

# **The iPad & Autism:**

**An Investigation into the Grace Application and how iOS Devices may Offer Effective Alternatives to Traditional Intervention Methods in Aiding Communication and Learning in Children with Autistic Spectrum Disorders.**

Cathal Gearty

A research paper submitted to the University of Dublin, in partial fulfilment of the requirements for the degree of Master of Science Interactive Digital Media

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## Declaration

I declare that the work described in this research paper is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university.

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## **ABSTRACT**

This research paper analyses the potential benefits of utilising iOS technologies as an aid for communication and learning in children with autistic spectrum disorders. The emergence of touch controlled consumer electronics such as the iPad in recent years has allowed for new and exciting opportunities in creating innovative ways to tackle some of the impairments faced by children with autism. This paper examines these opportunities from a theoretical perspective and investigates some of the key concepts and issues surrounding the use of interactive technology as an aid for children affected by these disorders. The aims of this are to highlight some core insights into the design process of applications targeted at an end user base consisting of children with autism, and determine the effectiveness of iOS technology as a potential alternative to some traditional intervention methods such as the Picture Exchange Communication System (PECS).

To carry out this research, the iOS application “Grace” designed for aiding communication in children with autism has been selected for analysis. Grace has been scrutinized in terms of interface design, and a detailed comparison with its traditional equivalent method, the Picture Exchange Communication System has been conducted. Through the application of theory extracted from the literature review in the areas of autism and interactive design, several findings have been made.

The findings of this study conclude that from a theoretical point of view, iOS technologies are a promising alternative to more traditional methods in aiding with communication and learning. In many ways, the use of an iPad is a more appropriate solution to aiding communication and learning in children with autism, particularly in terms of practicality and individuality. However, acknowledgment is made that further study is required in order to shape a firm empirical basis for these findings.

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# **1. INTRODUCTION**

## ***1.1 BACKGROUND***

The emergence of the iPad and the Apple mobile operating system, iOS, have presented exciting opportunities for innovative new ways to target some of the impairments associated with autism. As of January 2013, there are over 800,000 applications available for download on iOS devices, with over 300,000 of these designed specifically for the iPad (Apple.com, 2013b). In tandem with this statistic, the number of children diagnosed with an autistic spectrum disorder has risen considerably. The United States Centre for Disease Control<sup>1</sup> in a report released in March 2012, estimates that the number of children now diagnosed with autistic spectrum disorders has increased to an average of one in every eighty eight children. This is up significantly from 2006 when the incidence of an autistic spectrum disorder diagnosis was closer to one in every one hundred and ten (Biao, 2012). While it is acknowledged that this surge may be as a result of a greater awareness and broader definitions of what constitutes an autistic spectrum disorder (ibid), this fact only highlights the awareness of the disorder in society today. This increased awareness is underpinned by new, exciting and innovative ways of using interactive technology to help those affected by autism. This paper investigates the feasibility of utilising one of these innovative tools, the iPad, as an effective instrument for aiding communication in children with autistic spectrum disorders.

## ***1.2 METHODOLOGY***

One specific iOS application, “Grace”, based on a traditional intervention method for aiding communication for children with autism, the Picture Exchange Communication System (PECS), has been selected for analysis. Investigating this one application in detail facilitates an exploration of the potential relationship between the iPad and autism, and how this revolutionary piece of technology may possibly be used as a tool for aiding communication for children with this particular developmental disorder.

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<sup>1</sup> Although referred to by the Centre for Disease Control, it must be stated that autism is not in fact a disease but a developmental disorder.



In many cases, the first step in developing a solution is identifying a problem. However in this case, the issue is not to create a solution, but rather to examine a question and identify and critically analyse the key issues surrounding it. In order to do this, chapter two will review the literature used to frame the question; *can the use of interactive technologies such as Grace on an iPad, be a beneficial tool in aiding children with autistic spectrum disorders to communicate and learn?* The relevant literature is identified in three key areas pertinent to this study. In the first of these areas, autism as a developmental disorder and its associated impairments will be examined. Secondly, the picture exchange communication system which is the traditional system on which the Grace application is based will be looked at. Finally some theoretical approaches to interactive design will be explored. These will have specific considerations for an end user base of children with autistic spectrum disorders.

Chapter three assesses some of the key issues surrounding the use of iOS devices as potential communicative and learning tools. It looks in closer detail at the iPad and in particular the Grace application itself and in so doing attempts to identify potential advantages and disadvantages of using the Grace application as a learning tool for non-verbal children.

In order to carry out this research the Grace application has been downloaded and installed on a third generation iPad running iOS version 6.1. Grace was selected for several reasons. Firstly, it is held in high regard in technological circles having been awarded a prestigious e-learning prize by World Summit Award Mobile, and also an Irish Web Award soon after the applications initial release in 2010 (siliconrepublic.com, 2010). Another reason for this application's selection for analysis is the fact that it is directly based on the traditional picture exchange communication system. This allows for comparisons to be made in chapter four between both in order to determine the advantages and disadvantages of each.

The key features of the Grace application have been tested by the author, and through comparisons to some of the theories and concepts referred to in the literature review, implications for the use of Grace over PECS have been suggested. The final chapter discusses some of the limitations of this study and potential future work.

### ***1.3 RESEARCH ETHICS***

One of the primary concerns for any researcher is the area of ethics. The importance of carrying out research in an acceptable manner that takes all ethical considerations into account cannot be understated and any research involving human participants requires rigid adherence to good ethical practice (Trinity College Dublin, 2013). While this research paper does not involve direct human participation, it is important to note that the population sub-groups to whom this research indirectly refer, fall into an ethically controversial area.

The University of Lancaster (2012) defines vulnerable groups in society as:

*“those individuals or groups who, due to age, ill-health, infirmity, minority status or their otherwise disempowered position in society may be open to exploitation whether physical, emotional or psychological”* (University of Lancaster, 2012).

Children of all ability levels and in particular those with special needs are one of the most vulnerable groups in society. The Department of Children and Youth Affairs (2012) identifies children as a vulnerable group in society due to their:

*“...legal status, their knowledge and experience of the world, their differing levels of cognition and their relative lack of independence and autonomy, all of which require particular attention in order to ensure appropriate and ethical research practice.”*  
(Department of Children and Youth Affairs, 2012:1)

As this study refers to children with special needs, very careful consideration must be made to ensure that none of the core ethical principles of research involving vulnerable groups of people are breached.

In following these considerations all case studies and literature referred to in this paper are available in the public domain. In particular where studies may potentially contain personally identifiable information, attention has been given to ensure that each of these have in their own rights followed good ethical practice procedures.

## **2. LITERATURE REVIEW**

### ***2.1 INTRODUCTION***

When Grady was eighteen months old he was diagnosed with autism. Having never spoken a word and fearing that her son would never be able to develop speech or communicate his needs and feelings, Grady's mother began to explore new possibilities for aiding her son's ability to communicate and learn. She had heard about other previously non-verbal autistic children who had learned to develop speech with the help of applications developed for the iPad, which was what at the time a relatively new and unique piece of hardware. Through online fundraising, Grady's mother raised the money needed to purchase the device and the results were astonishing (Hilyard, 2011). In a very short space of time, Grady went from having no speech whatsoever, to being able to use ten words. As well as this, his general communicative skills and emotional capacity appeared to increase significantly (ibid). This report, despite being anecdotal still raises a very relevant research question; can technology, such as the iPad be used to aid communication and learning for children with autism more effectively than would be possible with traditional methods?

