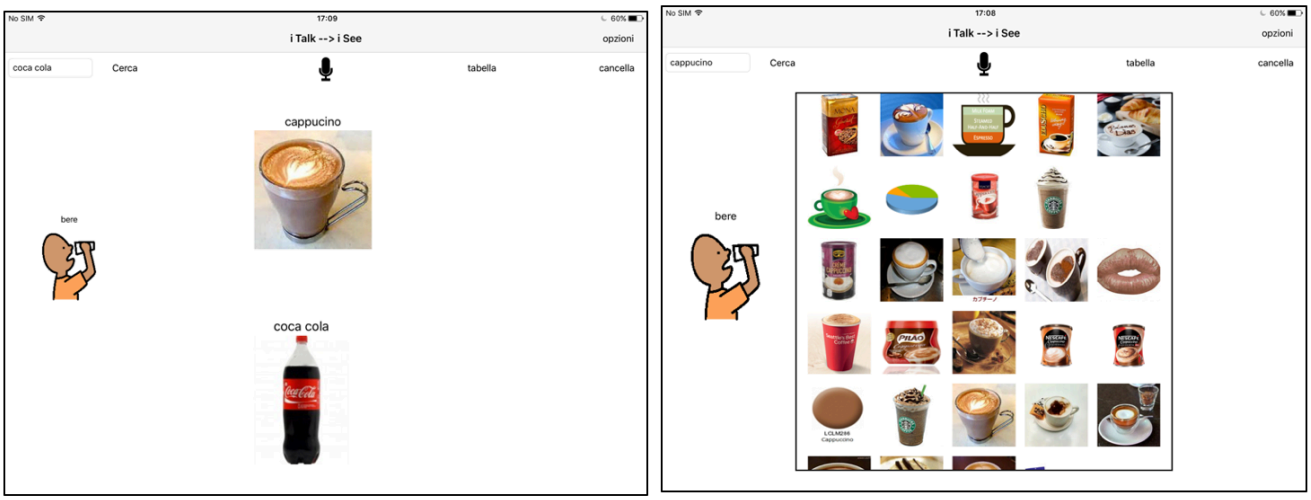


Figure 7. Screenshot of the new version of the app

CHAPTER 6

A PILOT INVESTIGATION WITH THE SPEECH-TO-SYMBOL APP

6.1 RESEARCH QUESTIONS AND HYPOTHESIS

Based on the results of the pilot study described in Chapter 7, we decided to compare the speech-to-symbol (StS) app programming procedure with another traditionally designed AAC app (TalkTablet) with 7 AAC professionals using a single-case design. The purpose of this study is to investigate how the reduced operational demands required to program the Speech-to-Symbol (StS), Just-In-Time (JIT) based AAC app affect the vocabulary expansion of children with communication needs during natural interactions.

6.1.1 Research questions

Specifically, this research study investigates the following research questions (***Tab. 1***).

1. **How many words and what type of words (verbs, nouns, adjectives) are professionals able program in an AAC app while engaging in a play activity using the StS-JIT based app compared with a traditionally designed AAC app (TalkTablet)?** The number and type of words are considered important because the more concepts available to the child, the more access to, and potential use of, vocabulary concepts (Caron et al., 2015). The number of images programmed during the interaction is relevant because children learn language within a context (Hoff, 2006; Snow, 1999) and modeling new words supports language learning by capturing these shared contexts;
2. **Is there a difference in the consumer satisfaction when the StS - JIT based app programming is compared with a traditionally designed AAC app (TalkTablet)?** Satisfaction for AAC intervention can be defined as a communication partner's opinion of the impact of a specific AAC system, technique or the overall intervention. Consumer satisfaction is considered a very important source for obtaining outcome data (Cook & Polgar, 2008; Weiss-Lambrou, 2002). In this research study, both the professionals and parents (the children's mothers) will be asked if the usability of the AAC apps they used, or have observed to be used, allow them to meet their need for programming new vocabulary;
3. **Is there a difference in the level of anxiety when the StS - JIT based app programming is compared with a traditionally designed AAC app??** Research studies on communication partners' perception of AAC devices report that they often perceive them as a barrier to communication (Baxter et al.,

2012a). Learning how to use and maintain a communication device poses significant operational demands to communication partners (Caron et al., 2015) that may arise negative feelings such as frustration or lack of confidence (Baxter et al., 2012). In this study, we assess the level of anxiety of professionals to verify if the operation demands of an app may or may not impact their anxiety level;

4. **Is there a difference in the child and professionals' behavior when the StS - JIT based app programming is compared with a traditionally designed AAC app?** The operational demands of an AAC device have been found to affect the children and communication behaviors during an AAC intervention (Baxter et al., 2012b; Caron et al., 2015). However, no research studies have so far compared the number and type of behaviors of both children and professionals during the programming procedures of an AAC JIT based app and a traditionally design AAC app. Therefore, it may be interesting to explore if the operational demands of an AAC app may impact on the number and type of AAC professionals and children behavior during the apps programming. According to Caron and colleagues research study (2015), we are going to measure the child engagement, which is operationally defined as the child looking at the iPad or at the professional. We are also going to consider the children behaviors when they are not engaged, that is, their behaviors when they are not looking at the iPad or at the professionals. Regarding the professionals' behaviors, task focused behaviors such as focus on the programming procedure (e.g. describe the procedure of programming) or child focused behaviors such as focus on the child rather than on the programming procedure (e.g. held the child hands off the device) are also going to be measured.

6.1.2 Hypothesis

Regarding the **first research question**, we hypothesized a difference in the number of vocabulary programmed between the two AAC apps. We hypothesized that professionals would programmed more vocabulary with the JIT app than with the other AAC app (TalkTablet) because of the reduced operational demands.

Regarding **second research question**, we hypothesized that the level of consumer satisfaction will be higher with the StS - JIT based app due to the reduced operational demands that it requires for programming. Having the symbols right available during the interaction, instead of having to program it, is expected to better meet the communication partners' needs of programming and modeling new vocabulary (Porter & Cafiero, 2009).

Regarding the **third research question**, we hypothesized that the level of anxiety after the session with the StS - JIT based app will be lower than the level of anxiety after the session with the AAC app that requires programming (TalkTablet). The reduced operational demands the StS - JIT based app requires for programming are expected to allow professionals to keep engaging in the play activity with the child without having to interrupt it to program the app. A smoother interaction is expected to allow the professional to focus on the interaction itself without worrying about the operational demands to program the app if the need of a new symbol arises (Baxter et al., 2012).

Regarding the **fourth research question**, we hypothesized a difference in the interaction between

professionals and children. The reduced operational demands of the StS - JIT based app will allow professional to carry on with the interaction without having to try to keep the children engaged while they are waiting for the professional to program the AAC app. Therefore, we are expecting children to have higher level of engagement and professionals to have a higher number of task focused behavior with the StS - JIT based app.

Table 1. Pilot investigation design, research questions and hypothesis

Aims	Design	Participants	Apps	App use interaction	Research questions	Hypothesis
Comparing a traditionally designed AAC app with an innovative designed AAC app with reduced operational demands thanks to the speech to symbol features	Single-case design	7 professionals	Traditionally designed AAC app (TalkTablet)	Child and professional engage in a play activity	Number of words and type of words programmed in the AAC apps	More vocabulary is to be programmed with the Sts - JIT based app than with the other AAC app (TalkTablet)
					Communication partners' level of satisfaction with the AAC apps programming	The level of consumer satisfaction is to be higher with the StS - JIT based app
		3 children with communication needs	Speech-to-symbols JIT based app		Communication partners' level of anxiety	The level of anxiety is to be lower with the StS - JIT based app
					Professionals and children behavior during the programming procedure	Children level of engagement is to be higher and so as the task focused behaviors of professionals when te StS - JIT based app is used

6.2 METHODS

6.2.1 Design and Variables

A **single-case design** was used to compare two AAC apps programming during a play activity interaction between AAC professionals and children with communication needs. This design was chosen because it allows for investigation of the stated research questions and for exploration of the effects of the Independent Variable (Schlosser, 1999). Single case designs, and their available options (e.g. the Alternating Treatments Design, the Adapted Alternating Treatments Design) are the most applied research study designs in the field of AAC (Ralf Schlosser, 1999a).

The **Independent Variables** in this study is the AAC app used from the professionals to program new symbols. The Independent Variable has two levels: level 1 or App 1 (TalkTablet app) and level 2 or App 2 (StS – JIT based app).

The **Dependent Variables** of this study are four:

1. the number of words programmed in the AAC apps during the interaction with the children;
2. the professionals' and children parents' consumer satisfaction about the AAC apps used to program new symbols;
3. the professionals level of anxiety before and after using the AAC apps to program new symbols;
4. the professionals' and children' behaviors during the app programming.

The play activity selected ("play with Bubbles") and the training sessions delivered to professionals are the **Constant Variables** of this study.

6.2.2 Participants

AAC professionals and children criteria for participation

AAC professionals and children were selected based on selection criteria. Selection criteria for professionals included: a) have AAC experience working professionally with individuals with communication needs, b) have no prior knowledge of how to use the two AAC apps under investigation, c) were willing to commit to the research study with no benefit.

Selection criteria for the children included: a) familiar with AAC use, b) able to participate in playing activity tasks for a minimum of 10 minutes, c) Italian as primary language.

AAC professionals and children demographics

Seven professionals with experience working with children with communication needs participated in the study (***Tab. 2***). The majority of the AAC professionals that participated in the research study are females (n° male = 1). The mean age is 46.7 years, with a mean of 8.7 years of AAC experience. Regarding their profession, three of the AAC professionals are registered educators, two are special pedagogy therapists, one is an occupational therapist and one is a neuro-psychologist.

Table 2. AAC professionals' demographic

Professional	Gender	Age	Profession	Years of AAC experience
1	Male	50	Occupational Therapist	18
2	Female	40	Registered Educator	16
3	Female	56	Special Pedagogy therapist	8
4	Female	50	Registered Educator	3
5	Female	51	Neuropsychologist	8
6	Female	40	Registered Educator	5
7	Female	40	Special Pedagogy therapy	3

Three children, one boy and two girls, with communication needs participated in the study (***Tab. 3***). The mean age of the children is 6.1 years. Two of the children are diagnosed with Angelman Syndrome whereas one child is diagnosed with the Phelan McDermid Syndrome. The children used, and still use, AAC as their primary way of communication.

Table 3. Children' Demographic

Children	Gender	Date of birth	Age (as to December 2016)	Diagnosis
1	Female	January 2011	5 Years, 11 Months	Phelan McDermid Syndrome
2	Male	February 2011	5 Years, 10 Months	Angelman Syndrome
3	Female	May 2010	6 Years, 7 Months	Angelman Syndrome

6.3 MATERIALS

6.3.1 Target vocabulary.

In order to allow professionals to start to engage in the play activity ("play with Bubbles") with the child, 10 target vocabulary words have been selected and programmed on the two AAC apps.
To select the target vocabulary for the play activity, 11 AAC professionals, 7 of which participate in the study, were asked to list 8 to 10 words they use the most when playing the "Bubbles" activity. The most frequent eight words of these lists were selected as the activity target vocabulary. The words "More" and "All done" were also included to the activity target vocabulary as appropriate words across routines (Caron et al., 2015).
The activity target vocabulary included three verbs ("pop", "blow" and "get"), one noun ("bubbles"), two adjectives ("big", "small"), two adverbs ("up", "down") and two across routines words ("more", "all done"). The vocabulary was randomly inserted in a 5x3 grid on both apps. The symbols and their disposition on the grid was the same for the two AAC apps.

6.3.2 AAC apps

In this research study we used an iPad Air2 with touch screens display, built-in cameras and speakers on which the two AAC apps under investigation were installed.

TalkTablet App
TalkTablet app (**App 1**) offers communication supports through grids of symbols. The app allows for customization options, such as adding symbols or images taken from the iPad library or the Internet, synthetized voice or recording messages and texts, through a programming steps procedure. The app screen has an "Edit" button and a "Main Page" button. It also includes a "Keyboard" button, a "Settings" button and a "Chat" button, that were not needed for the purpose of this study. The app included a pre-stored communication grid board (5x3) with 15 cells, 10 of which were filled with the target vocabulary selected (**Fig. 1**).
App 1 used the speech, a digitalized voice and direct selection to access the symbol for modeling the target vocabulary. For example, the professional would say "pop bubbles" while touching the icon of the symbol "Pop" and "Bubbles" to activate the digitalized voice. To program a new symbol, the communication partner needed to go through a 10 steps procedure to retrieve a symbol from the iPad library or an 11 steps procedure to retrieve a symbol from the Internet.
Among all the AAC apps available on the App store, TalkTablet was chosen as its layout and features (especially the possibility to use the Internet) were the most similar to the layout and features of the other AAC app used in this research study.

Speech-to-Symbols – JIT based - App
StS – JIT based App (**App 2**) offers communication support through grids of symbols. The app allows for customization options, such as adding symbols using the speech to symbols feature that retrieves symbols from the app data base or the internet with both the synthetic voice and text automatically

included, with no programming steps procedure. The app screen displays a “Mic” button and a “Delete” button. It also included a “Settings” button and a “Search” button that were not needed for the purpose of this study. The app included a pre-stored communication grid board (5x3) with 15 cells, 10 of which were filled with the target vocabulary selected.

App 2 used the speech, a digitalized voice and direct selection to access the symbol for modeling the target vocabulary. For example, the professional would say “pop bubbles” while touching the icon of the symbol “Pop” and “Bubbles” to activate the digitalized voice. To program a new symbol, the communication partner needed to go through a 1 steps procedure to retrieve a symbol from the app data base and a 3 steps procedure to retrieve a symbol from the internet (**Fig. 2**).