The aim of this section of the paper is to identify and analyse key texts and concepts relating to the subject matter in order to frame the research undertaken in the latter stages of the paper. Due to the interdisciplinary nature of the paper, this section is divided into three subsections. The first section aims to give a brief overview of the nature of autistic spectrum disorders and the impairments associated with it. Section two analyses one specific traditional intervention method; the Picture Exchange Communication System (PECS) and explores some of the evidence based literature in determining its effectiveness. Finally section three examines some core theory regarding interactive design, specifically in terms of designing and developing technologies for children with autism. By critically analysing the literature in these three sections, the question regarding the potential for the iPad as an effective intervention tool is framed and ready to be explored in the latter stages of the paper.

## **2.2 AUTISM**

### **2.2.1 INTRODUCTION**

This chapter aims to give an overview of autism as a developmental disorder. This will be done by giving a brief overview of the history of autistic spectrum disorders in order to contextualize the key issues and inherent disabilities associated with autism. These will then be examined in more detail. While the core focus of the research paper is related to children whose level of autism confines them to very little, if any, verbal skills, it is essential to establish a firm understanding of autistic spectrum disorders in a wider context.

### **2.2.2 WHAT IS AUTISM?**

The term autism was first coined by Leo Kanner. Kanner, who was the founder of the first Academic Child Psychiatry Department at John Hopkins University in the USA, observed eleven children exhibiting the same set of abnormal behaviours in the early nineteen forties (Jordan, 1999). While Kanner did not formally set out a diagnosis for autism, he identified the disorder as having some key defining features:

1. The inability to develop relationships with people before the age of thirty months.
2. Significant difficulty developing language skills which, by comparison, were normal for non-autistic children of the same age group.
3. Obsessional behaviour.

Kanner also noted that children who exhibited the aforementioned deficiencies also had the “potential for normal intelligence” (Williams & Reinbold, 1999: 69).

At the same time, Hans Asperger, an Austrian paediatrician also identified four children as having similar impairments. While the work of Asperger only became widely acknowledged posthumously in the 1980’s, both Asperger and Kanner are regarded as the fathers of autism (Jordan, 1999).

While these defining criteria have remained constant over time, it has become evident in the years since Kanner first defined the disorder that the symptoms occur in varying degrees of intensity. Consequently, people with autism are often referred to as being ‘on a spectrum’

(Kluth, 2003). While some view ‘Asperger’s syndrome’ as a similar but entirely separate condition to autism, the predominant acceptance is that Asperger’s Syndrome falls within the autistic spectrum (Jordan, 1999). This paper acknowledges the debate surrounding the issue, but for the purposes of this research, identifies the term ‘autistic spectrum disorders’ (ASD) as being interchangeable with the term ‘autism’.

### 2.2.3 TRIAD OF IMPAIRMENTS

The current understanding of autistic spectrum disorders centres on the *triad of impairments* which was first developed by Lorna Wing and Judith Gould in 1979. Gould and Wing conducted an epidemiological survey of children living in the Camberwell area in London, England who had been screened for severe learning difficulties (Jordan, 1999). This resulted in a sample size of 132 children whom were subject to medical and psychological tests. From these 132 children the group was divided in two based on their social skills. The group who were deemed to be “socially impaired” (ibid: 37) were also found to have other common characteristics that were present in a much smaller number in the group of socially capable children.

This led to the development of a triad of impairments which became synonymous with the diagnosis of an autistic spectrum disorder. This triad consists of impaired *social interaction*, impaired *social communication* and impaired *social imagination and thought* (Wing et al, 2011). It is important to note that these impairments are universal throughout the entire ability range on the spectrum. As a result, this triad has formed the basis of the Diagnostic and Statistical Manual of Mental Disorders (DSM) from which all diagnoses of autism are now made (Government of Ireland, 2001).

#### *Social Interaction*

Howlin (1998) discusses four general categories of impaired social interaction in children on the autistic spectrum. The first and most common are perceived as aloof. They have difficulty maintaining eye contact, dislike physical contact and are indifferent towards others. In contrast, but also firmly on the autistic spectrum are those who fall into what is known as the passive category (ibid). These children exhibit more social interaction than the aloof group by maintaining eye contact when reminded and will allow social interaction with others as passive partners in a game (ibid).

The active but odd group are more intellectually able than the previous groups. This category often initiate social contact, however this will often be perceived as inappropriate by others and can lead to difficulties for this group (Government of Ireland, 2001).

The final category in terms of social impairment is the overformal stilted group whose social impairments may not be noticeable until adolescence or early adulthood through excessively polite and rigid behaviours (Howlin, 1998). Regardless of the category a child falls under, there are certain core characteristics shared amongst all children on the spectrum including impaired empathy, lack of reciprocity and absence of joint attention (ibid).

### *Social Communication*

One of the defining features of autism is deficient linguistic and communication ability. Verbal issues such as unusual use of vocabulary and accents may cause difficulties in comprehension (Government of Ireland, 2001). Similarly, non-verbal communication issues can be detrimental to social interaction. These include an inability to interpret social cues, facial expressions and body language (ibid). Even those who would be considered high functioning individuals and who have a strong grasp of verbal language can struggle greatly with correct social use of language (Jordan & Powell, 1995).

Speech cadences in children with ASD are often missing causing a monotonous or mechanical sounding voice. Autistic children may develop an accent that differs from that of their family and peers, while many children with ASD have extremely limited or do not develop speech at all (Attwood, 1998). One typical characteristic of an autistic child is the use of echolia; the repetition of what is said to them. Jordan and Powell (1995) suggest that able speech may actually only highlight the fundamental difficulties of communication that children with ASD really have. For example, despite potentially having a greater vocabulary than many non-autistic children, it is the manner in which they speak and the things they say that sets them apart from typically developed children (Kluth, 2003).

### *Social Imagination & Thought*

Children with ASD are frequently characterised as lacking the ability to think flexibly. They resist change and display a narrow range of interests (Baron-Cohen, 1991). Routines and rituals are important, and disruption can cause upset (Howlin, 1998). This impairment also impacts on the child's ability to play. Jordan & Powell (1995) suggest that the lack of

empathy and ability to engage in role play situations can have a very significant impact on how children with autism develop their entire set of social and linguistic skills.

#### *2.2.4 CONCLUSIONS ON AUTISM*

The recurring message from much of the literature regarding ASD is that no two children are the same. The inference we can make from this is that it can be extremely difficult to devise a learning program to suit all children across the autistic spectrum. The triad of impairments establishes some core shared characteristics of all children with ASD, though an understanding that the intensity of these can vary greatly between children is essential. Many intervention methods for aiding communication and learning for children with autism have been tried and tested over the years. Because of the abundance of the research on autism and given the limited scope of this paper, one of these methodologies, namely the Picture Exchange Communication System (PECS) will be examined in detail. This particular intervention method focuses on aiding those on the more extreme end of the autistic spectrum who exhibit limited or no verbal communication skills.

### ***2.3 PICTURE EXCHANGE COMMUNICATION SYSTEM (PECS)***

#### *2.3.1 PECS IN CONTEXT*

Bondy and Frost (2002) provide an anecdote to frame the relevance and benefits of PECS. They speak of a three year old girl named Anne who had been diagnosed with autism. Anne lacked speech and was without any kind of formal communication system whatsoever. However it was evident by her behaviour that she enjoyed snacks and juice as she would often take these items if they were left on a table near her. If she went to take a snack but an adult picked it up before her, she would attempt to pry it from their hands. If she could not get it, she would cry. Similarly, Anne enjoyed watching cartoons, and if her favourite video was switched off she would fall on the floor and could become quite violent and self-harming by banging her head. Unfortunately it was not always evident what Anne's desires were. The frequency and intensity of her tantrums increased. Attempting to teach Anne to imitate actions or repeat simple words were futile. Eventually, other measures had to be explored.

Anne was taught PECS, a method described as a “specific manualized intervention protocol” (Flippen et al, 2010: 179) whereby children with severe communication difficulties, most notably autism, are taught to interact with others through the use of picture cards and a Velcro “communication board” (Charlop-Christy et al, 2002: 214).

Children learning PECS are taught to first associate pictures with desirable objects and then gradually learn to spontaneously communicate by presenting the picture cards to others in order to obtain the objects they desire. Eventually, they develop the ability to construct full sentences by combining cards with desired images on them and sentence constructor picture cards which display phrases such as “I want” or “I see” (Cosman, 2008).

Bondy and Frost (2002) describe how Anne, when introduced to PECS became a lot calmer, and rather than throw a tantrum would simply pick up a picture card and hand it to one of her parents to indicate what she desired. While Anne had not developed the ability to imitate speech, she had established an important step in learning functional communication, and this is described by Bondy and Frost as the essence of the picture exchange system. The following sections will discuss why PECS may be chosen over another intervention method for children with autism before examining some potential criticisms of the system.

### 2.3.2 *WHY PECS?*

In theory at least, PECS should aid improvement in all areas of Wing and Gould’s triad of impairments. In terms of social interaction, PECS forces the child to interact with others through the use of the picture cards. Bondy & Frost (2001) explain that children will quickly learn that the pictures do not automatically appear in front of them when they need them, and so spontaneous social communication is required in order to get what they desire.

Social communication is also improved as the child not only learns to interact with people, but also how to communicate in a variety of ways. The literature referenced in this paper predominantly suggests a correlation between PECS and the development of verbal speech. Yoder & Stone (2006) imply that the reasoning for this is that the listener often operates a cloze procedure through prompts to the child such as “I want \_\_\_\_”. This requires the child to produce the key word in the request. As well as this, linguistic mapping is used consistently after each picture exchange. For example, if the child presents the picture of a ball after the “I



want” prompt, the listener relays this verbally by stating “a ball” and gives the item to the child.

Polles (2010) suggests the possibility that the child’s progression in terms of speech development may be coincidental, making the point that it is feasible to consider that the children studied may have acquired speech at that point in development even without the intervention of PECS. This view however is not widely accepted. The reason for this is the wide age range in children in case studies who have been shown to have made progress using PECS. (Flippen et al, 2010 & Charlop-Christy et al, 2002).

Finally, it can be inferred from the evidence presented above that the use of PECS can have a positive effect on impaired social imagination and thought. As communication is increased and a child has access to a greater number of objects, there is a probability that their play and imaginative capacity will improve as a result of the increased use of objects whose primary functions are to stimulate imagination and creativity.

There are many arguments advocating the use of PECS as a viable communication and learning intervention for children with ASD. Firstly, PECS systems are relatively inexpensive. A velcro communication book can be purchased for somewhere in the range of €15 to €30, while sets of official picture cards cost approximately €30 (researchautism.net, 2012). By comparison, some Augmentative Communication Devices (AAC’s), such as computerized devices designed to synthesize speech, have been proven in some cases to yield similar or even less successful results than PECS. These can cost in the region of \$5000 (De Leo et al, 2011).

Other advantages of PECS include the portability of the system, the requirement of limited motor skills to operate it, and the fact that the ‘listener’ does not require knowledge of any additional skills such as sign language (Charlop-Christy et al, 2002).

### *2.3.3 CRITICISM OF PECS*

While PECS has its many advantages over other forms of interventions, it also has its drawbacks. Flippen et al (2010) highlight the potentially limited range of communication functions in the approach taken by PECS. Bondy and Frost (2001) claim that one of the primary aims of PECS is to increase the frequency of spontaneous communication in children

with autism. This entails not only promoting communication in the form of requests such as “I want”, but also as more conversational comments, such as “I see”.

While these cards form an integral part of the picture exchange communication system, the “comments” taught by PECS, according to Flippen et al (2010), are not representative of what a true self-initiated comment really is. Instead, all forms of communication through the PECS system are merely responses to adult prompts, which are reinforced through a response and reward system. Flippen et al (2010) would suggest that the child is not really making conversation out of desire to communicate for no other reason than to communicate, but instead reacting to a situation where they perceive a reward at the end. If this is true, PECS then does not promote true communication relating to the sharing of interests, or indeed other communicative acts that could be referred to as “commenting”.

Finally, one other criticism of PECS is the limitations of empirical studies to measure the true effectiveness of the system. While PECS was first introduced by Bondy and Frost in 1994 and very quickly became universally used in approaches to teaching communication in children with autism, the first empirical investigation into its effectiveness did not take place until 2002 (Charlop-Christy et al, 2002). While a correlation was noted with positive gains between the use of PECS and communicative abilities, Charlop-Christy et al (2002) did acknowledge the limitations of their study, most notable the small sample size used for research. While other empirical studies on the effectiveness of PECS have been undertaken since this research and advocate the use of PECS as an effective aid to communication, these studies again either utilised a small sample size, or else the independent variables examined were not limited to PECS alone (Flippen et al, 2010).

#### *2.3.4 CONCLUSION ON PECS*

While there may be some validity in the criticism of PECS, the predominant message in the literature is that beneficial aspects of the system appear to outweigh any potential negatives. Regardless of whether or not PECS truly does promote “spontaneous comments” or not, the evidence clearly suggests that the system provides an effective formal communication system for children with autism who have limited or no verbal capabilities.

## **2.4 INTERACTIVE DESIGN**

### **2.4.1 INTRODUCTION**

It is important to acknowledge how technology evolves over time. Today's average smart phone contains more computing power than the Apollo 11 shuttle which landed on the moon in 1969 (Gibbs, 2012). Consequently, this paper takes a predominantly theoretical approach to both the design and development aspects of technology in order to establish some fundamental concepts that should remain relevant regardless of potential future technological developments. While this research paper examines the iPad, the objective is to show how general principles of interactive design can be applied to any specific technology. In this case, the iPad is used as an example of its application.

This section will evaluate some of the literature surrounding general principles of interactive design with specific considerations for designing and developing applications and technologies which are geared specifically for children with autistic spectrum disorders.

### **2.4.2 DESIGNING AND DEVELOPING TECHNOLOGY FOR CHILDREN WITH AUTISM**

Just like a desktop computer the iPad is capable of running programs created by third party developers, known as applications or 'apps' for short (Rosenzweig, 2012). One of the key considerations regarding these is their design. One way to approach interactive design is to look at the process from four different perspectives; *user centred design*, *activity centred design*, *systems design*, and *genius design* (Saffer, 2010: 32).