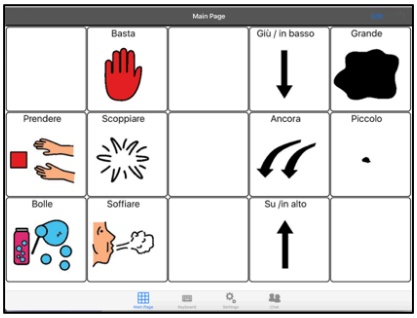


Figure 1. TalkTablet main page

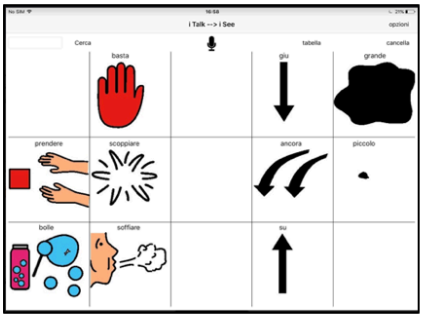


Figure 2. StS – JIT based main page

6.4 MEASURES

6.4.1 App programming

The number and type of symbols programmed were counted together with the time taken to program them and the type of word they were (verb, noun, adjective, adverb or subject). The number of symbols that failed to be programmed and the time it took to try to program them were counted as well when applied. In order to account for reliability check, the sessions have been videotaped.

6.4.2 Consumer satisfaction questionnaire

To measure the consumer satisfaction, we used the the System Usability Scale (SUS) questionnaire developed by J. Brooke (1996). The consumer satisfaction questionnaire includes ten 5-point Likert scale questions ranging from “Strongly Disagree” to “Strongly Agree” and it is designed to measure the perceived usability of a user with a .91 reliability (Tullis & Stetson, 2004). The higher is the mean the higher is the consumer satisfaction. The SUS questionnaires was provided at the end of each session to both the professional and parent.

6.4.3 STAI State questionnaire

The State-Trait Anxiety Inventory (STAI) State questionnaire (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was provided to each professional before and after each session to measure the level of anxiety. The STAI State scale questionnaire is a self-report questionnaire that measures the current state of anxiety of a person (right now) and includes 20 items rated with a 4 point Likert scale ranging from "not at all" to "very much so". The STAI State questionnaire was used to verify any difference in the professionals' level of anxiety pre and post session.

6.4.4 Interaction check list

A check list was created to analyze the professionals and the children' behaviors during the AAC apps programming. The children observational parameters accounted for behaviors related to the children engagement or disengagement's behaviors while the professional programmed the app.
The child engagement related behaviors selected for the purpose of this study are:

- the child looks at the iPad;
- the child looks at the professional.

The child disengagement related behaviors included are:

- the child looks around;
- the child is interested in another object, iPad included (i.e. looks, points, tries to grab or grab a toy);
- the child plays alone with the bubbles or another object;
- the child leaves or try to leave the side of the professional;
- the child engages with another adult in the room.

The professionals' observational parameters accounted for behaviors related to the AAC professional focus on the programming procedure (task-focused) and to the AAC professional attempt to keep the child engaged during the programming procedure (child-focused).
The AAC professional task-focused behaviors included are:

- describing the programming procedure out loud (e.g. I have to press edit, then type the label, then select a picture);
- explaining to the child they were programming a new symbol (e.g. I am programming the word "funny" on the iPad as you are having so much fun playing);
- mumble talking (e.g. I do this, I think it's ok).

The AAC professional child-focus behaviors included:

- attracting the children attention to the programming procedure (e.g. look how many images are there);
- asking the children to wait;
- moving gently the children's hands off the iPad;
- gently holding the children to their side.

To account for reliability checks, all the sessions have been videotaped.

6.5 PROCEDURE

Before the beginning of the sessions, consent and demographic forms were collected. Sessions were 10 minutes in length and consisted of the play activity “play with the Bubbles”. To ensure equal time, the activity was monitored with a timer. Intervention sessions were also videotaped for reliability checks.

6.5.1 Training

The professionals engaged in approximately 20 minutes of training per app. The training consisted in the use of a step- by-step printed user guide that walked the participant through the programming procedure of adding a new symbol for each app. The researcher read the guide with the professionals while performing the procedure on the app. The professionals were than asked to perform the programming procedure with the researcher three times and they were encouraged to ask questions if something was not clear. When all the answers have been addressed, the professionals were asked to perform the programing procedure three times independently to ensure that performance standards were met and that all the participants knew how to program the AAC apps. The time taken to perform the last three programming procedure was measure for both AAC apps. The professionals were free to use the printed user guide during the session.

6.5.2 Sessions

Professionals were asked to use the AAC apps for 10 minutes with the child and to program a minimum of one symbol during the interaction. Each professional performed at least one sessions per app. In order to mitigate practice effects, data were collected at least two days apart for each AAC app. The sequence of the AAC apps was counterbalanced across professionals to account for sequence effects. The professionals were then randomly assigned to a sequence of conditions (i.e., App 1 then App 2 or vice versa). All the sessions took place in a room with a small table and chairs. The bubbles, the iPad and the printed user guide were positioned on the table. A tripod with a camera was positioned in a corner of the room toward the table. Each professional was told to sit at the table and start playing with the child.

6.5.3 Play activity

The play activities “play with the bubbles” was chosen to test the AAC apps. The play activity “bubbles” is a gender neutral activity and was among the favorites play activities of the children involved in the study. The play activities consisted in making bubbles and pop them. The “bubbles” activity allows for many communication opportunities between the professionals and the children. It allows turn taking

(e.g. who blows or pops the bubbles), choices (e.g. many bubble, a few bubbles, big bubbles, small bubbles, blow bubbles up, blow bubbles down), comments (e.g. I like it, wet, good job, funny), and requests of repetition (e.g. more or all done).

6.6 RESULTS

In order to answer the research questions, we compare the use of the AAC apps under investigation, which is the Independent Variable of this study. Seven professionals used both App 1 (TalkTablet) and App 2 (StS – JIT based), at least once, with three children with communication needs for a total of 22 sessions (**Fig. 3**). Therefore, professionals held 11 sessions with App 1 (TalkTablet) and 11 sessions with App 2 (StS – JIT based). The AAC apps sequences have been counterbalanced across professionals to account for sequence effects. The professionals were then randomly assigned to a sequence of conditions (i.e., App 1 then App 2 or vice versa).

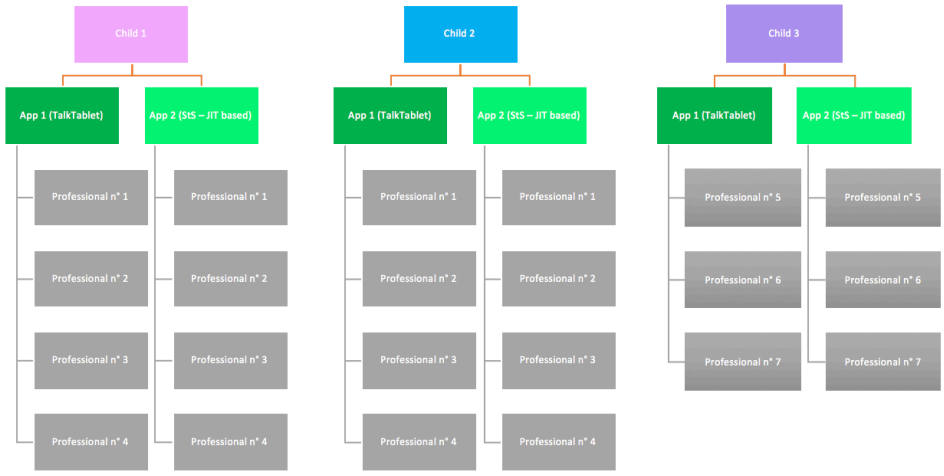


Figure 2. Sessions held by professionals per app and per child

All the professionals met the performance standards in the training sessions as they were all able to program three symbols without any help from the researcher. The time needed to program the AAC apps independently (three symbols) during the training session is reported in ***Tab. 4***.

Table 4. Time to program the AAC apps during the training sessions

TIME TO PROGRAM THE APPS DURING THE TRAINING SESSION	
Mean App 1 (TalkTablet) Minutes	Mean App 2 (StS JIT based) Minutes
02:30	00:24

Moreover, to account for familiarity with the use of the iPad, professionals were asked three 5-points Likert scale questions ranging from “Always” to “Never”. From 15 to 12 professionals were considered to have a low level of familiarity with the iPad, from 11 to 7 professionals were considered to have

medium level of familiarity with the iPad, from 6 to 3 professionals were considered to have a high level of familiarity with the iPad. Professionals reported overall a 7 (medium level) mean of familiarity.
In order to ensure that the two AAC apps could be considered equally used during the 22 sessions, we monitored the way they have been used to model symbols during the play activity interactions with the children. We counted all the symbols modeled during the 10-minutes interaction for each professional. ***Tab. 5*** shows the results.

Table 5. Use of the AAC Apps during the play activity interactions

	tot symbols modeled on ipad	tot names modeled on ipad	tot verbs modeled on ipad	tot adjectives modeled on ipad	tot adverbs	tot across routines words	bubbles	get	pop	blow	big	little	stop	down	more	up
APP 1	324	73	116	31	29	75	73	18	37	61	23	8	12	13	63	16
APP 2	306	72	110	31	17	76	72	16	47	47	15	16	7	9	69	8

Overall, the two AAC apps have been used to model the target vocabulary in a very similar way. Professionals modeled more symbols with App 1 (n = 324) than with App 2 (n = 306) with 18 symbols of difference. Verbs are the type of symbols that have been used more often (App 1 = 116; App 2 = 110) followed by across routines words (App 1 = 75; App 2 = 76), names (App 1 = 73; App 2 = 72), adjectives (App 1 = 31; App 2 = 31) and adverbs (App 1 = 29; App 2 = 17).
Regarding the **first research question**, related to the number and type of words that professionals programmed in the AAC apps, ***Tab. 6*** shows the results.

Table 6. Number of symbols programmed in App 1 and App 2

APP	N° OF DESIRED SYMBOLS	N° OF SYMBOLS FAILED TO PROGRAM	N° OF SYMBOLS PROGRAMMED	FREQUENCE OF USE OF THE PROGRAMMED SYMBOLS	NAMES	FREQ OF MODELING	VERBS	FREQ OF MODELING	ADJECTIVES	FREQ OF MODELING	ADVERBS	FREQ OF MODELING	SUBJECTS	FREQ OF MODELING	TOTAL TIME SPENT FOR THE PROGRAMMING PROCEDURE	TIME SPENT FAILING TO PROGRAM	TIME SPENT PROGRAMMING
APP 1	20	4	16	76	3 (FAILED 2)	15	3 (FAILD 2)	15	9	44	0	0	1	2	18:06 (mean = 0:54 per symbol)	4:16 (mean = 1:04 per symbol)	13:50 (mean = 0:51 per symbol)
APP 2	37	6	31	90	6 (FAILED 1)	11	14 (FAILED 2)	42	9 (FAILED 3)	33	0	0	1	4	6:19 (mean = 0:10 per symbol)	2:13 (mean = 0:22 per symbol)	04:06 (mean = 0:07 per symbol)

Regarding the number of symbols programmed with App 1 (TalkTablet), professionals attempted to program 20 symbols (mean = 1.8 symbols per session). The number of symbols that failed to be programmed were 4 whereas 16 have been actually programmed. The frequency of modeling of the programmed symbols is 76, meaning that professionals modeled the symbols programmed 76 times during the interactions with the children. The majority of the words programmed were adjectives (n = 9) followed by names (n = 3) and verbs (n = 3). In particular, the words that have been programmed the most across professionals were the word “many” (n=4) and the word “funny” (n=4). The most

programmed words received also the higher frequency of modeling (Many = 27 times; Funny = 13 times). Related to the time needed to program the app, professionals spent a total of 18:06 minutes on the programming procedure (mean = 00:54 min per symbol). The time needed for the 16 symbols programmed was 13:50 minutes (mean = 00:51 minutes per symbol) whereas the time spent failing to program symbols was 4:16 minutes (mean = 01:04 minutes per symbol).

Regarding the number of symbols programmed App 2 (StS JIT based) professionals attempted to program 37 symbols (mean = 3.4 symbols per session). The number of symbols that failed to be programmed were 6 whereas 31 have been actually programmed. To be noticed is that 2 of the symbols programmed were used to create one word. Indeed, one of the professional first programmed the word "eat" and then programmed the word "don't". The professional put the symbol for "don't" on the symbol "eat" and used it as a single symbol (**Fig. 4**). Therefore, although it required two programming procedures, it has been counted as a single symbol type (verb) and as a single symbol when modeled.

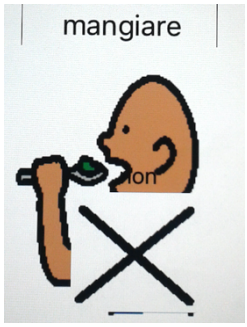


Figure 3. Combination of two symbols to create a word

The frequency of modeling of the programmed symbols is 90, meaning that professionals modeled the symbols programmed 90 times during the interactions with the children. The majority of the words programmed were verbs (n = 14) followed by adjectives (n = 9) and names (n = 6). In particular, as for App 1, the words that have been programmed the most across professionals were the word "many" (n=4) and the word "funny" (n=4). The most programmed words received the higher frequency of modeling, together with the verb "fly" (Many = 20 times; Fly = 13 times; Funny = 11). Related to the time needed to program the app, professionals spent a total of 06:19 minutes on the programming procedure (mean = 00:10 min per symbol) which is almost 1/3 of the programming time spent for App 1. The time needed for the 31 symbols programmed is 04:06 minutes (mean = 00:07 minutes per symbol), again 1/3 of the time spent programming App 1, whereas the time spent failing to program symbols is 02:13 minutes (mean = 00:22 minutes per symbol) which is half of the time spent for App 1.

To verify if there was a statistically significant difference between the number of symbols programmed on App 1 and App2, we run an ANCOVA analysis. Results are shown in ***Tab. 7.***

Table 7. ANCOVA analysis for number of Symbols programmed

Variables	F	Sig.	Partial ETA squared
APP	6.316	.022	.260
CHILD	.606	.446	.033
PROFESSIONALS	2.744	.115	.132

Results show that there is a statistically significant difference (Sig. = .022; F = 6.316) between the symbols programmed in App 1 and in App 2. By looking at the mean we could say that the number of symbols programmed with App 2 (mean = 2.82; SD = 1.722) is statistically greater than the number of symbols programmed with App 1 (mean = 1.45; SD = .688). Although the Independent Variable of this

study is the AAC apps used, we also account for the effects of the children and the professionals as covariate variables. As shown in ***Tab. 7***, neither the children nor the professionals have a statistically significant effect on the AAC apps programming.

Regarding the type of symbols programmed with the AAC apps, results show that the majority of the symbols programmed were verbs and adjectives (74%): 21 verbs (37%) and 21 adjectives (37%), whereas nouns were only 12 (21%) out of a total of 57 symbols programmed with App 1 and App 2. Very significant is the case of App 2 with which 16 (43%) out of 37 symbols programmed were verbs.

In addition to that, we asked to all the professionals that participated to the study to list 8 to 10 words they would use the most when playing the bubble activity prior to the beginning of the sessions. They listed 64 words from which we took out the target vocabulary words and the duplicates words. We obtained a list of 19 words. Of these 19 words listed as frequently used during the bubbles play activity, we noticed that 10 of them (53%), although listed as words to use during the bubbles activity, have not been programmed in the AAC apps along the 22 sessions, whereas 9 of them (47%) were listed and actually programmed in the AAC apps. Interesting enough is that 18 words, almost the same number of the words listed from the professionals when excluding the target vocabulary, have been programmed in the AAC apps although they did not appear in the list. Two of them were programmed both in App 1 and App 2, five of them were programmed only in App 1 whereas 11 of them were programmed only in App 2 (***Tab. 8***).

Table 8. Lists of words programmed and not programmed in the AAC apps

APP 1		
type	number of times programmed	frequence of use
many	4	27
funny	4	13
fight	1	7
to eat	1	7
set, go	1	7
to mash	1	6
i like it	1	4
to dry	1	2
you	1	2
eyes	1	1
FAILED		
finger	1	
to wait	1	
to dry	1	
eyes	1	

APP 2		
type	number of times programmed	frequence of use
many	4	20
to fly	1	13
funny	4	11
wet	2	7
to draw	1	6
hand	2	5
I have failed	1	4
you	1	4
another toy	1	3
to open	1	3
do not eat	1	3
to bounce	1	3
few	1	2
set, go	1	2
to clean	2	1
to mash	2	1
to twist off	1	1
head	1	1
to dry	1	0
face	1	0
FAILED		
funny	1	
many	2	
towel	1	
i like it	1	
to dry	1	

APP 1 AND APP 2		
Predicted but NOT used	NOT prdicted AND used	Predicted AND used
I	fight	funny
soap	set, go	many
want	to dry	to fly
water	eyes	wet
to twist on	finger	you
bottle	to wait	i like it
how nice	to draw	to bounce
to play	hand	to mash
tired	i have failed	to twist off
wind	another toy	
	to open	
	few	
	to clean	
	head	
	face	
	towel	
	to eat	
	don't eat	

Regarding the **second research question**, related to the consumer satisfaction about the AAC apps, we used the System Usability Scale (SUS) questionnaire to verify any statistically significant difference between the AAC apps. We decided to measure both the consumer satisfaction of professionals and

children's parents. We considered the consumer satisfaction of parents as important as the one of professionals. Indeed, research studies demonstrated that one of the main barriers of AAC device use for parents is the operational demands of the device (Caron et al., 2015; Baxter et al., 2012). Results are shown in ***Tab. 9***.

Table 9. Professionals and parents SUS ANCOVA analysis

SUS	APP	Mean	Standard Deviation	F	Sig.	Partial ETA squared
SUS PROFESSIONAL	TALKTABLET	53.23	20.4284	19.302	.000	.517
	SPEECH2SYMBOL	81.86	6.5730			
SUS PARENTS	TALKTABLET	65.45	21.0303	4.621	.045	.204
	SPEECH2SYMBOL	76.36	16.5968			

Results show that there is a statistically significant difference between App 1 and App 2 in the consumer satisfaction of professionals (Sig. = .000; F = 19.302). By looking at the means, App 2 is significantly higher than App 1 meaning that professional considered App 2 to be more usable than App 1.
Results shows that there is also a statistically significant difference between App 1 and App 2 in the consumer satisfaction of the children's mothers (Sig. = .045; F = 4.621). By looking at the mean App 2 is significantly higher than App 1 meaning that parents considered App 2 to be more usable than App 1.
What is interesting to notice, is how parents' satisfaction changed during the sessions (**Fig.5**). Except for Child 1, the parents' satisfaction tends to move upwards for App 2 whereas it tends to move downward for App 1.

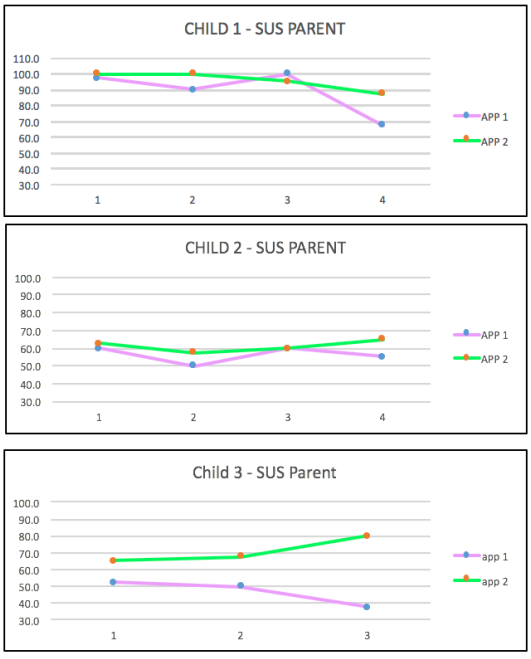


Figure 4. Parents' satisfaction changes along sessions

In addition to the SUS questionnaire, professionals were also asked to value the price they would pay to buy the AAC apps. Overall, App 1 (€54) was valued less than App 2 (€72).

Regarding the **third research question**, related to the level of anxiety of the professionals when using the AAC apps during the sessions, we run a Paired Wilcoxon Test to measure the STAI pre and post test questionnaire. We also calculated the effect size of both App 1 and App 2. Results are reported in ***Tab. 10***.

Table 10. Descriptive Statistics, Paired Wilcoxon Test and Effect Size of the STAI pre-post Test questionnaire

		Mean	Standard Devication	Sig.	Effect size
App 1	PRE_STAI	36.36	6.516	.038	.74
	POST_STAI	32.45	3.588		
App 2	PRE_STAI	35.18	5.636	.012	.43
	POST_STAI	32.64	6.038		

Results show that there is a statistically significant difference in the level of anxiety of professionals for both App 1 (Sig. = .038) and App 2 (Sig. = .012). However, as the effect size demonstrates, the level of anxiety was significantly lower when professionals used App 1 (d = .74) then when they used App 2 (d = .43).

Regarding the **fourth research question**, related to the professionals and children's behaviors during the programming procedure, we created and used a check list to account for any difference. All the sessions have been videotaped and the videos were used to fill in the check list. Results are shown in ***Tab. 11***.

Table 11. Professionals and children' behavior during the programming procedure

	CHILD								PROFESSIONAL						
	the child looks at the ipad	the child looks at the professional	the child looks around	the child is interested in another object, iPad included (looks, points, tries to grab or grabs it)	the child plays alone	the child leaves or tries to leave the professional's side	the child engages with another adult	the professional talks with the child	the professional describes the programming procedure out loud	the professionals explain to the child he/she is programming a new symbol	the professional mumble talks	the professional attracts the child attention	the professional asks the child to wait	the professional moves gently the children's hands off the iPad	the professional gently holds the children to their side
app 1	42	19	9	41 (9 iPad)	9	8	9	17	3	4	27	12	21	8	5
app 2	31	13	8	27 (15 iPad)	3	1	5	4	0	0	6	0	2	10	0
when app 1 failed	11	0	2	20	0	4	1		0	3	6	4	9	6	5
when app 2 failed	20	5	5	24	1	1	0		0	0	3	0	1	10	0

Regarding the children's behaviors during the programming procedure, we took into consideration the child engagement related behaviors (the child looks at the iPad, the child looks at the professional) and the child disengagement related behaviors (the child looks around, the child is interested in another

object, the child plays alone with the bubbles or another object, the child leaves or try to leave the side of the professional, the child engages with another adult in the room).

Related to the engagement behaviors, children looked more at both the iPad (42 times) and at the professional (19 times) when App 1 was programmed compared with App 2 (31 times at the iPad; 13 times at the professional). Related to the disengagement behaviors, children were overall more disengaged when App 1 was programmed than when App 2 was programmed. The major differences relate with the child being interested in another object (App 1 = 41; App 2 = 27) and the child trying to leave the professionals' side (App 1 = 8; App 2 = 1).

Regarding the professionals' behavior during the programming procedure, we took into consideration the professional's task-focused behaviors (the professional describes the programming procedure out loud, explains to the child they are programming a new symbol, mumbles talk) and the professional's child-focused behaviors (the professional attracts the children attention to the programming procedure, asks the children to wait, moves gently the children's hands off the iPad, gently holds the children to their side).

Related to the task focused behaviors, the professionals were overall more task-focused when programming App 1 then when programming App 2. In particular, professionals mumble talked more when programming App 1 (n = 27) than when programming App 2 (n = 6). Indeed, professionals tend more to mumble talk rather than explaining to children they were programming a symbol or anticipating to children they were about to program a symbol. They explained to children they were programming a symbol 4 times out of 20, 3 of which when they failed to program a symbol, with App 1 whereas 0 time out of 37 with App 2. Before starting to program the AAC apps, professionals provided children with "hints" about their programming intention, as none of them explicitly anticipated the child that they were about to program a symbol in the app. When programming App 1, professionals gave children hints of what they were about to do 6 times (e.g. shall we put the word eat in it?; let's add it) whereas 14 times they didn't say anything. When programming App 2 professionals gave children hints of what they were about to do 8 times (e.g. let's put in a word; shall we put in funny?) whereas 29 times they didn't say anything.

Related to the child focused behaviors, professionals were overall more child focused when programming App 1 then when programming App 2. In particular, professionals had to ask the child to wait more frequently when programming App 1 (n = 21) than when programming App 2 (n = 2), whereas professionals had to move the children's hands off the iPad more often with App 2 (n = 10) than with App 1 (n = 8).

6.7 DISCUSSION

The purpose of this study was to investigate if the reduced operational demands of App 2 (StS – JIT based) compared to the operational demands of App 1 (TalkTablet), that relies on a traditional programming procedure, would affect: 1) the number and type of symbols programmed, 2) the

consumer satisfaction about the AAC app, 3) the professionals' level of anxiety and 4) the professionals' and children's behaviors during the programming procedure (***Tab. 12***).

Related to the **first research question**, results show that the AAC apps under investigation have been used to model vocabulary in a very similar way. This result may indicate the two AAC apps did not significantly differ in term of their use for AAC purposes. The two AAC apps were indeed supposed to differ only for their programming procedure of new symbols. Based on this, we hypothesize a difference in the number and type of symbols programmed with App 1 and App 2, and as a matter of fact, a difference was measured on both the number and type of symbols programmed.

Related to the number of symbols programmed, we hypothesize that the reduced operational demands of App 2 would allow for a larger number of symbols programmed. Results confirmed this hypothesis as App 2 was used to program a larger and statistically significant number of symbols than App 1. Moreover, the symbols programmed with App 2 have been modeled more frequently than the symbols programmed with App 1. These results may lead to the assumption that the reduced operational demands of App 2 allow professionals of this study to expose children to a larger amount of new symbols and exposing children to new vocabulary is reported in literature studies to both support vocabulary expansion, and children' language learning through their modeling (M Romski & Sevcik, 1996).

Related to the type of symbols programmed, results show that the majority of the symbols programmed by professionals of this research study were verbs and adjectives. This result is significant considering that the vocabulary mainly included in AAC communication boards or devices is names (Lauren B Adamson et al., 1992). Interesting enough about the verbs programming is that professionals have mostly used verbs in their infinitive form except one time with App 1 and 2 times with App 2. This result is particularly interesting if considering that both AAC apps allowed for using the verbs in their conjugated forms. Different from verbs was the use of adjectives that have been used more often in their plural/singular, feminine/masculine forms (App 1 = 5 out of 9; App 2 = 6 out of 12). More over, by looking at the symbols programmed, we may also assume that although professionals may program in advance the symbols they think they would need for a play activity, it is still not possible to predict beforehand all the symbols that are actually going to be needed. The words listed from professionals, prior the beginning of the sessions, compared to the one actually programmed in the AAC apps, confirm that predicting in advance, and out of context, the vocabulary needed for an activity may result in the selection of inaccurate and not exhaustive vocabulary (Donato et al., 2014; Janice Light, 1997; Porter & Cafiero, 2009). Considering that the degree to which the children can fully participate across contexts and partners is largely determined by adults selecting and programming appropriate vocabulary within their AAC systems (Light, 1997), the reduced operational demand together with having access to a larger number and type of vocabulary may increase the children opportunities for language learning (Light, 1997). Indeed, if looking at the words programmed with App 1 and App 2, not only App 2 allowed a larger number of symbol programmed but it also allowed to program the majority of the unpredicted vocabulary. A final consideration can be drawn on the AAC apps features. First of all, the internet features of App 1, although available, have been overall used once from only one professional. Second,

the speech to symbol feature of App 2 was used from one professional to combine symbols to create a new word. This feature was not "available" as the speech to symbol feature was never supposed to be used for symbol combination. However, the professional used the speech to symbol feature creatively to meet her vocabulary need. These results may indicate that the features of an AAC app may not alone account for the way an app might be used but it rather is the communication needs that lead the way the device is used. This assumption reinforces the need to design AAC devices based on the users', or communication partners', needs of communication (Kent-Walsh et al., 2015; Janice Light, Drager, Currall, et al., 2012).