User centred design involves focusing on the needs and goals of the end user. Activity centred design, in contrast, focuses on behaviour surrounding certain tasks rather than the end goals of the users. Systems design analytically arranges a set of established components in such a manner as to create design solutions. Genius design on the other hand is solely based on the experiences and wisdom of the designer who use his or her best judgement in order to determine what users want. The design is then based on this (ibid).

Each of these approaches has its merits for different purposes. However when developing technology for children with special needs, and more specifically autistic spectrum disorders, it is widely acknowledged that a user centred design is the most appropriate way to approach interactive technological development (Alper et al, 2012, De Leo et al, 2011 & Porayska-

Pomsta et al, 2011). The reasoning for this is that while developing technology for non-autistic children, developers can draw on their own personal childhood experiences. In contrast, when it comes to designing for children with ASD, most developers require the input of others with first-hand experience in order to fully understand the requirements of the technology being developed (Alper et al, 2012).

When taking a user centred design approach, Alper et al (2012) propose four principles for guiding interactive design in technology for children with special needs; *deep engagement, interdisciplinarity, individuality and practicality*.

With user centred design it is up to the designer to establish what the goals and needs of the end user are and adapt the technology accordingly. Deep engagement refers to the need for increased and cooperative input in the design and development process (ibid). A key issue however is the fact that the communication deficits exhibited by children with ASD inhibit them from making their own goals clear to the interactive designers. There is a much more complex web involved in developing technology for children with special needs than for typical children. For one, the number of stakeholders is higher. Alper et al (2012) suggest that teachers, parents, siblings, therapists and special education staff should all be included in the process of design and development. This is primarily because of the necessity for the technology to function in daily interactions with all these people in the children's lives. This is particularly true of children with ASD due to their perceived importance of routine, which can cause upset if disrupted (Howlin, 1998).

Proxy users can be a valuable asset for the design process and also remove the difficulties associated with not being able to incorporate the end users themselves in the design process. De Leo et al (2011) in their development of the smart phone application "PixTalk" aimed at aiding communication for children on the autistic spectrum, note how they involved teachers working in special education schools for children with autism at all stages of the design process. They cite this as one of the most important factors in their design process.

Porayska-Pomska et al (2012) emphasise how participatory design is even more crucial to the design of technology for children with ASD than when developing for typically developed children. They discuss how the design aspect, such as aesthetics and the look and feel of the technology, determine whether or not a user will be engaged with the technology. Due to the nature of autism, aesthetics can play a much larger role in whether or not the technology will appeal to the individual more so than it would for typically developed children (ibid).

Deep engagement is synonymous with Alper et al's (2010) interdisciplinarity principle. The interdisciplinarity principle refers to how it is crucial to involve people from multiple disciplines in the design process. In the case of developing technology for children with ASD, those from a child psychology background must work with programmers and designers in order to create an end product that can be effective and help the end user achieve their goals (De Leo, 2011). This collaboration is a core component in designing technology for children with ASD. Knowledge of clinical settings and intervention theories are important for ensuring the technology adheres to the theoretical frameworks (such as for example PECS) on which it is based. Programming expertise is a prerequisite to ensuring that the technology utilises the most advanced system design methods and programming for human computer interaction. In many cases the challenge is in designing technologies which are totally adaptable for their users (Porayska-Pomsta, 2012). Porayska-Posmska argue that combining the expertise of people from different disciplines is crucial to the design process in establishing common ground where each participant can draw on the strengths of their respective expertise to successfully collaborate and create something that can really support users with ASD.

Individuality then refers to how there is no "one size fits all" approach to interactive design for children with autism (Alper et al 2012: 366). Not only must designers allow for the varying severity of social impairments in children with autism, but they must also accommodate for significant differences in cultures. Social norms in one location may be very different to those in another (ibid). The implications of this are that the target audience for the technology must be carefully analysed. One possible method for doing this could be to identify a key group within the autistic community, for example non-verbal children within a certain age range in a specified location. By analysing this subgroup carefully and developing a successful and effective end product, it could then be carefully adapted to meet the requirements of other types of children with autism from alternative cultural backgrounds.

Finally, practicality is the acknowledgement of the necessity to create a technology that can be used in real world environments for children with autism (Alper et al, 2012). The focus must be on functionality which has to underpin all design considerations. In theory, a complex application dealing with all aspects of the various impairments associated with autistic spectrum disorders appears appealing. In reality if its target audience i.e. the children with autism are unable to use it due to its complexity, then the advanced technology loses its merit. Another vital consideration is that not only does the child have to be able to operate the

technology but parents, teachers and others who work with the children must also be able to understand and use it.

### *2.4.3 CONCLUSION ON INTERACTIVE DESIGN*

Interactive design is a fast growing science which is indicative of the increasing popularity of devices such as the iPad and smartphones. These devices create new ways of interacting with technology and allow for more innovative and creative applications which would not have been possible on a desktop computer. In terms of children with special needs and, in particular children with autism, this opens up an array of possibilities regarding potential aids for communication and learning. While the increased activity and interest in this area can only bring about positive results, there are still many considerations which must be made. For developers, good design and development practice approaches are pivotal. Best practice for autism applications indicates development should take a user centred approach with high participation from multiple parties throughout the design process. Considerations for individuality and practicality in combination with interdisciplinary input can, at least theoretically, yield positive results. A key theme throughout the literature is the emphasis on how vital it is to strategically approach the design process and continue to test the technology at each stage to ensure its effectiveness.

## **3. INTERACTIVE DESIGN: THE IPAD & GRACE APP**

### ***3.1 INTRODUCTION***

This section will begin by discussing the emergence of the iPad and the Apple mobile operating system, iOS on which the Grace application runs. Following this, the interface of the Grace application will be examined and key features explained. The application will then be applied to some of the interactive design principles explored in chapter three in order to determine whether or not the Grace application follows best practice procedures and is a potentially viable option as an intervention tool for aiding communication and learning in children with autism.

### ***3.2 THE IPAD***

The first iPhone and the iPod Touch represented a huge step forward in the technology that was previously commercially available. Steve Jobs, CEO of Apple at the time of the products release said of the iPhone:

*“iPhone is a revolutionary and magical product that is literally five years ahead of any other mobile phone.... We are all born with the ultimate pointing device—our fingers—and iPhone uses them to create the most revolutionary user interface since the mouse.”* (Jobs, 2007).

This multi-touch gestural interface was central in the development of the iPad which was first announced two years after the first iPhone in January 2010 (Apple, 2010). Jobs described the iPad as a “third category device”, fitting between the laptop and smartphone in terms of market position (Jobs, 2010). Jobs (ibid) also demonstrated the ability of the iPad to complete tasks in a more ergonomically friendly and simple way than a laptop, while allowing for a more fluid experience than the limited screen size a phone could offer. This is demonstrated by the large (9.7 inch) screen size, and the patented multi touch interface (Apple.com, 2010).

The touch screen interface is intuitive in that it facilitates direct interaction with the technology. For example, with a typical desktop computer the control devices are a keyboard and mouse. Knowledge is required in determining the relationship between the mouse and the pointer displayed on the monitor. iOS devices such as the iPad and iPhone remove the necessity to learn how to interact with what is on screen through proxy hardware. Based on some of the impairments associated with autism this may have implications for children with

autistic spectrum disorders such as difficulties realizing the ‘cause and effect’ relationship between a mouse and pointer on a monitor. Through the use of an iOS device however, this potentially challenging learning stage can become obsolete as the child can directly interact with the technology by touching the screen.