Related to the **second research question**, we hypothesize that the consumer satisfaction of professionals would be higher with App 2 than with App 1 because of the reduced operational demands. Results confirmed our hypothesis. Indeed, there is a statistically significant difference between App 1 and App 2 in the SUS questionnaire. Considering that the AAC apps differ mainly in the programming procedure we may also assume that the operational demands required to program the AAC apps do affect its usability. The SUS questionnaire provided a statistically significant difference between App 1 and App 2 for children' parents as well. This result is significant considering that the children's mothers never had the opportunity to try the AAC apps, but they could only observe their use and programming procedures when performed from the professionals. Two considerations can be drawn from this result. First of all, parents could form a clear opinion about the AAC apps without having to use or program them although different professionals used them, second, and perhaps more importantly, their consumer satisfaction about the AAC apps changed over time with a clear direction's tendency. Indeed, **Fig. 5** shows that the starting point for the consumer satisfaction of App 1 and App 2 are very similar. However, the direction of the parent's satisfaction changes along the session with a tendency of App 1 to move downward and a tendency of App 2 to move upward. This difference may be explained with the AAC apps functioning more than with the AAC apps features or operational demands. Indeed, Child 1 parent satisfaction about App 1 and App 2 slightly differs from Child 2 and Child 3 parents. Child 1 was the child with whom App 2 symbols programming failed the most (5 times out of 6) due the internet connection, whereas Child 3 was the child with whom App 2 never failed. By looking at Fig. 5 we can see that, for Child 1, App 2 satisfaction move downward, although not as much as App 1, whereas for Child 3, App1 and and App 2 satisfaction split in two very clear separate directions. Interesting enough is to see that, although App 2 features and operational demands remain the same, if the app does not meet the vocabulary needs by functioning appropriately, the consumer satisfaction of parents moves in a similar way as when the operational demands of an app makes it harder to be programmed. Considering that they never used the AAC apps under investigation, we may assume that is the app functioning, more than its features or operational demands, that affected the parents' satisfaction of this study. Again, the communication needs seem to matter more that the apps' features.

Related to the **third research question**, we hypothesized that the professionals' level of anxiety would be lower with App 2 than with App 1 due to its reduced operational demands. Results however rejected our hypothesis. Indeed, professionals experienced a statistically significant higher level of anxiety with App 2 than with App 1. Based on this results, we may assume that the operational demands of the AAC

apps under investigation did not affect the level of anxiety of the professionals of this study. However, a difference between App 1 and App 2 have been measured. Considering that the AAC apps differed from the way they can be programmed, we may assume that it was something about their programming features that may have affected the professionals' anxiety level. App 1 programming relies on features through which AAC device have been traditionally programmed, whereas App 2 programming relies on an innovative feature, the speech to symbol feature, that has never been used in AAC devices yet. This difference in the programming features, one more traditionally based and the other more innovative based, may be a possible explanation of the difference in the anxiety level. We may assume that it was the novelty in the programming procedure, compared to a more traditional one to which professionals are more used to, that may have resulted in a higher level of professionals' anxiety. Indeed, the speech to symbols feature, to which professionals are not used too, has never been used before to retrieve AAC symbols during AAC session.

Related to the **fourth research question**, we hypothesize a difference in the children and professionals' behaviors when using App 1 compared to App 2. Related to the children behaviors, we found a difference between both the children engagement and disengagement behaviors. Children were more engaged when App 1 was programmed. Children looked more to the iPad and the professionals with App 1 than with App 2. To be said however, is that the time taken to program App 1 was considerably longer than the time taken to program App 2. Children were also more disengaged when App 1 was programmed, and again, the time taken in the programming procedure may be a possible explanation of this difference. We may assume that the time needed to program App 1 was long enough for the children to start engaging in something else, whether it was playing by themselves or showing interest in another object or another adult. Specifically, the amount of times children showed interest in another object is almost the same amount of time they looked at the iPad. This assumption seems to be confirmed from the behaviors the children held when professionals failed to program App 2, requiring more time in the programming procedure. Indeed, the majority of disengagement behaviors appeared in the 6 times professionals failed to program App 2 compared to the other 31 times they succeeded in programming. For the children of our study, the time they needed to wait the professionals to program the app, and not the professionals failing to program it, seems to be associated with disengagement behaviors. Indeed, although professionals failed to program symbols in App 1 as well, the number of behaviors does not change much from their total as the number of behaviors of App 2 from their total.

Regarding the professionals' behaviors, we found a difference between both the task focused behaviors and the child focus behaviors. Professionals were more task focused with App 1 than with App 2. Again, the differences in the time spent to program the app may have affected this behavior. Interesting is that, when focused in the app procedure, professionals tends to mumble talk with themselves rather than explaining to the child what they are about to do or they are actually doing (programming a symbol). Looking at it from the child point of view, it should not be a surprise their disengagement behaviors. Professionals may have been seen as suddenly paying attention to the iPad instead of keep playing with them. Moreover, if we considered the amount of attempts of professionals in trying to attract the attention of children to the programming procedure we may also find a possible explanation

for the differences in the children engagement behavior with App 1 and App 2. In order to account for the children disengagement behaviors professionals acted out different strategies to try to keep him engaged. These strategies were the only one used across professionals. It is interesting to notice that the strategy most used with App 1 was to ask children to wait whereas the most used with App 2 was trying to hold the child hands off the iPad. These strategies were also the most used strategies acted out when professionals failed to program the AAC apps.

6.8 LIMITATION AND DIRECTION FOR FUTURE STUDIES

This research study presents limitations. One limitation is the sample size. Although the sample size is consistent with other research studies that compare AAC apps (Caron et al., 2015), a larger sample may have allowed to identify differences between the AAC apps that could not be detected in this research study. Another limitation is the app selected for the comparison (TalkTablet). Although TalkTablet features were consistent with the StS – JIT based app features (layout, internet feature, customization options), it is not the only traditionally designed AAC app available. Therefore, we cannot overrule the possibility that another traditionally designed AAC app would have provided different outcomes. Considering the limitation of the study, further investigation should be required. The results of this research studies provided us with several possible directions for future studies. First, the StS – JIT based app should be used by a larger sample size, possibly with another traditionally designed AAC app to allow for a generalization of the outcomes of this research study. Second, considering that an AAC app with reduced operational demands exposes to a larger size of vocabulary and considering that a larger exposure to vocabulary is associated with vocabulary expansions and language learning, future research studies may focus on verifying if the vocabulary to which children are exposed to with an app such as the StS – JIT based app is actually learned and used functionally in their communication. The StS – JIT based app was proved to allow professionals to meet their need of programming new vocabulary.

Third, considering that for the parents of this research study the consumer satisfaction changed over time and seemed to be related with the app functioning, future research studies may focus on investigating how the satisfaction of parents and professionals' changes over time and what is the cause of the change: does it rely on the operational demands of the device, does it rely on its functioning or is it a combination of the two?

Fourth, considering the unexpected low level of anxiety when professionals used App 1, future studies may focus on verifying if the level of anxiety may be influenced by the traditional versus innovative features of an AAC device. Related to the use of technology, it may also be interesting to investigate the self efficacy or level of confidence that professionals have toward traditional, low tech AACC devices, versus less traditional high tech AAC devices. Fifth, in this study, the children disengagement behaviors seemed to be related with the time they had to wait for the professionals to program the AAC app. However, with only a few exceptions, none of the professionals told the child that they were about to program a symbol on the device, neither they tried to engage the child in the programming

procedure. Future studies should investigate if the disengagement behaviors of children decrease if professionals explain them they have to program the device, engage them in the programming procedure or they combine these two strategies.

6.9 CONCLUSION

The StS – JIT based app was developed to better need the communication partners' need for expanding children' vocabulary during the interaction by reducing the operational demands required to program a symbol into an AAC app. The results of this study demonstrated that the reduced operational demands of StS – JIT based app do increase the amount of symbols programmed and used from professionals, within a context, during interactions with children with communication needs. Moreover, compared to a traditionally designed AAC app (TalkTablet), StS – JIT based app better met the professionals needs of programming symbols that professionals did not predict in advance. StS – JIT based app was also considered as more usable from both professionals and children' parents. In particular, the use of the StS – JIT based app allowed to notice that parents' satisfaction of an AAC app may change over time indicating that if the iPad and AAC apps do not support communication partners' needs the parents' satisfaction decrease no matter what the iPad or AAC apps features are. This result is interesting as it may reinforce what stated in literature studies, that is, AAC devices design should meet the communication needs of both the communication partners and AAC users.
Finally, considering the results of this study, further explorations of JIT based AAC devices, with reduced operational demands, should be encouraged.

Table 12. Summary of the research study's research questions, hypothesis, outcomes and direction for future studies

Aims	Research questions	Hypothesis	Outcomes	Direction for future studies
Comparing a traditionally designed AAC app with an innovative designed AAC app with reduced operational demands thanks to the speech to symbol features	Number of words and type of words programmed in the AAC apps	More vocabulary is to be programmed with the Sts - JIT based app than with the other AAC app (TalkTablet)	**Hypothesis confirmed**. More symbols were programmed with App 2 compared to App 1 indicating that the reduced operational demands do have an effect on the amount of vocabulary that children could be exposed to. Suggestion also comes from the type of symbols programmed: a) the majority of the symbols programmed are verb,s although communication boards typically includes mainly nouns; b) consisten with research studies, the professionals prediction of the vocabulary that could be used in the play activity resulted inaccurate and not exaustive.	In order to generalize the results of this study, further investigation with a larger sample size and a different AAC app may be required.
	Communication partners' level of satisfaction with the AAC apps programming	The level of consumer satisfaction is to be higher with the StS - JIT based app	**Hypothesis confirmed**. Both professionals and parents reported a statistically significant higher level of satisfaction with App 2 compared to App 1 indicating that the reduced operational demands do have an effect on the consumer satisfaction.	Professionals and parents consumer satisfaction may be based on different aspects. Parents satisfaction seems to be more related with the appropriate functioning of the AAC app than with its operational demands. Further investigation should then be required.
	Communication partners' level of anxiety	The level of anxiety is to be lower with the StS - JIT based app	**Hypothesis not confirmed**. Professionals experienced a statistically significant lower level of anxiety with App 1 compared with App 2, indicating that the operational demands did not positively affect the anxiety level of professionals. A possible explanation of such difference may relate with some aspects of the app other than the operational demands.	The innovative programming feature of App 2, the Speech to symbols feature, compared with the traditional programming features of App 1 may be responsible for the difference in the professionals level of anxiety. In order to verify this assumption, further investigation should be require.
	Professionals and children behavior during the programming procedure	Children level of engagement is to be higher and so as the task focused behaviors of professionals when te StS - JIT based app is used	**Hypothesis not confirmed**. Children were more engaged with App 1 compared with App 2 and professionals were more task-focused when programming App 1 that when programming App 2 indicating that the reduced operational demand did not have an effect on the children engagement behaviors and on the professionals task focused behaviors. However, children were also more disengaged and professionals more child focused when App 1 was programmed indicating that the operational demands do have an effect on the children disengagement behaviors and on the professionals' child focused behaviors. To be said is that the time needed to program App 1 was significantly longer that the time needed with App 2.	The children disengagement behaviors seemed to be related with the time they had to wait for the professionals to program the AAC app. However, with only a few exceptions, none of the professionals told the child that they were about to program a symbol on the device, neither they tried to engage the child in the programming procedure. Furhter investigation may then be required.

CHAPTER 7

TEENAGERS' ATTITUDES TOWARD A PEER USING DIFFERENT AAC DEVICES

7.1 ABSTRACT

The purpose of this study is to investigate the attitudes and the communication competence perceived from teenagers (13 to 18yo) toward a peer with communication disabilities who uses different AAC devices: an iPad based SGD, a communication board, and the AAC user natural voice. A 3 x 2 design was used to analyze the type of device and the participants' gender impact on both attitudes and communication competence perception. We used the CATCH questionnaire and the Communicative Competence questionnaire as measure. The results of this study show that females tend to have more positive attitudes toward individuals using AAC than males, as well as the impact that the type of device has on the communication competence perception. Clinical implications are also discussed.

7.2 INTRODUCTION

Attitudes toward individuals with physical and intellectual disabilities, have been found to **affect people's willingness to interact** with individual who uses AAC (Kim et al., 2015), in particular when this individual is a member of a group that holds the same attitude (Beck et al., 2010). School classrooms are "social communities in their own right" (Nowicki & Sandieson, 2002, pp. 244) in which attitudes, if negative, "are generally recognized as being a major barrier to full social inclusion at school for children and youth with disabilities" (McDougall et al., 2004, p. 288). Research studies showed that AAC allows children to interact with peers in the classroom context (Dalton & Bedrosian, 1989), exposes them to learning and communication activities (Downing, Ryndak, & Clark, 2000; Erickson, Koppenhaver, Yoder, & Nance, 1997; Pat Mirenda & Beukelman, 1992), increases access to curricular areas (Ralf Schlosser et al., 2000) and promotes literacy skill development (Alant & Emmett, 1995).

Attitudes toward individuals who use AAC have been extensively studied in literature studies (e.g. Beck, Bock, Thompson, Bowman, & Robbins, 2006; Beck, Bock, Thompson, & Kosuwan, 2002; Beck, Fritz-Verticchio, Keller, & Dennis, 2000; Beck & Dennis, 1996; Blockberger, Armstrong, O'Connor, & Freeman,

1993; Dudek, Beck, & Thompson, 2006; Gorenflo & Gorenflo, 1991; Gorenflo & Gorenflo, 1997; Lilienfeld, Lilienfeld, Alant, & Alant, 2002) with a particular focus on the variables that affect them.
The majority of research studies that investigated students' attitudes toward individuals who use AAC, focused on variables such as a) the type and characteristics of the AAC system used to communicate such as for example high tech versus low tech devices and b) the characteristics of respondents such as familiarity, gender and age and c) the communicative competence of the individuals who use AAC.

a) Characteristics of AAC systems (e.g., high tech versus low tech devices)

This group of research studies aims at verifying if there is a relationship between the attitudes toward an individual who use AAC and the AAC device, that is used to communicate. The majority of the research studies that investigated this relationship are based on the comparison of a low tech AAC device, such as a communication board, with a high tech AAC device such as SGDs (Beck & Dennis, 1996; Beck et al., 2000, 2010; Beck et al., 2001; Blockberger et al., 1993; Dada & Alant, 2002; Gorenflo & Gorenflo, 1991).
The results of these research studies have been somewhat inconsistent. Some studies have not found any difference in the attitudes associated with the type of system used (Beck et al., 2002, 2000; Beck & Dennis, 1996; Beck et al., 2001; Blockberger et al., 1993; Dudek et al., 2006; Hyppa-martin et al., 2016) whereas some other have (Dada, Horn, Samuels, & Schlosser, 2016; Gorenflo & Gorenflo, 1991; Lasker & Beukelman, 1999; Lilienfeld et al., 2002). In Blockberger study (1993), three videos depicting an AAC user using sign language, a communication board and an SGD device where compared. Children ranging from 9 to 10 years of age where divided in three groups each of which watched one video condition. Results show that there were no significant differences in the attitudes relating to the AAC device used.
In Hyppa-Martin and colleagues study (2016), 115 first graders watched two different videos depicting a child using a communication board and an iPad based SGD device. Results of this study did not provide any significant difference in children' attitudes based on the type of device used from the AAC user.
In Gorenflo and Gorenflo (1991) study a group of a 151 undergraduate students watched three different videos of a peer using either an unaided communication technique (his own voice together with gestures), an alphabet board and an SGD. Results of this study indicate that the more sophisticated the device was the higher were the attitudes. Indeed, the condition that had a lower level of attitudes was the one in which the user used his own natural voice.
In Dada study (2016), an iPad-based SGD was compared with a communication board in a crossover design involving 78 children from 9 to 12 years of age. The children were divided in two groups. Both groups watched two videos, one depicting an AAC user having a conversation with a peer using an iPad and the other depicting the same user using a communication board. Results of this study show that children perceived more favorably the peer when using an iPad based SGD than when he was using a communication board. To be said is that studies on attitudes toward individuals who use AAC including iPad-based devices are still very limited (Achmadi et al., 2015).

b) Characteristics of respondents (e.g., familiarity, gender and age).

This group of research studies aims at verifying if there is a relationship between the characteristics of the respondent such as familiarity with disability, gender and age and the attitudes toward an individual who uses AAC. Many research studies have investigated these characteristics (Beck, Kingsbury, Neff, & Dennis, 2000; Beck et al., 2002, 2000; Beck & Dennis, 1996; Blockberger et al., 1993; Dudek et al., 2006). Relating with **familiarity** with disability, the respondents level of familiarity with disability have been found to influence attitudes toward individuals who use AAC. Research studies on children's and adults' attitudes indicate that individuals who are more familiar with people with disability hold more positive attitudes toward them compared with those who are less familiar (Beck et al., 2000; Beck et al., 2002, 2000; Beck & Dennis, 1996; Blockberger et al., 1993; Dudek et al., 2006; Gorenflo & Gorenflo, 1991; Bedrosian, Hoag, Calculator, & Molineux, 1992; Hoag & Bedrosian, 1992). The results of Beck and colleagues (2010) research study show that not only familiarity with disability is related with more positive attitudes but they also demonstrate that as familiarity increase so di the positive nature of attitudes.

Relating with **gender**, the respondents gender has been found to influence attitudes toward individuals who use AAC. A consistent finding in research studies is that boys tend to hold less positive attitudes than girls (Beck et al., 2000; Beck et al., 2002, 2010; Beck & Dennis, 1996; Blockberger et al., 1993; Lilienfeld et al., 2002). In Hyppa-Martin and colleagues study (2016) a sample of 115 first graders where divided in two groups to investigate whether attitudes were influenced by the gender of participants. The results indicate that girls tend to have more positive attitudes than boys.

Relating with **age**, the majority of studies report the attitudes of young children or adults toward their peers who use AAC (Beck et al., 2000; Beck & Dennis, 1996; Beck et al., 2000; Blockberger et al., 1993). Results from these research studies demonstrate that the attitudes of children toward a peer who uses AAC tend to become less positive as they age. Significant is the study of Beck and colleagues (2000) in which is reported a grade by gender interaction. Boys attitudes have been found to decrease, if compared with girls' attitudes, from 1st grade (6-7 yo) to 3rd grade (8-9 yo) indicating that boys' nature of attitudes become more negative across grade levels. Different from children's attitudes is adults. Gorenflo and Gorenflo (1991) investigate adults' attitudes toward an individual who uses AAC. Results from this study show that the attitudes of adults correlate more with the amount of information received about the individual using AAC. Indeed, the attitudes were more positive for the participants who received information about the AAC user.

If the area of children and adults' attitudes toward an individual who uses AAC have been extensively investigated based on their characteristics (familiarity, gender and age), little is known about teenagers' attitudes toward their peers who use AAC. Two studies investigated the attitudes of adolescents toward a peer using AAC with mixed results (Lilienfeld, 2002; Beck 2010) which may suggest that adolescents' reactions are not always predictable and therefor further investigations may be required.

A better knowledge on adolescents' attitudes toward their peers who use AAC may allow to overcome some of the difficult challenges that adolescents AAC users face in these years of transition. For AAC

users, peer acceptance is critical for their successful integration in the high school setting (McDougall, DeWit, King, Miller, & Killip, 2004).

c) Communicative Competence

Communicative competence has been defined in AAC as "the quality of being functionally adequate in daily communication or of having sufficient knowledge, judgment, and skills to communicate" (Light, 1989, pp. 138). In the majority of studies investigating the variables affecting attitudes, the AAC user depicted in the videos was a competent communicator able to express ideas or thoughts with little or no difficulty. Therefore, it is possible to assume that as long as AAC users communicate competently, the type of device used or the characteristics of the respondents may not be the controlling factors that influence the attitudes toward them. Research studies indeed, considered communicative competence as a variable that may be a controlling factor for attitudes toward AAC users (Beck et al., 2000). Beck and colleagues (2002) investigated communicative competence by using a clinical case study in which five special education students who used AAC were included with their typically functioning peers for an academic semester. Three of these students were competent communicators whereas the other two were not. Teachers collected a charts of behaviors that the peers directed toward the special education students and results indicate that students were more willing to interact with the three competent special education students than with the other two. Since the willingness to interact and the perception of the competence of the AAC users increased based on their communication skills, the findings of these two studies suggest that peers' attitudes might become more positive as the communication competence of the AAC user increases (Beck et al., 2002). Other research studies investigated communicative competence in interaction with the type of AAC device used to communicate (Bedrosian, Hoag, Calculator, & Molineux, 1992; Bedrosian, Haog, & McCoy, 2004; Bedrosian, Hoag, Johnson, & Calculator, 1998). In these studies, results show a positive correlation between the type of device and the communicative competence dimension indicating that high tech devices may shape the perceptions of communication competence.

Considering the research studies results reported in literature, the purpose of this study is to compare both the communicative competence perceived and the attitudes toward an individual using different types AAC devices (iPad, communication board and the AAC user natural speech) in teen-agers ranging from 13 to 18-year-old. This age specific target was chosen considering that the majority of the literature studies analyzed the attitudes of children or adults toward either a peer or, more in general, an individual who use AAC. Only a few studies (Lilienfeld and Alant, 2002; Beck et al., 2010) investigated adolescents' attitudes toward individuals using AAC devices.

The types of devices were chosen for two main reasons. First of all, the majority of studies compared aided modalities, which relied mainly on communication boards and SGDs. However, including an unaided modality in the comparison may provide further data about the nature of the interaction occurring between the type of device used and either the attitudes or the perception of the user's

communicative competence. Second, considering the wide use of iPads as a communication device a further investigation may be required to collect more data on its impacts on attitudes. So far, only a few studies included the iPad in the comparison (Achmadi et al., 2015; Dada et al., 2016; Hyppa-martin et al., 2016) with mixed results. Therefore, further investigation may be required.

7.3 HYPOTHESIS AND EXPERIMENTAL DESIGN

Consistent with previous research studies, we are expecting significant differences both in the attitudes and communicative competence' perception (dependent variables) related to the type of device used and the gender of respondents (independent variables). First of all, we are expecting females to hold higher attitudes and communicative competence's perceptions than males. This hypothesis is consistent with previous research studies claiming that females tend to have more positive attitudes toward individuals using AAC than males (Beck et al., 2000; Beck et al., 2002, 2010; Beck & Dennis, 1996; Blockberger et al., 1993; Lilienfeld et al., 2002; Rosenbaum, Armstrong, & King, 1986). Second, we are expecting a possible interaction between the dependent and independent variables. Specifically, we are expecting the attitudes and communication competence' perceptions of females to be higher than males when the device used provides a more sophisticated type of communication (iPad) (Gorenflo & Gorenflo, 1991).
A 3 (type of devices) x 2 (gender) factorial, between-groups, design was used for the purpose of this study.

7.4 METHOD

Participants

The participants of this study were students (n=135) attending three different high school, for a total of nine classes (4 classes correspond to 11th grade, 5 classes correspond to 12th grade), located in the same neighborhoods in Milan, Italy. Two classes were from an economic high schools, two classes were from a social high school and five classes were from a catering institute high school. The schools agreed to participate to the study, and the students, or the students' parents if they were minors, signed a consent form to participate to the study. The mean age of the student is 16.8 yo ranging from 15 to 19. More than a half of the sample were females (female n=94; Male n=41). Each condition included 45 students. **Tab 1**. describes the demographics of the sample divided per device.

Tab. 1 Demographics of the sample divided per devices

		iPad	Communication Board	Speech	Tot
Gender	Female	33	34	27	94
	Male	12	11	18	41
Mean Age		16.4	17	16.9	16.8

7.5 STIMULI

Test Video

A test audio and video was shown in each class at the beginning of the experiment session in order to verify that all students could hear the audio and see the monitor screen. The audio provided them the instructions for the experiment. The instructions provided described to the students what AAC is used for and explained that they were going to see a video of an adolescent girl with disabilities talking with her friend using an AAC device (the speech condition did not include any explanation of AAC devices). The video showed the computer animation that is produced when the visualizer of iTunes is activated.

Experimental Videos

Three different experimental videos were developed, one for each experimental condition: iPad, communication board and speech. In each video, the scene depicted a communicative interaction between a girl without disabilities and a girl with physical disabilities. Both girls were visible half-length. The girl with disability is an 18 years old girl with cerebral palsy, named M. M. has a fairly intelligible speech, limited use of the arms and no use of the legs. She uses a wheel chair with a table. Although verbal, M. was very familiar with AAC devices, since she regularly used AAC to communicate until the age of 7. M. communication partner is a 24 years old PhD student girl with no disability.

The two girls sit one besides the other. In this position, M. communication partner could see both the device placed on the table, if any, and M. In the background, only a wall and a door were visible. The girls were dressed in gender-neutral clothes (i.e., a black and white T-Shirt).

The experimental videos differed only for the device used to communicate. The contents of the conversation were the same in each video.

The **iPad video** showed M. communicating with the other girl using an iPad app. The iPad was visible and positioned in portrait position on the wheelchair table facing M. The iPad device used was an iPad air2 with the TalkTablet app installed and programmed for the video. Symbols were displayed on a single page and selected through direct selection (pointing). The page displayed 27 SymbolStix symbols and 5 written words. The output used was an Italian synthetized speech of an adult female voice. The video lasted 1:19 min. M. accessed 26 symbols to produce 15 turns in responding to and maintaining the conversation (M. took 8 turns and 7 her communication partner).

The **communication board video** showed M. communicating with a communication board. The communication board was visible and placed on a paper notebook in portrait position facing M. on M. table. The communication board consisted in a printed A4 sheet representing the screenshot of the app TalkTablet. The symbol organization and appearance was the same as the one on the iPad video. The symbols were accessed through direct selection (pointing) and read aloud from the other girl. To ensure that the intent of the AAC user's message was clear to viewers, the speaking partner produced a re-auditorization (expanded repetitions) of some of M. communications (n=1). Procedures for re-auditorization were similar to those described by Beck et al. (2002) in which communication partner used natural speech to produce a slightly expanded repetition of the message that corresponded to the AAC user selection on the communication board. The video lasted 1:17 min. M. accessed 25 symbols (a

"Yes" symbol was not selected) to produce 15 turns in responding to and maintaining the conversation (M. took 8 turns and 7 her communication partner).
The **speech video** showed M. communicating using her verbal speech. The video lasted 0:50 min. M. took 8 communicative turns and 7 were taken from her communication partner, for a total of 15 turns.

Conversational script
An Italian age appropriate and gender neutral scripted conversation was used. This script was created with M. based on the conversation she has at school with her peers' classmates. The topic of the script were the activities done during the week--end and the next day oral test at school. The same script was used for each videotaped condition.

7.6 MEASURES

The Chedoke-McMaster Attitudes Towards Children with Handicaps (CATCH)
The first dependent variable of this studies are attitudes toward individuals who use AAC. Attitudes were assessed using the Chedoke-McMaster Attitudes Towards Children with Handicaps (CATCH) scale (Rosenbaum et al., 1986). Research studies reported the CATCH questionnaire as a valid, comprehensive and reliable measures of attitudes toward disability (C et al., 2008).
The CATCH questionnaire is composed of three subscales measuring affective attitudes, cognitive attitudes and behavioral intentions as resulting from the three component model of attitudes (Triandis, 1971). Each subscale includes twelve 5-point Likert scale ranging from strongly agree to strongly disagree. Higher scores indicate more positive attitudes towards disability. Although the CATCH was created to assess attitudes of children ranging from 9 to 13 years of age, several research studies used it with samples ranging from 12 to 20 years old (Bossaert, Colpin, Pijl, & Petry, 2011; De Laat, Freriksen, & Vervloed, 2013; McDougall et al., 2004; Vignes et al., 2009).
A Rasch analysis carried out in 2016 (Armstrong, Morris, Tarrant, Abraham, & Horton, 2016) shows that the CATCH questionnaire could not be considered as a unidimensional scale and suggests to consider the subscales separately. The affective and behavioral subscales' construct validity was improved by removing four items from each subscale and changing the response set from 0-4 to 0-3. The cognitive subscale did not form an internally consistent subscale and therefore conclusion from this subscale should be drawn carefully. Therefore, although the CATCH was based on a three-dimensional conceptualization of attitudes (Triandis, 1971), based on the results of the factor analysis, a two dimensional model of attitudes consisting of affective and behavioral components may be more appropriate (Blockberger, 1993; Rosenbaum et al. 1986).

Communicative competence questionnaire
The second dependent variable of this study was the communicative competence perception of the AAC user. The questionnaire for evaluating the communicative competence was developed by Bedrosian (1992). The questionnaire includes 30 items and it uses a 5-point Likert-type scale ranging

from "definitely false" to "definitely true". The summation of the participants' responses to the questionnaire items served as the dependent variable of this investigation. Higher scores indicate a perception of more communicative competence. Bedrosian et al. (1992) estimated the internal consistency that indicates a Cronbach alpha of .94.