### ***3.3 TRANSLATING PECS INTO TECHNOLOGY - THE GRACE APPLICATION INTERFACE OVERVIEW***

The Grace application essentially attempts to emulate the picture exchange communication system by using interactive technology rather than manually held cards. The application purposely utilises a minimalistic interface prioritising functionality ahead of aesthetic design. By so doing, children with autism can now operate the application with the same level of independence which they would heretofore have had with the picture exchange communication system (graceapp.com, 2013).

The home screen of the Grace Application displays several categories denoted by pictures and associated words such as “Sentence Makers” and “Things I Like”. Figure 1 below illustrates the main user interface of the application.

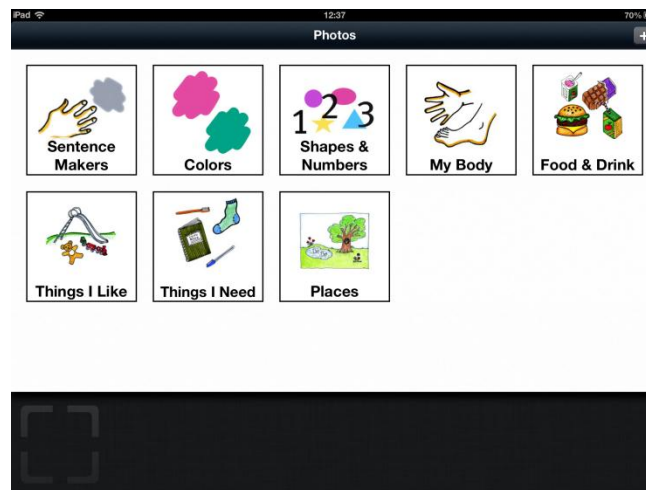


Figure 1: Screenshot of the Grace application interface

The bottom of the screen displays the current sentence which can be constructed by the child by tapping on the required category and touching the appropriate images in order to add it to the sentence strip. Double tapping an image in the constructed sentence will remove it. One of the advantages of the Grace Application is the level of customisation available within it. By pressing the plus symbol on the top right of the interface, new images can be added to the



library. The edit button can also be used to rearrange pictures and categories and unwanted images can be easily deleted from the application using this. These two features are illustrated in figure 2 and figure 3 below respectively.

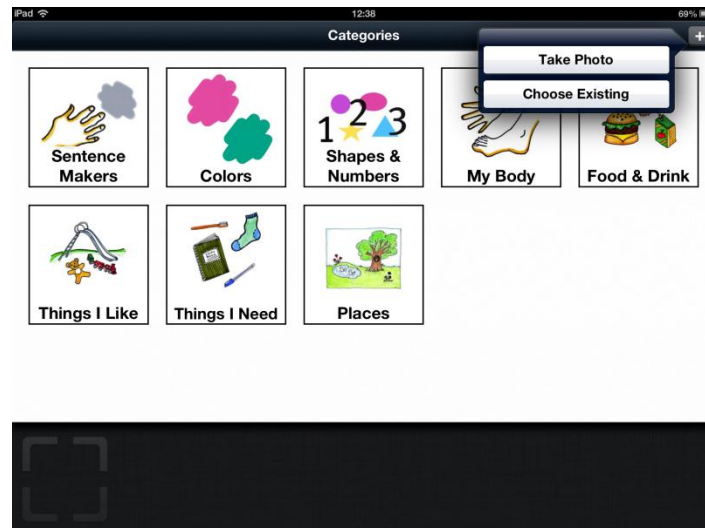


Figure 2: Screenshot of customisation in the Grace application

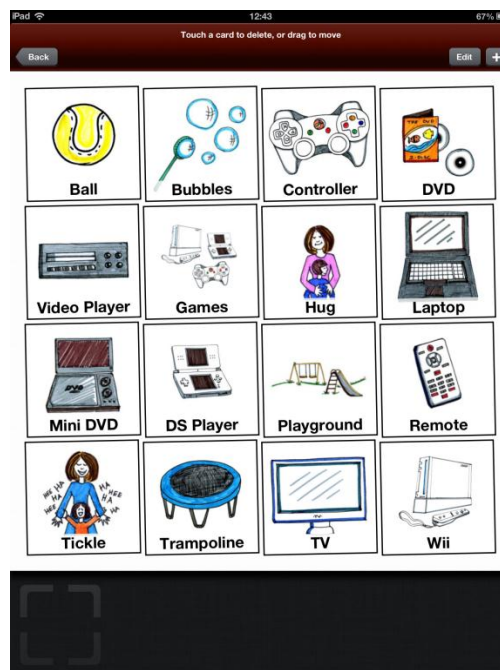


Figure 3: Screenshot of editing in the Grace application

### **3.4 GRACE & INTERACTIVE DESIGN PRINCIPLES**

#### *Interdisciplinary and Deep Engagement*

The Grace application follows all four of Alper et al's (2012) principles for interactive design for children with autism and special needs. Firstly, there is clear evidence of an interdisciplinary approach with deep engagement in the design process of the application. The concept was the brainchild of a mother whose daughter, Grace, has autism (graceapp.com, 2013). The programming for the application was then undertaken by a professional iOS developer, and the art work for the picture cards was developed by a professional graphic designer (ibid). The advantages of following an interdisciplinary approach far outnumber any benefits which might be gained if one person alone was working on the application. For example, if we refer to Saffer's (2010) user centred design approach, it can be presumed that a mother whose child has autism will, in all probability, have significantly more insights into the condition that a computer programmer alone would have. Much like Alper et al (2012) suggest the use of proxy users, by utilising these insights the developer can then program the application to meet the needs and goals of the end user base.

The Grace Application website shows the deep engagement and in depth involvement which the creators have with the application. Workshops run by the designers are available to anyone who wishes to learn how to maximise the efficiency and benefits of the app. A plethora of information is available on everything from detailed instructions for running the application to reviews of iPad covers. The website also offers information regarding other applications which complement the users experience with the both the iPad and the Grace (graceapp.com, 2013).

#### *Individuality and Practicality*

In terms of individuality, the Grace application is fully customisable and can be tailored to a specific child's needs. Personal use of the application has given first-hand knowledge of how pictures can be taken using the built in camera in the iPad and added easily to the library. Through the use of another free application called "PicCardMaker," these photographs can be edited to format the same style as the cards used in Grace<sup>2</sup>. The cards can also be removed or rearranged in a way that is optimal to the child who is using the application. For example the

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<sup>2</sup> "PicCardMaker" is available from the Apple App Store as a free download and is compatible with devices running iOS 4.0 or later. Url: <https://itunes.apple.com/ie/app/picture-card-maker-for-communication/id419089000?mt=8>.

most frequently desired items can be placed strategically and in an easy to find manner at the top of the screen.

There are some potential disadvantages to this level of customisation and individuality however. For example the personalised images and customised arrangement of icons can generally only be optimised for one specific child. Therefore the sharing of one iPad between several children with autism could be problematic. With iOS 6.1 on iPad, the operating system on which the application has been tested for this research paper, it is not possible to run several versions of the same application on one device. One potential solution to this issue is perhaps the integration of user profiles within the application. This feature would allow an adult to open the application and chose the profile of the child with whom they are working. Currently this option is not available with the Grace application.

Finally Alper et al's (2012) principle of practicality can be looked at in relation to the Grace app and the iPad. Both affordability and accessibility underpin concerns regarding how practical a technology is. For example a state of the art novel system that cannot leave a laboratory setting is not as practical as a real world application (ibid). As a commercial and widely available product, the Apple iPad can be seen as an affordable alternative with a modest price tag in comparison to some other augmentative communication devices targeted at children with autism, some of which can cost in the range of \$5000 (researchautism.net, 2012). Despite its relative affordability, an iPad, with the basic second generation 16 gigabyte model currently retailing at €399 directly from Apple (apple.com, 2013a) can still be a costly investment for many families. This may be a significant issue for schools and other facilities for children with autism which may have to purchase multiple devices. It is important to acknowledge that the iPad is not actually optimized as an augmentative communication device for children with autistic spectrum disorders. It is merely an instrument capable of running specific software such as the Grace application, which is designed specifically for children with autism.

From a practical point of view it should be noted that alternative hardware exists on which the Grace app can also be run. Other iOS devices such as the iPod touch and iPhone offer this facility provided the device is running iOS 4.0 or later. Irish Autism Action is a registered charity that raises money to aid people affected by autistic spectrum disorders. One of their more successful fundraising initiatives in recent years focuses on the collection of old phones which are then traded for iPads to help children with autism (autismirelandphones.ie, 2013).

It is also possible to obtain older versions of iPhones or iPods when friends or family members upgrade them, or to purchase pre-owned devices at a lower cost than the Apple retail price. Given the fundamental nature of autism, and in particular the obsessional behaviour and demand for routine (Howlin, 1998) it can be assumed that while the software may be the same, the differences between different types of hardware may lead to confusion and problems for a child with autism. For example, if a child learns to use Grace on an iPad in an educational setting, but at home he or she uses the application on an iPhone or iPod Touch, there may well be issues caused by the different screen sizes and general feel of the device. This is an issue which would require further research and extends well beyond the scope of this particular study.

The portability of the Grace app is a key advantage of the device in terms of practicality over traditional PECS. The iPad can be more easily moved from one location to another. It also allows for consistency with the system. For example, with the traditional PECS system cards can easily be misplaced or left behind. They can also be damaged, and organisation of the system can become cumbersome. With the Grace application, the images can be organised in order of most frequently used and the issues associated with the physical system become obsolete (gracepp.com, 2013). In this sense it can be said that in terms of practicality, the use of the Grace app has many advantages over the traditional picture exchange communication system.

## 4. PECS AND THE IPAD

### 4.1 INTRODUCTION

The previous chapter applied some interactive design principles to the Grace app and made some comparisons to PECS in terms of practicality and individuality. The aims of this chapter are to expand on these comparisons and identify in depth, the key differences between training a child with autism in the use of the traditional picture communication exchange system and training a similar child how to effectively use the Grace application on an iPad. In order to do this, the core means of communication which both systems attempt to teach will be discussed. Following this, each stage of the PECS training phases as provided by Bondy & Frost (2001 & 2002) will be examined in comparison to the equivalent training phases using the Grace app. Finally a case study undertaken by Kaghora et al (2010) investigating the use of an iOS device as an augmentative communication device will be explored and its implications discussed.

### 4.2 TYPES OF COMMUNICATION

Bondy and Frost (2002) describe five broad types of communication; *spontaneous request*, *spontaneous comment*, *responsive request*, *responsive comment* and *imitation*. They provide an example of a typical child without autism interacting with its mother and a bowl of popcorn to explain each these communicative methods.

Firstly if the child sees the mother holding the bowl of popcorn and desires it, the child will initiate a *spontaneous request*, for example “I want”. The outcome is that the child receives the popcorn. The second form of communicative behaviour is when a child sees the mother holding the popcorn and utilizes a *spontaneous comment*, for example “I see popcorn”. The third form of communication is not initiated by the child but by the mother. The mother asks the child “what do you want?”, and as a *responsive request* the child replies “popcorn”. The fourth form of communication involves the mother prompting a *responsive comment* from the child by asking “what do you see”, to which the child responds “popcorn”. It is important to distinguish between the third and fourth type of communication. In both cases the child’s response is verbally the same but the meaning and implications vary. In the case of a responsive request, the outcome of the exchange is the child receiving popcorn. By contrast, the outcome of the fourth type of communication in which the child provides a responsive comment rather than a request, the outcome does not directly result in the child receiving the

popcorn (ibid). Finally the fifth type of communication as described by Bondy and Frost is *imitation*, where in this example, the mother says “say ‘popcorn’”, and the child replies “popcorn”.

While the above may appear pedantic at first, given the impairments which children with autism exhibit in social communication and interaction, differentiating between these forms of communication is essential in structuring PECS’s training.

### ***4.3 TRAINING PECS & TRAINING GRACE – A COMPARISON***

Traditional PECS’s training attempts to emulate the various forms of verbal communication provided by Bondy & Frost as detailed above. Training in this system involves two parties; one acts as a trainer providing physical and verbal prompts, while the other acts as the listener, providing the items and responses to the child’s requests and comments (Bondy & Frost, 2001).

Prior to PECS’s training, the first thing that must be done is to teach spontaneous requests. In order to do this, the items the child desires most frequently must be determined. This ensures that latter stages of training the system are working for its intended purpose and that the picture cards are not just being selected by the child at random. To do this, the trainer offers items to the child without verbal prompts and notes the child’s reaction. Through this process the child’s preferences can quickly be identified and a preference hierarchy can be developed (Bondy & Frost, 2002).

When using an iPad as opposed to the traditional picture exchange communication system, this is an equally important stage which must be done manually in the same way as if we were preparing for traditional PECS training. The manual for the Grace application provides a sample “reinforcer inventory” chart which can be used as a basis for establishing this hierarchy based on the individual subject’s known preferences (graceapp.com, 2013).

#### *Phase I*

The first phase of training PECS involves teaching the child to communicate without using spoken words. The teacher selects a picture, and shows the child the item that corresponds with the image. When the child reaches for the item, the picture is presented and the trainer assists the child in picking up the visual cue. They then assist the child in presenting the

picture card to the listener, who provides the item to the child. This is repeated and reinforced in an attempt to have the child, upon seeing a desired item, pick up the corresponding picture and hand it to the listener in order to obtain the desired item. Bondy and Frost (2001) estimate that this phase may take as little as ten to fifteen minutes for the child to learn to exchange the image independently.

With the Grace app, this phase involves categorising the applications appropriately and showing the child how selecting the image on screen results in the desired outcome of receiving the item. One key feature of the Grace app is the ability to fully customise these images through the use of the iPads built in camera. Images from another source can also be very easily imported. The advantage here is that items that are known to be highly desirable to the child, but which may not be included in the PECS or Grace stock inventory can be easily added to the application. In terms of presenting the visual cue to the child, the process can be done in a similar fashion as done with PECS except that rather than physically picking up the card, the child touches the relevant image on the screen of the iPad (graceapp.com, 2013).