7.7 PROCEDURE

Classes were randomly assigned to each condition. This type of randomization was used in several other research studies (Beck et al., 2000; Blockberger et al., 1993; Dada et al., 2016; Dudek et al., 2006). Experimental sessions were conducted in the students' classrooms in the spring of the school year. The research took place in the classroom that was regularly attended by each participant. A monitor was brought in each class and positioned so that all students could view the experimental videos of the experiment. The questionnaires were distributed face down and placed on the students' desk before the beginning of the experiment session. Students were told not to turn the questionnaire up until they were told to do so. Classroom teachers did not directly participate to the research. However, they were in the classroom during the whole experiment.

The experimental session began with the distribution of the questionnaires face down and the recommendation of not turning them up. The test video was then played and, if needed, the students were repositioned and the volume adjusted until all of them could see the monitor screen and hear the audio. Then, the assigned experimental video was played. At the end of the video, the instructions to complete the questionnaires were given to the students through an audio file. After that, the students started to completed the questionnaires. The same procedure was implemented across all three schools.

7.8 RESULTS

To measure the attitudes toward individuals who use AAC, we used the CATCH questionnaire (Rosenbaum, 1986). An ANCOVA analysis was run for the independent variables (Gender and Devices) and the two dimensions (Affective and Behavioral) of the CATCH questionnaire. Results of the Affective and Behavioral scale are shown in **Tab. 2**, **Tab. 3** and **Tab. 4**.

Table 2. ANCOVA results of the Affective scale of the CATCH questionnaire

	Variables	**F**	**Sig.**
Affective scale	Gender	1.688	.196
	Devices	2.110	.125
	Gender * Devices	2.965	.055

Table 3. ANCOVA results of the Behavioral scale of the CATCH questionnaire

	Variables	**F**	**Sig.**	**Effect size**

Behavioral scale	Gender	12.485	.001	.068
	Devices	.301	.740	.018
	Gender * Devices	1.632	.200	.006

Table 4. Mean and Standard Deviation of the Behavioral scale of the CATCH

Gender	Devices	Mean	Standard Deviation
Females	iPad	13.491	2.5130
	Communication board	12.841	2.3115
	Voice	13.974	3.3942
	Total	13.395	2.7391
Males	iPad	10.783	3.6389
	Communication board	12.327	2.5326
	Voice	11.256	3.6674
	Total	11.405	3.3647

The Affective scale is not statistically significant for neither the Gender, Device nor for the Gender by Devices interaction, whereas the Behavioral scale shows a statistically significant difference for the variable Gender (F=12.485; Sig.= .001).

To measure the communication competence perceived we used the Communication Competence questionnaire (Bedrosian 1992). An ANCOVA analysis was run for the independent variables (Gender and Devices) and the Communicative Competence questionnaire. Results are shown in **Tab. 5** and **Tab. 6**.

Table 5. ANCOVA results on the Communicative Competence questionnaire

	Variables	F	Sig.	Effect size
Communicative Competence	Gender	.343	.559	.003
	Devices	2.488	.087	.037
	Gender * Devices	4.668	.011	.067

Table 6. Mean and Standard Deviation of the Communicative Competence questionnaire

Gender	Devices	Mean	Standard Deviation
Females	iPad	106.79	9.575
	Communication board	110.26	6.680
	Voice	105.11	7.934
	Total	107.56	8.343
Males	iPad	111.33	8.026
	Communication board	103.18	6.178
	Voice	105.00	7.444
	Total	106.37	7.864

The Gender by Devices interaction shows a statistically significant difference (F=4.668; Sig.= .011).
In order to verify the effect of the two questionnaires on the dependent variables we calculate the effect size. The Gender in the Behavioral scale (effect size= .068) and the Gender by Devices interaction in the Communicative competence questionnaire (effect size=.067) presents both a small effect size.

7.9 DISCUSSION

The purpose of this study was to compare both the attitudes and communication competence perceived of teenagers ranging from 13 to 18 years of age toward a peer using different AAC devices such as an iPad based SGD, a communication board and the natural voice.
Regarding the attitudes toward an individual using AAC, the two scales of the CATCH questionnaire provide different results. The Affective scale does not show any statistically significant difference for the two independent variables, gender and devices. The Behavioral scale, on the contrary, does show a statistically significant difference for the variable gender. By looking at the means of the Behavioral scale, we noticed that females tend to have higher attitudes toward a peer using AAC than males. This result is consistent with literature studies stating that females have more positive attitudes toward individuals using AAC. In particular, the result of this study show that the means of females are higher for either the iPad and voice condition compared to the communication board.
The results of the CATCH questionnaire are also interesting as it indicates that there is not a statistically significant difference in the teenagers' attitudes for the devices variable. Once more, this result is consistent with literature research studies in which the type of AAC device used to communicate is not a controlling factor for attitudes. What is to be noted however, is that not only the aided devices did not control for attitudes toward an individual who uses AAC but also the unaided modality, the speech, which is the most natural modality of communication, did not significantly differ from the other, aided and less natural, conditions. This result may have two important clinical implications that may be taken into consideration during the assessment of the AAC device to choose. First of all, the use of aided or unaided devices do not provide significant differences in attitudes toward individuals who use AAC. Moreover, the use of a high tech device such as the iPad or the use of a low tech device such as the communication board does not seem to influence attitudes as a result of this study.
Second, if there was a statistically significant difference between the voice condition and the aided devices conditions (iPad and communication board) it could have been possible to assume that some of the features or characteristics of the devices may, somehow, impact on the attitudes. Since no difference have been found in this study, it is possible to assume that aspects, other than the modality through which the communication is conveyed, may influence attitudes or perceptions toward individuals who use AAC.
Indeed, a statistically significant difference have been found in the communication competence. Research studies found out that communicative competence could impact attitudes toward AAC and it could correlate with the type of the device used (Beck, 2002; Bedrosian et al., 1992; 1998; 2004). The

results of this research study show that communicative competence is indeed statistically significant for the Gender by Devices interaction.

By looking at the means of the communication competence questionnaire it is possible to draw two considerations. The first one relates with the difference in the type of AAC device that females and males perceived the peer to be more competent with. Considering the females, the highest device mean is the communication board, meaning that females perceived the peer as more competent when using the low tech aided device. Considering the males, the highest device mean is the iPad, meaning that males perceived the peer as more competent when using the high tech aided device. It may than be possible to assume that the type of AAC device does have an impact on the communication competence perceived that differs between females and males.

The second consideration relates with the voice condition. It could have been possible to assume that by using the speech, the AAC user could be perceived as more competent than when using other AAC modalities because natural speech is the modality of communication that the majority of speakers are more used to during communication exchanges. However, by looking at the means, the voice condition is not the one with the highest mean for both females and males. On the contrary, it was perceived as the least competent modality of communication for females.

A possible explanation may relate with the intelligibility of the speech. As previous research studies demonstrate, attitudes toward individuals who use AAC were influenced by the type of speech synthesizer. The more the speech synthesizer was intelligible, the more it was preferred over speeches lees intelligible (Richter, Ball, Beukelman, Lasker, & Ullman, 2003). Further investigation however may be required to verify this assumption.

7.10 LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The limitations of this study are the size of the sample and the restricted geographical area in which the schools were located. Further investigation, with a larger sample size located in different geographical areas, is than required to generalize this research study's results. Another limitation of the study is the duration of the video realized for this research study, although the length of them was consistent with some of the research studies carried out on attitudes toward individual who use AAC (Beck et al., 2010).

Future investigation should consider to analyze the aspects investigated in this research study separately. In particular, the iPad should be compared with an SGD since so far it has just been assumed as equal to an SGD device but no data so far justify this equivalence (Dada et al., 2016). Moreover, the aspect of the natural speech communication of an AAC user should be further investigated to assess if it is the intelligibility of the communication or other aspects of it, that may influence the communicative competence perception. Finally, it could be interesting to investigate if the use of the natural speech of a young child who use AAC may or may not influence the communicative competence perception of both children and teen-agers. The research studies carried out so far on attitudes toward an individual using AAC used, as AAC user, a peer or an older user compared to the age of the sample. It could be

interesting to verify if attitudes and communicative competence perception toward a younger individual, compared to the age range of the sample, may or may not be different compared with attitudes and communicative competence perception of a peer using AAC.

7.11 CLINICAL IMPLICATIONS

This research study has tow clinical implications. First of all, professionals who work with teenagers using AAC that are included in setting with their typically functioning peers should take into consideration that males tend to have lower attitudes toward individuals who use AAC compared to females. In order to account for it, professionals may provide more monitored opportunities of interaction for males to increase their attitudes. Indeed, research studies showed that familiarity with disability tend to result in more positive attitudes toward individuals using AAC.

Second, professionals should also take into consideration that the type of device used from the individuals who use AAC impact the communication competence perceived in a different way for females and males. Females tend to consider individuals more competent when they use low tech aided AAC devices whereas males tend to consider more competent individuals who use high tech aided AAC devices. Therefore, together with creating opportunities for interaction, professionals may consider to prefer the use of a low tech device when the individuals who use AAC interact with females, and a high tech device when the individuals interact with males.

CHAPTER 8

TEACHERS' ATTITUDES TOWARDS CHILDREN WHO USE AAC IN CLASSROOM IN ITALIAN PRIMARY SCHOOLS

8.1 ABSTRACT

Early Augmentative and Alternative Communication (AAC) interventions in school environments aim to support the development of the communication skills of children with communication disabilities. The goals of this study were to analyze the teachers' attitudes towards children using AAC in primary schools in Italy and their perceptions of the barriers and the benefits of using AAC. Two groups of teachers, those with and without AAC experience, responded to an online survey. The five scales of the Teacher Attitude Scale (TAS) questionnaire and two open ended questions were used to compare the attitudes and the perceptions among the groups of teachers. Results showed that there is a significant difference among the two groups for two of the five scales of the TAS questionnaire. Both groups reported similar barriers and benefits and indicated the use of AAC as being the main barrier. In conclusion, having experience with children who use AAC in class impacts the teachers' perceptions of their own abilities and the teachers' perceptions of the abilities of the children.

8.2 INTRODUCTION

Early in life, communication is a fundamental skill for children to convey wants, needs and basic necessities to their parents, siblings, peers, educators, teachers and the community at large. Improving communication skills allows children to take an active part in social settings and provide them with the tools necessary to engage in meaningful conversations (David R. Beukelman & Mirenda, 2013). Indeed, literature studies recognize the merits of starting AAC interventions with young children (CJ Cress & Marvin, 2003; Culp, 2003). Early interventions can facilitate and maximize the development of speech and language skills (CJ Cress & Marvin, 2003; Janice Light & McNaughton, 2012; Mary Ann Romski & Sevcik, 1993; MaryAnn Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015), minimize the potential for intervention delays and provide support to families and other communication partners (Drager, Light, & McDNaughton, 2010). Early AAC interventions are considered fundamental also to the educational

process (David R. Beukelman & Mirenda, 2013; Cumley & Beukelman, 1992) of these young children. The sooner the school implements AAC the better are the learning and communication opportunities for the child. Indeed, research studies showed that AAC allows children to interact with peers in the classroom context (Dalton & Bedrosian, 1989), exposes them to learning and communication activities (Downing, Ryndak, & Clark, 2000; Erickson, Koppenhaver, Yoder, & Nance, 1997; Pat Mirenda & Beukelman, 1992), increases access to curricular areas (Ralf Schlosser et al., 2000) and promotes literacy skill development (Alant & Emmett, 1995).

Teachers have important responsibilities in facilitating effective and efficient communication for children who use AAC during classroom interactions (Kent-Walsh & Light, 2003). Research studies have demonstrated that both regular and special education teachers are crucial for the success of children who use AAC (Cumley & Beukelman, 1992; Giangreco, 2000; Locke & Mirenda, 1992). In addition to that, teachers share responsibilities in providing children with augmented communication input and opportunities to communicate with AAC (Kathryn Drager et al., 2006; Harris & Reichle, 2004; E. Jones & Bailey-Orr, 2012; Mary Ann Romski & Sevcik, 1996; Sevcik & Romski, 2002).

In order to support AAC in the classroom, teachers working with children who use AAC need to combine the traditional teacher role, that include adapting the curriculum and writing goals and objectives, with the unique role of facilitating access to symbolic representation and adaptive devices (Locke & Mirenda, 1992). Implementing and using AAC in classrooms require teacher to be willing to use innovative instructional approaches and procedures in addition to the traditional one (Mirenda, Iacono, & Williams, 1990; Sigafoos & Iacono, 1993). Soto and colleagues (Soto et al., 2001) investigated the willingness of teachers in using AAC in classroom through focus groups aimed at identifying teachers' beliefs, perceptions and attitudes. The focus groups analyzed what are the benefits and barriers perceived by teachers that contribute to successful social and academic inclusion. Benefits in AAC can be defined as factors that enhance a children participation in their contexts, such as for example academic participation, social interactions between the child who use AAC and peers and natural support from classmates in using AAC. Barriers can be defined as constrains that may affect a children participation such as for example staff turnover, lack of support from administration, rigid understanding of professional roles and staff attitudes (Soto et al., 2001).

Attitudes barriers, such as having reduced expectations toward the child or reduced expectations towards the use and effectiveness of AAC, may lead to limited participation opportunities (Beukelman & Mirenda, 2005) and AAC outcomes (Lund, Light, 2007). Research studies on teachers' attitudes demonstrated that they impact the inclusion of children with special needs in the classroom (Avramidis, 2000) and the implementation of AAC intervention (Patel, 2005). Teachers' attitudes toward AAC resulted to be predictive of their cooperation with students with communication needs and give information about the interactions that will occur between teachers and child who use AAC. In particular, Soto (1997) showed that the variables that strongly influence teachers' attitudes towards the use of AAC in the classroom were teachers' perceptions of their students' abilities to learn to communicate, teachers' perceptions of their own skills and responsibilities and teachers' perceptions of other professionals' responsibilities.

Besides the variables identified by Soto (1997), teachers' training programs are considered a significant variable for AAC implementation and use since they allow to overcome the adverse effect of attitudes barriers (Barker, Akaba, Brady, & Thiemann-Bourque, 2013). Teachers attitudes toward children with special needs and AAC are reported to be more positive and the implementation of AAC improved after following training programs (Patel, 2005).