### *Phase 2*

The second phase of PECS' training is known as "distance and persistence" (Bondy & Frost, 2002: 730). In this phase the children are taught the importance of persistence when faced with a variety of obstacles (ibid). With a typical child, when their request is ignored, they will often raise their voice. However a non-verbal autistic child will not have this option at their disposal and so will have to learn to adapt other approaches to getting what they want. Bondy & Frost (2001) claim that many children will attempt to reach out farther with their picture cards or else walk a longer distance in order to get what they want. The primary learning objective here is that the child learns that the picture cards will not "magically" appear in front of them, and that other people will not always be immediately available to see what the child wants. Therefore the child is taught to get the picture they need to communicate with and also how to get the attention of an adult even if they are not in the same room (ibid).

This stage of training presents the most difficulty if we attempt to directly apply the physical training system to training Grace. One of the most problematic issues is that at this point it is unwise to give the child full control and access to the iPad. First of all, as the iPad can be an

entertaining device with other applications other than Grace, there is a possibility that the iPad can become a toy and desired item, rather than a communication device (graceapp.com, 2013). There is also the fear that leaving the iPad unsupervised with a child could lead to the device being broken or damaged. Despite taking precautions such as utilising a protective cover, the iPad is still a fragile device, and accidents can still occur. To resolve this issue, the Grace Application manual stresses the importance of the trainer taking full instructional control over the device (graceapp.com, 2013) This involves getting the child to approach the trainer in order to use the iPad. By creating the necessity for the child to approach and interact with the trainer in order to use the iPad the same impact as enforcing “distance and persistence” with the physical system should result.

### *Phase 3*

The third stage of PECS’ training involves learning to discriminate between symbols. This is done by presenting the child with two picture options and then showing how the choice of one over the other results in a different set of consequences. The key to this stage is to ensure that one of the options is preferable to the child than the other. By so doing, they can see that choosing the picture with the preferred item is rewarding, while selecting the non-preferred option results in a less favourable outcome. Gradually the choices become more equally desirable so that the child can begin to face a possible dilemma (Bondy & Frost, 2001). In this case the child is presented with images of two preferred images and prompted to choose one. The two desirable objects are then presented and the child is again given choice. If they select the same object as the picture they chose, they are given that object. However if they select the alternative object, they are blocked access to it, thus reinforcing the fact that the picture is associated with the image and ensuring that the child is truly selecting the item which they have a preference for (ibid).

Many stock images that come preloaded in the Grace application may not be readily available if the child successfully selects it. For example the icons “DS player” and “trampoline” are not likely to be a practical option for many children. In these cases it may be advisable to remove any such images particularly during the training stages. Deleting these is a straightforward process, and at any point the application can be restored with all stock images being returned to the interface. It is also notable that custom images will not be removed if the application is restored, thus making this stage a more convenient process than if images had to be repeatedly deleted and reimported and arranged.



#### *Phase 4*

Phase four builds upon the discrimination learnt in the third stage of training and introduces the fundamental skills required for utilising commenting as a form of communication through the use of PECS. Because they are non-verbal, children who use PECS cannot use inflections in their tone of voice to discern between requests and comments. Consequently “sentence starter” cards are taught to be combined with picture cards in order to construct sentences and allow the child to communicate in more ways than just to say they want something (Bondy & Frost, 2001). Bondy and Frost (2002) stress the importance of teaching one new skill at a time, and how it is necessary to build upon previously learned abilities. As the child has already learned spontaneous requesting by picking up a picture card and handing it to an adult in order to receive a desired object, this skill can be used to introduce the “I want” sentence building card. A picture card with an icon representing “I want” is created and the child is taught to place both the “I want” and the desired picture together in order to receive the item. Through reinforcement, similar to how the previous skills were learned, the child soon realises that in order to attain the desired object, a combination of both cards must be used.

With Grace, this process has many similarities. However rather than using the physical cards, the child is taught to discriminate between categories and begin their sentence with an image from the sentence maker categories. The general concept behind this is the same as with PECS and follows equivalent reinforcement procedures such as only providing the desired item when the child successfully constructs the sentence.

#### *Phase 5*

The fifth phase of PECS training attempts to introduce the ability to answer a direct question or as Bondy and Frost describe it as “responsive commenting”. Instead of waiting for the child to produce a card, the adult prompts the child with a question such as “what do you want?” Through delayed prompts gesturing towards the “I want” sentence starter card, the child gradually associates the question with constructing an “I want\_\_\_” sentence which triggers receiving a desired item. It is crucial however that the child learns to use responsive requests in tandem with the spontaneous request ability which they have already acquired. With Grace, this stage can be instructed in a similar fashion to PECS. Assuming the child has mastered the first four stages using the iPad, the process of teaching responsive commenting using Grace should be no more complex than using PECS as the methodology is the same. In

fact, this stage may actually be easier to instruct with the iPad due to the instructional control the trainer has over the device. For example, the trainer can set up an opportunity to create the demand for an item such as stopping with the child by a vending machine. They can then begin to ask the question “what do you want?” and present the iPad to the child to construct the sentence using the “I want” sentence maker image. If the child constructs the sentence correctly, they are then rewarded with the desired item. Conversely with PECS, the onus is on the child to pick up the cards and construct the sentence which could potentially be more problematic (graceapp.com, 2013).

### *Phase 6*

The final stage of PECS training, and potentially the most difficult, involves teaching spontaneous commenting. At this point the child should be able to initiate a spontaneous request by presenting the “I want” sentence starter card together with the picture card denoting the desired item. They should also be capable of responding to the question “what do you want?” using the same method. The trainer can then build on these skills in the sixth phase by introducing new sentence starters such as “I see” to the child’s vocabulary. By arranging for something interesting to appear, the trainer can use the same kind of delayed prompting used in stage four to teach the “I want” sentence builder to implement “I see” into the vocabulary. The most important part here is the trainers reaction to the furnishing of the “I see” card by the child. Rather than give the item to the child, the trainer must respond in a social manner by either pointing at the object or in some other way communicating that they recognise the fact that the child has acknowledged the object. They must however ensure that they do not give the item to the child in the same manner they would if the child had produced the “I want” sentence starter. There are minimal notable discrepancies between teaching spontaneous commenting using the physical system and Grace. As it is assumed at this stage that the child is capable of incorporating the methods described above through the use of the iPad rather than the physical cards, their ability to effectively use the application should, at this stage, not be an issue. The Grace Application manual suggests that at this stage it can be encouraged to allow the child to “wear” the iOS device by using a neck strap thus removing the instructional control of the trainer in the previous phases (graceapp.com, 2013). Important considerations are to ensure that applications such as the internet browser or camera features are blocked, possibly through the use of lock codes which can easily be set up in the settings screen of the iPad itself. By ensuring only the Grace application is

accessible by the child, the iPad is perceived by the child as a communication device, and potentially unwanted scenarios from the unsupervised use of other applications are avoided.

### *Conclusion on Training*

It is clear from the above analysis that there are many similarities and shared concepts between teaching PECS using physical cards and teaching Grace using an iPad or other iOS device. The most significant differences occur in the early stages of training where the key lessons are instructing the child to touch the relevant icon on screen as opposed to picking up and presenting a physical card. A potential concern is that this may be a more difficult skill to acquire using an iPad as it requires more precision than the traditional method. In the following section, a case study will be examined. This study by Kaghora et al (2010), deals with this specific issue while looking at the use of an iPod touch as an aid for communication and learning.