The need for teachers' training in AAC has been extensively documented in the literature (Balandin & Iacono, 1998; King, 1998; Simpson, Beukelman, & Bird, 1998; Sutherland, Gillon, & Yoder, 2005; Wormnæs & Abdel Malek, 2004). Teachers working with children who use AAC have unique training needs that may not be met in traditional special education training (Soto, 2001; Kent-Walsh, 2003). Teachers require to have education not only on the strategies necessary for enabling students to access the curriculum and participate in class with the other students but also on the technical skills related to the use and maintenance of the AAC system (Kent-Walsh, 2003). However, teachers training in AAC are not very frequent and teachers often reported a lack of training as a limitation for AAC use (Soto, 2001) that also impact their ability to meet the specific AAC needs of AAC students (Kent-Walsh, 2003). Indeed, it is not uncommon to have teachers working with children who use AAC that did not receive any training in AAC (Kent-Walsh & Light, 2003; Kessel & Sickman, 2010). However, a teacher experience working with children using AAC in class may still have an impact on a teacher's attitude. Indeed, teachers that never had experience with children using AAC may have different perceptions due to their lack of knowledge about how to teach to a child who uses AAC, what to expect from that child's communication, interactions or performances, which may impact their attitudes toward a child using AAC.

The Italian School System

The majority of research studies related to AAC in schools are conducted in the United States of America. The investigation on this topic in other countries, such as Italy where the educational system is different, is still minimal. Notwithstanding, the number of children with disabilities in Italy is significant. In 2014, the Italian National Institute of Statistics (ISTAT) estimated that there were approximately 150,000 children with disabilities of which 85,000 (57%) were enrolled in primary schools. Based on ISTAT Statistics (2014) children with disabilities engaged in inside class activities for 24.5 hours per week and they engaged in self-contained activities for 3.8 hours per week. So far, there are no statistics available on children with disabilities who use AAC in schools.

The Italian school system provides children with a disability with a special education teacher for approximately ten hours per week. The main role of special education teachers is to support and help integrate the child in the classroom.

To become a special education teacher, the Italian school system does not require a specific background in special education. Teachers in Italy are selected based on their ranking score in a specific educational subject list (math, history, geography, etc.). The ranking score is based on educational background and experience. Teachers that have higher scores have better chances to be temporary or permanently hired in a school when a position opens. Special education teachers, whose background is in special

education, have their own list. However, every teacher has the possibility, by law (n° 104/92, art. 14, clause 6), to be inserted both in their specific subject list and in the special education list. When there are no special education teachers available, the headmaster of a school can still select one teacher to fulfill the special education teacher position. Therefore, in Italy, it may be likely that a special education teacher does not have any background or training in special education.

In Italy, every school has a special education manager. The special education manager is a special education teacher that is nominated from the headmaster of a school to be the connection between the children with disability, their family, the health services, the other special education teachers and headmaster with a specific focus on their organization, coordination and management.

Considering these differences in the school system and the lack of data about AAC in Italian schools, primary schools' teachers' perceptions and attitudes toward children who use AAC have been investigated. Primary schools have been chosen because in Italy they are the first mandatory level of instruction to which all children must be enrolled at 6 years of age (max 7 for children with disabilities – "Legislation of the 27/12/12"). Choosing a non mandatory level of instruction, such as kindergartens, could have biased the investigation and data collections of AAC in the Italian school system.

The purpose of this study is to investigates teachers' perceptions of using AAC with children with disability in the classroom, in terms of benefits and barriers, and teachers' attitudes toward children who use AAC. This study compares perceptions and attitudes of teachers who experienced having children who used AAC in the classroom with those who have never encountered children using AAC. Literature on teachers' attitudes towards children using AAC investigates teachers that have, or had in the past, experience with children using AAC. However, considering a teacher experience, or lack thereof, may be important for two different reasons. First of all, teachers that never worked with children using AAC may have different perceptions related to, for example, how to teach these children and how the children communication may impact the interactions or performances, compared with teachers that already learned that from their experience. Second, knowing attitudes of teachers that never had experience working with children using AAC may provide information about the nature of their perceptions if, soon or later, a child using AAC will be included in their class and it gives information about how to better help them supporting the implementation of AAC for that child without waiting for them learning it from their experience. In addition to that, the presence of a difference may provide further information related to the factors that impact teachers' attitudes toward AAC that need to be addressed in order to facilitate or improve AAC intervention in the classroom.

8.3 METHOD

Participants

The participants of this study are teachers (n=88) of primary schools (N=18) in the county of Milan, Italy. Participants have been divided in two groups based on their experience with AAC in class: teachers who have, or had in the past, experience with children using AAC in their classes (Group 1) and teachers who have never had any experience working with children who used AAC (Group 2).

Group 1 includes 39 (44.3%) teachers, 9 of which indicated to have had a specific training on AAC together with having had experience in class, whereas 30 indicated to have learn about AAC from their own experiences with children using AAC in class.
Group 2 includes 49 (55.7%) teachers that neither had any experience working with students using AAC nor had any specific training about AAC.
As mentioned in the above session, being a special education teacher in Italy does not entail having had a special education background or training. Therefore, no differences between special and general education teachers have been included in the analysis. Moreover, according to literature studies (Cumley & Beukelman, 1992; Giangreco, 2000; Locke & Mirenda, 1992) both special and general education teachers are important for the success of children who use AAC.

8.4 MEASURES

We designed a questionnaire aimed 1) to collect basic demographic information (gender, age, degree, years of teaching, main subjects taught), 2) to analyze the teachers' perception of the barriers and benefits of using AAC in the classroom by asking two open ended questions and, 3) to determine teachers' attitudes towards children using AAC by adopting the Teacher Attitude Scale (TAS) questionnaire (Dada, 1999).
The two opened questions (1. List two benefits of using AAC in the classroom; 2. List two barriers of using AAC in the classroom) have been used to collect information about teachers' perceptions of the positive and negative issues related to the use of AAC in class. As Kent-Walsh (2003) highlighted, teachers' perceptions of benefits and barriers would be strongly related to specific classrooms and student situations (Lincoln & Guba, 1985) and therefore a qualitative investigation, that provide a deep description of the contextual situation of teachers' individual experiences, was considered the most appropriate (Gubrium & Holstein, 1997; Patton, 1990; Strauss, 1988).
The Teacher Attitude Scale Questionnaire (TAS) was developed by Dada (1999) and based on the framework developed by Soto (1997) to measure teachers' attitudes toward children using AAC in classroom. The TAS questionnaire has been used in previous research studies (Dada, 2006; Soto, 1997) about teachers' attitudes toward children using AAC.
The TAS questionnaire is composed of 35 close-ended 5 point Likert Scale questions, from strongly disagree to strongly agree, with statements that are both positively and negatively worded in order to minimize extreme response bias and acquiescent bias (Dada, 2006).
The TAS questionnaire assesses five scales: 1) teachers' perceptions of their own abilities (7 items), 2) teachers' perceptions of the child (7 items), 3) teachers' perceptions of classroom interaction (7 items), 4) teachers' perceptions of the AAC device (8 items), 5) teachers' perceptions of the communication interactions (6 items). The higher is the mean score of each scale, the more positive are the attitudes toward children who use AAC in the classroom. We translated the TAS questionnaire in Italian with a bilingual scholar proof reading it in order to ensure for a correct translation.
Our questionnaire was distributed online using Google Drive Docs through a WordPress website plug-in (https://caanellescuolebicocca.wordpress.com/). The website included the purpose of the study, a

short explanation of the procedure to follow in order to complete the survey and a recommendation of answering all the items included.

8.5 PROCEDURE

We consulted the governmental web site of the Italian education (http://www.istruzione.gov) to identify all the primary public schools in Milan county, Italy (n = 136). Then, we contacted the special education managers to identify the schools (n = 49) that had at least one child who was using AAC in their classroom. We then reached out to the headmasters and asked if they were interested in having their teachers involved in our project. Among the schools contacted, 18 schools decided to take part to our research study. After a telephone explanation of the procedure to follow for distributing the surveys, the headmaster of the school received an email in which there were included both the purpose of the studies and the procedure to have access to the survey. In order to preserve the privacy of the school's teachers, the headmasters forwarded the email to their staff. The online survey was distributed in the 18 schools that agreed to participate between May 2015 and June 2015.

8.6 RESULTS

A total of 88 (16.3%) teachers completed the questionnaire, with Group 1 including 39 (44.3%) teachers that have, or had in the past, experience with children using AAC in the class and Group 2 including 49 (55.7%) teachers that never had any experience working with children using AAC. The majority of teachers were female (96.6%) with a mean age of 47 (Standard Deviation (SD) = 8.95 years old). The mean of years of teaching was 21 (SD = 11.52) years, ranging from 1 year of experience to 40 years. Teachers with a degree higher than high school were 34 (38.6%). This is not surprising considering that, before 2003, the minimum education requirement needed to become a primary school teacher in Italy was a high school diploma with specialization in teacher training. Our sample included 66 (75%) general teachers and 22 (25%) special education teachers. **Tab. 1** shows the demographic details of our sample.

Table 1. Summary of Sample Demographics

Group	Number of respondents	Gender		Age*	Education Level						Education Type		Years of teaching
		Female	Male		High school diploma	4 years college	3 years college	2 years post college	PhD	Other	Special	General	Mean*
Group 1	39 44.3%	37 95%	2 5%	47.41 (10.39)	23 59%	10 25.6%	1 2.6%	2 5.1%	0 0%	3 7.7%	13 33.3%	26 66%	22.54 (11.929)
Group 2	49 55.7%	48 98%	1 2%	46.29 (7.73)	31 63.3%	12 24.5%	2 4.1%	3 6.1%	0 0%	1 2.0%	9 18.4%	40 81.6%	18.92 (11.038)
Sample	88 100%	85 96.6%	3 3.4%	46.78 (8.95)	54 61.4%	22 25%	3 3.4%	5 5.7%	0 0%	4 4.5%	22 25%	66 75%	20.52 (11.517)

* Standard deviation is reported in parenthesis

The Mann-Whitney U test was used to test the statistical differences between the two independent groups with ordinal data (Corston and Colman 2000). **Tab. 2** shows the mean results of the TAS questionnaire scales. There is a significant difference ($p < .05$) between Group 1 and Group 2 in the first and second scale of the TAS questionnaire.

Regarding Scale 1 "Teachers' perception on their own abilities", Group 1 (mean = 2.993; SD = 0.858) reported a higher score compared to Group 2 (mean = 2.388; SD = 0.747) indicating that teachers who had experience working with children using AAC in class have higher perceptions of their own abilities. However, the mean of Group 1 is considerably low, indicating that teachers do not have, overall, positive attitudes toward their own abilities.

Table 2. Summary statistics and Mann-Whitney test for equality of means for the TAS questionnaire Scales

Scales	Groups	N	Minimum	Maximum	Mean	Standard Deviation	Mann-Whitney p-value
Teachers' perceptions on their own abilities	Group 1	39	1.00	5.00	2.993	0.858	0.0007**
	Group 2	49	1.00	4.57	2.388	0.747	
	Sample	88	1.00	5.00	2.656	0.849	
Teachers' expectations of the child	Group 1	39	1.14	4.14	2.945	0.810	0.0134*
	Group 2	49	2.29	4.57	3.303	0.512	
	Sample	88	1.14	4.57	3.145	0.681	
Teachers' perceptions on classroom interactions	Group 1	39	1.00	5.00	3.447	0.971	0.1436
	Group 2	49	1.57	5.00	3.729	0.815	
	Sample	88	1.00	5.00	3.604	0.893	
Teachers' perceptions of the device	Group 1	39	2.25	4.88	3.599	0.645	0.3632
	Group 2	49	2.75	4.88	3.714	0.528	
	Sample	88	2.25	4.88	3.663	0.582	
Teachers' perceptions on communication interactions	Group 1	39	1.67	5.00	3.603	0.847	0.0858
	Group 2	49	2.83	5.00	3.867	0.574	
	Sample	88	1.67	5.00	3.750	0.716	

$^{**}p < 0.01$, $^{*}p < 0.05$

Regarding Scale 2 "Teachers' expectations of the child", Group 1 (mean = 2.945; SD = 0.810) reported a lower score than Group 2 (mean = 3.303; SD = 0.512) indicating that teachers with experience working with children using AAC in class have lower expectations of the child.

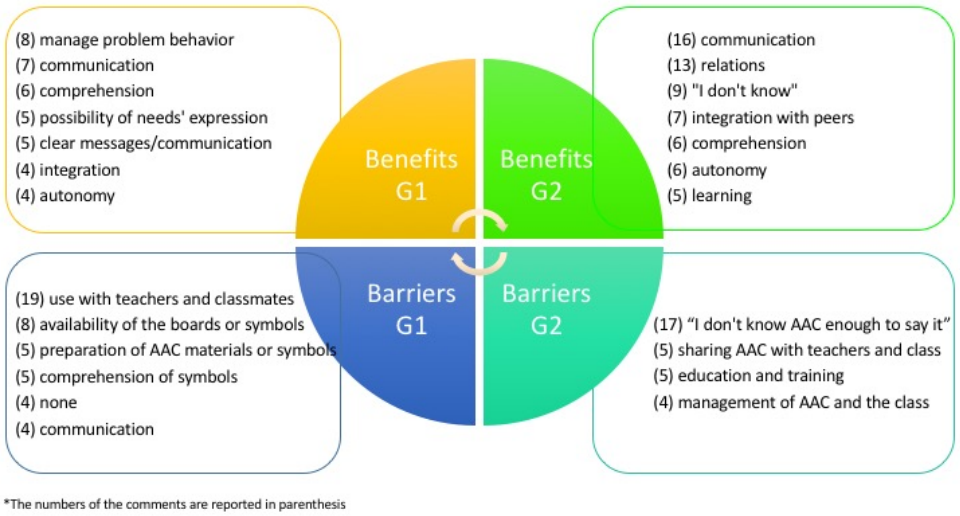
Teachers in both groups had also to answer to two open-ended questions related to their perception of benefits and barriers about having a child who uses AAC in class.

Each teacher had the opportunity to provide, in free text form, up to two benefits and two barriers of using AAC in the classroom. Although teachers could list two benefits and barriers, many of them provided only one answer for the benefits and one answer for the barriers.

The answers related to benefits and barriers have been summed into categories based on the content of the answer. For example, answers such as "AAC allows the child to communicate", "AAC permits

greater communication" and "AAC gives the child a voice" were summed in a category named "Communication". Categories with 4 or more similar answers are reported in **Fig. 1**.
Regarding the benefits, Group 1 most frequent benefit listed is the use of AAC to manage problem behaviors (8 comments) whereas Group 2 identify communication (16 comments) as the highest benefit. Both groups consider AAC important for the child's comprehension, integration and autonomy. It is interesting to notice that in Group 2, 9 comments where about the impossibility of listing benefits due to a lack of knowledge of AAC.

Fig. 1 Teachers' perceptions of benefits and barriers



Regarding the barriers, Group 1 most frequent barrier listed is the use of AAC in the class context (19 comments) whereas the majority of the comments provided from Group 2 (17) relates with the impossibility to list any barrier due to the lack of knowledge about AAC.

8.7 DISCUSSION

The aims of the study were to 1) analyze teachers' attitudes toward children using AAC and 2) to investigate the teachers' perceptions of the barriers and benefits of children using AAC. The perceptions of teachers with experience in working with a child who use AAC in class (Group 1) were compare with the perceptions of teachers with no experience (Group 2).
Regarding the first research question, result show that there is a statistically significant difference between teachers who have, or had in the past, experience with AAC and teachers who never have any experience in working with children using AAC in the teachers' perceptions of their own abilities TAS scale and in the teachers' expectations of the child TAS scale. These results are consistent with Soto (1997) research study which stated that teachers' perception of their own abilities and teachers'

perceptions of their students' abilities to learn to communicate, impact the attitudes toward children who use AAC.

As in Soto (1997) study, teachers of Group 1 have higher perceptions of their own abilities to teach children using AAC compared to teachers of Group 2. A possible explanation of this result may rely on the fact that teachers of Group 1 did actually have the possibility to use their abilities to teach to these children and therefore their experience may have affected their perceptions of their own skills. Teachers of Group 2, on the contrary, never had the possibility to apply their teaching abilities with children who use AAC and therefore their lack of experience may have affected their perceptions.

However, different from Soto (1997) research study result, in which teachers' higher perceptions of their own abilities positively impacted the expectation of children performances, teachers of Group 1 have lower expectations of the child compared to teachers of Group 2. This result may indicate that although teachers from Group 1 perceive to have the abilities to teach children who use AAC, their abilities do not seem affect their expectations toward the child performances. This assumption may also suggest that the expectations of the child may rely on different aspects other than the teachers' abilities to teach.

Overall, the presence of a statistically significant differences between Group 1 and Group 2 may indicate that experience alone may be enough to impact teachers' attitude toward a child who use AAC in class.

Regarding the second research question, Group 1 and Group 2 differ in their perspective about the benefits and barriers of using AAC in the classroom. Group 1 considers AAC a benefits especially as a support in the relationship between teacher and child not only for communication purposes but also for behaviors management. This result should be further analyzed since it may provide important information about the role of communication in helping children with problem behaviors to better adjust in the class context.

Teachers of Group 1, consider the possibility of sharing the use of AAC in the classroom context, that is with other teachers and classmates, as a significant barrier together with the availability of AAC materials. On the other hand, Group 2 considers AAC a benefit especially as a support of the child's communication and of the child's development of relationship in the class context. Consistent with literature studies (Soto, 2001), teachers of Group 2 reported the lack of knowledge as the most significant barrier.

8.8 LIMITATION OF THE STUDY

The study presents several limitations. The first limitation is the sample size. A larger sample may allow to identify other differences between teachers with and without experience in working with children who use AAC that could not be detected in this research study. Another limitation is the use of self report questionnaire to measure explicit attitudes. Explicit attitudes, which are consciously accessible and controllable (Prestwich, Kenworthy, Wilson, & Kwan-tat, 2008), could be biased for social desirability, which occur when individuals give what they believe to be the most socially appropriate answers (Antonak & Livneh, 2000). Moreover, the research study took place in a restricted geographical

area (Milan), and therefore, it is not possible to assume that teachers from other areas would have given the same answers.

8.9 CONCLUSION

The purpose of this study was to investigate Italian primary school teachers' attitudes and perceptions toward children using AAC in classrooms. The results of this study provide important information, although partial, about the use of AAC in the Italian school system and it provides preliminary data about the impact of teachers' experience working with children using AAC in primary schools.

First of all, this research study allowed to gather preliminary data about the actual use of AAC in Italian primary schools. No previous research studies have investigated the use of AAC in the Italian school system. Moreover, there were neither data about teachers' experience, or lack thereof, of working with children who use AAC nor research data related to primary school teachers' attitudes toward children who use AAC in class.

This research study allowed to start gathering preliminary information about the teachers' experience and training in AAC. Indeed, more than a half of the sample (Group 2 - 49 teachers) indicated to never had experience working with children using AAC in class and 9 teachers out of 88 teachers of our sample indicated to have had a specific training in AAC This data is consistent with literature studies in which the lack of training is reported as a significant limitation (Soto, 2001). Knowing the importance of AAC training for teachers working with children who use AAC, principles of Italian schools should be informed and encouraged to consider training in AAC as an important variable for AAC implementation when a child who uses AAC is included in the school.

Second, the impact of teachers' attitudes toward children using AAC has been widely highlighted in literature studies (Beukelman & Mirenda, 2005; Lund, Light, 2007; Soto, 1997, 2001), therefore investigating teachers' attitudes in Italian primary schools could provide important information. Related to attitudes, this research study results provided two source of data that future research study should further investigate. First of all, experience may be a variable that, along with the other listed in literature studies (Soto, 1997), seems to impact teachers' attitudes toward children using AAC. Second, different from previous research studies, Italian teachers' working with students who use AAC have lower expectation toward them compared with teacher with no such experience. This result should be further investigated in future research studies.

CONCLUSION

The purpose of this PhD was to investigate the role of communication partners in AAC intervention as providers of communication opportunities. In particular, we focused on two aspects that affect their role in AAC interventions: 1) language learning opportunities and 2) interaction opportunities.

Related to the **language learning opportunities** we focused on the communication partners' use of the AAC devices for modeling and vocabulary expansion. According to literature studies (Baxter et al., 2012a; Caron et al., 2015) communication partners perceive the use of the AAC device as a barrier. On that matter we focused on the challenges related to **the design of AAC devices** and the operation demands they pose for programming and implementing vocabulary. In order to investigate these aspects we developed and tested an innovative AAC app (Speech to Symbol – StS) based on the speech to symbols feature for programming and vocabulary expansion purposes. The app design followed the inputs coming from relevant stakeholder such as AAC professionals. We used a focus group to gather professionals' feedback about the app features and functioning. Professionals agreed in considering the design of the new app useful to meet their needs for vocabulary expansion. Based on their feedbacks a beta version of the app was developed and tested from two AAC professionals during an AAC session. The results of this tests allowed to improved the design and functioning of the StS app. Specifically, we modified the way the symbols could be placed or visualized on the display and the visualization and selection of the symbols retrieved from the internet.

In order to **test** the real efficacy of the app in AAC intervention, we create a prototype of the app. We used a single case design to compare the programming procedure of the StS app with a traditionally designed AAC app. This investigation provided several interesting outcomes.

First of all, StS app was proved to allow a higher number of symbols programmed in the app thanks to its reduced operational demands. Moreover, professionals showed a higher satisfaction when using StS app then when using the traditionally based app. Significant was also the satisfaction outcomes coming from children' parents. Second, we also measured the professionals' level of anxiety and the professionals and children's behavior during the programming procedure. Professionals' level of anxiety resulted to be lower when using the traditionally designed app than when using the StS app. A possible explanation may rely on the novelty of the app features, compared to features they are more familiar with. In addition to that, children' level of engagement was lower with StS app than with the traditionally design app. Relating to professionals and children's behaviors, two considerations may be drawn. First the time taken to program the app differs and this difference may be related in the time children had to wait for the professionals to be done with the programming procedure. Indeed, children where also more disengaged and professionals tried to attract the children attention more often. Second, professionals neither anticipate to children nor engage them in programming procedure.

The outcomes of this research study suggest some direction for future research. First, the StS – JIT based app should be used by a larger sample size, possibly with another traditionally designed AAC app to allow for a generalization of the outcomes of this research study.

Second, considering that an AAC app with reduced operational demands exposes to a larger size of vocabulary and considering that a larger exposure to vocabulary is associated with vocabulary expansions and language learning, future research studies may focus on verifying if the vocabulary to which children are exposed to with an app such as the StS – JIT based app is actually learned and used functionally in their communication. The StS – JIT based app was proved to allow professionals to meet their need of programming new vocabulary.

Third, considering that for the parents of this research study the consumer satisfaction changed over time and seemed to be related with the app functioning, future research studies may focus on investigating how the satisfaction of parents and professionals' changes over time and what is the cause of the change: does it rely on the operational demands of the device, does it rely on its functioning or is it a combination of the two?

Fourth, considering the unexpected low level of anxiety when professionals used App 1, future studies may focus on verifying if the level of anxiety may be influenced by the traditional versus innovative features of an AAC device. Related to the use of technology, it may also be interesting to investigate the self efficacy or level of confidence that professionals have toward traditional, low tech AACC devices, versus less traditional high tech AAC devices.

Fifth, in this study, the children disengagement behaviors seemed to be related with the time they had to wait for the professionals to program the AAC app. However, with only a few exceptions, none of the professionals told the child that they were about to program a symbol on the device, neither they tried to engage the child in the programming procedure. Future studies should investigate if the disengagement behaviors of children decrease if professionals explain them they have to program the device, engage them in the programming procedure or they combine these two strategies.

Relating to **the interaction opportunities**, we focused on the attitudes that both teenagers and teachers may have toward individuals who use AAC.

The first research study on attitudes related with teenagers' attitudes toward a peer who uses different AAC devices and it also focused on the communication competence perceived. We chose to investigate teenagers' because literature studies mainly focused on either children or adults, whereas only a few studies investigated teenagers. Moreover, the use of the iPad in AAC does still need further investigation as only a few research studies included it in the comparison with other AAC devices. Finally, we decided to include an unaided condition, such as the speech, to investigate how a natural modality of communication is considered when compared to both low and high techs aided modality of communication. Results of this study are consistent with literature studies in which females tend to have higher attitudes toward individuals who use AAC. Moreover, the use of a high tech device such as the iPad or the use of a low tech device such as the communication board does not seem to influence attitudes as a result of this study. Therefore, it is possible to assume that aspects, other than the modality through which the communication is conveyed, may influence attitudes or perceptions toward

individuals who use AAC. Indeed, a statistically significant difference have been found in the communication competence. On that matter, it is possible to draw two considerations. The first one relates with the difference in the type of AAC device that females and males perceived the peer to be more competent with. Considering females, they perceived the peer as more competent when using the low tech aided device. Considering the males, they perceived the peer as more competent when using the high tech aided device. It may than be possible to assume that the type of AAC device does have an impact on the communication competence perceived that differs between females and males. The second consideration relates with the voice condition. The voice condition is not the one with the highest mean for both females and males. On the contrary, it was perceived as the least competent modality of communication for females, although it could have been possible to assume that by using the speech, the AAC user could be perceived as more competent than when using other AAC modalities because natural speech is the modality of communication that the majority of speakers are more used to during communication exchanges.

Future investigation should consider to analyze the aspects investigated in this research study separately. In particular, the iPad should be compared with an SGD since so far it has just been assumed as equal to an SGD device but no data so far justify this equivalence (Dada et al., 2016). Moreover, the aspect of the natural speech communication of an AAC user should be further investigated to assess if it is the intelligibility of the communication or other aspects of it, that may influence the communicative competence perception. Finally, it could be interesting to investigate if the use of the natural speech of a young child who use AAC may or may not influence the communicative competence perception of both children and teen-agers. The research studies carried out so far on attitudes toward an individual using AAC used, as AAC user, a peer or an older user compared to the age of the sample. It could be interesting to verify if attitudes and communicative competence perception toward a younger individual, compared to the age range of the sample, may or may not be different compared with attitudes and communicative competence perception of a peer using AAC.

The second research study on attitudes related with teachers' attitudes toward a child who uses AAC in class. We focused on elementary school teachers as literature studies recognize the merits of starting AAC interventions with young children (CJ Cress & Marvin, 2003; Culp, 2003). Early interventions can facilitate and maximize the development of speech and language skills (CJ Cress & Marvin, 2003; Janice Light & McNaughton, 2012; Mary Ann Romski & Sevcik, 1993; MaryAnn Romski et al., 2015), minimize the potential for intervention delays and provide support to families and other communication partners (Drager, Light, & McDNaughton, 2010). We decided to investigate how experience with children using AAC may impact teachers' attitudes towards them. Literature studies considered variables different form experience as all the teachers they have investigated had experience with children using AAC. However, a teacher experience working with children using AAC in class may still have an impact on a teacher's attitude. First of all, teachers that never worked with children using AAC may have different perceptions related to, for example, how to teach these children and how the children communication may impact the interactions or performances, compared with teachers that already learned that from their experience. Second, knowing attitudes of teachers that never had experience working with

children using AAC may provide information about the nature of their perceptions if, soon or later, a child using AAC will be included in their class and it gives information about how to better help them supporting the implementation of AAC for that child without waiting for them learning it from their experience. Results of this study provide preliminary data about the impact of teachers' experience working with children using AAC in primary schools. First of all, this research study allowed to gather preliminary data about the actual use of AAC in Italian primary schools. No previous research studies have investigated the use of AAC in the Italian school system. Moreover, there were neither data about teachers' experience, or lack thereof, of working with children who use AAC nor research data related to primary school teachers' attitudes toward children who use AAC in class. Second, related to teachers' attitudes, this research study provided two source of data that future research study should further investigate. First of all, experience may be a variable that, along with the other listed in literature studies (Soto, 1997), seems to impact teachers' attitudes toward children using AAC. Second, different from previous research studies, Italian teachers' working with students who use AAC have lower expectation toward them compared with teacher with no such experience.

Related to attitudes, this research study results provided two source of data that future research study should further investigate. First of all, experience may be a variable that, along with the other listed in literature studies (Soto, 1997), seems to impact teachers' attitudes toward children using AAC. Second, different from previous research studies, Italian teachers' working with students who use AAC have lower expectation toward them compared with teacher with no such experience. This result should be further investigated in future research studies.

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