#### ***4.4 CASE STUDY RELATING TO AN iOS DEVICE AS A COMMUNICATION AID***

Kaghora et al (2010) investigate some of the issues surrounding the use of iOS devices as an aid for communication. Their analysis centres on Steven, who is a seventeen year old non-verbal adolescent with an autistic spectrum disorder. Due to the nature of his disorder, Steven was deemed to be a suitable candidate for using an iOS device as a communication tool. It was found however that he had significant difficulties in operating the hardware. The initial problems were interpreted as motor control related and first suggestions were to abandon the device and prescribe an alternative technology in place of the iPod with which he was having limited success. Kaghora et al proposed a solution by presenting the credibility of adopting a behavioural intervention approach to the case as opposed to the more costly process of replacing the technology Steven had available to him.

Steven was using the application “Proloquo2Go”, which is similar in many respects to the Grace Application except that Proloquo2Go actually produces audible speech output when the images are pressed (ibid). The motor controls required to operate both applications however are the same, requiring the user to press an image on the iOS device screen in order to activate it. Kaghora et al note that many individuals, while capable of discriminating between images consistently fail to activate the desired image, often by pressing the screen with too much force. Kaghora et al discuss the implications of this stating that many trainers’

instincts would have them reward the user for discriminating between the images even if they had not correctly activated it. They stress however that this is an ineffective approach to take as the user does not appreciate the consequences of not interacting with the image correctly. They suggest that the difficulties most users experience when interacting with the device are not due to motor control issues, but rather the result of continued reinforcement of non-activating responses. Thus they suggest an alternative approach where the user is only rewarded when the device is successfully used.

In their study significant results were observed when adopting a behaviour intervention for occasions in which Steven chose the image, but did not successfully operate the device. In such cases he was prompted to try again rather than be rewarded (Kagohra et al, 2010). After the study, the number of successful requests Steven exhibited was significantly higher than before the behaviour intervention (ibid).

The notable implications of this study are that it is evident that utilising an iOS device required two sets of skills; the ability to discriminate between images, and also the ability to select the icon on the screen in order to initiate a response from the device. In the case of Kaghora et al's study, this successful activation would result in speech output from the device, while with the Grace application a successful interaction with the device would add an image to the sentence strip. While there is much guidance in the literature for developing this first set of skills, due to the relatively recent emergence of iOS devices, guidance for developing the second set of skills for those working with children with autism is still somewhat limited. Kaghora et al's study attempts to deal with some of these issues, but this is case specific to one adolescent, highlighting the limitations of the study. Therefore it is noted that further research into this area is necessary especially in light of the exponentially growing utilisation of iOS devices as communication and learning aids for children with autism.

## 5. CONCLUSION

Autistic spectrum disorders are characterised by a number of impairments. While the severity of these impairments varies from person to person, there is a general consensus in the literature that the inability to communicate normally and lack of social skills are two core deficits common to all those on the autistic spectrum. Many intervention methods exist for dealing with these impairments, and one of the most widely used especially for children with severe communication difficulties, is the picture exchange communication system (PECS). By utilising picture cards and a communication board, non-verbal children can develop a formal communication system that may, in time, lead to a significant improvement in communicative skills while in turn reducing frustration levels and the many associated behaviours associated with children with autism. This paper has identified some of the key literature surrounding PECS and established that while there are some justifiable criticisms of the system, it is serving its purpose well as an effective communication system for children with autism who exhibit little to no verbal communication abilities.

The emergence of new technologies such as the iPad has brought about new opportunities in terms of designing interventions for aiding with communication and learning in children with autistic spectrum disorders. The focus of this research paper is based around a conscious approach to the design process in developing any kind of interactive technology. This is especially true of an interactive technology aimed at children with autism. This paper identifies the Grace application on the iPad as an example of interactive technology for children with autism, and evaluates its design in terms of Alper et al's (2012) principles for designing interactive technology for children with autism. In so doing it examines its potential benefits compared to those of its equivalent traditional method, the picture exchange communication system.

Through this applied theory, the evidence suggests that Grace could be a suitable alternative for PECS. In many ways, Grace is a more appropriate solution to aiding communication than manual cards, particularly in terms of practicality and individuality. Some potential disadvantages of the application and use of iPads as an intervention method in general have been highlighted and potential solutions provided. The work of Kaghora et al (2010) suggests that the concerns regarding the set of skills required to effectively operate an iPad can be dealt with through behavioural intervention rather than abandoning iOS as a facilitator for augmentative communication. While the study has limitations in terms of sample size, it still

suggests that there is much scope in terms of iOS development specifically directed at children with autistic spectrum disorders. One limitation of the Grace appliance on the iPad, as identified in this research, is its present inability to allow customization for more than one single user. This could be solved by adding another option on the existing tool bar enabling multiple users to use the same piece of hardware. Doing so would make the Grace app and the iPad more cost effective for schools which appreciate the enormous benefits of interactive technology but cannot afford to equip classrooms with multiple pieces of hardware.

While it is notable that the iPad as a piece of hardware was not designed specifically for this purpose, in general the themes explored in this paper identify the iPad as an ideal device for aiding communication and learning in children with autism. In terms of affordability, the prices of consumer electronics, including the iPad have decreased significantly since the first model was introduced in 2010 (Apple.com 2010 & Apple.com, 2013b). This would suggest that in time, the device will become more affordable particularly as newer models come on the market and older models are being sold off at cheaper prices. This is especially relevant in the face of growing competition in the tablet market. With this in mind, the future looks bright in terms of the prospective use of iOS devices as user friendly and stimulating alternatives to traditional aids for communication and learning for children with autistic spectrum disorders.

In light of the evidence presented above, this paper acknowledges some of the limitations of this study due to scope and potential ethical issues as discussed in chapter one. While a theoretical basis for the use of the Grace app as an alternative to PECS has been established here, the author would like to investigate further to see if an empirical basis also exists. To do this would require evaluating the actual implementation of the application in an educational setting, establishing a reliable sample group that meets certain criteria, and monitoring progress both in terms of learning how to use the iOS device as well as possible improvements in communicative ability.

## 6. BIBLIOGRAPHY

### BOOKS

Attwood, T. (1998), *Asperger's Syndrome: a Guide for Parents and Professionals* Jessica Kingsley Publishers: London.

Bondy, A. & Frost, L. (2002), *A Pictures Worth; PECS and Other Visual Communication Strategies*, Woodbine House: Maryland.

Howlin, P. (1998), *Children with Autism and Asperger's Syndrome* John Wiley & Sons: London.

Jordan, R. (1999), *Autistic Spectrum Disorders; an Introductory Handbook for Practitioners* David Fulton Publishers: London.

Jordan, R. & Powell, S. (1995), *Understanding and Teaching Children with Autism* John Wiley & Sons: London.

Kluth, P. (2003), *"You're Going to Love This Kid!": Teaching Students With Autism in the Classroom* Paul H. Brookes: Maryland.

Rosenzweig, G. (2012), *My iPad 2; Third Edition* Que Publishing: Indiana.

Saffer, D. (2010), *Designing for Interaction; Creating Innovative Applications and Devices Second Edition* New Riders: California.

Williams W. & Reinbold C. (1999), 'Conditional Discrimination Processes, the Assessment of Basic Learning Abilities, and their Relevance to Language Acquisition in Children with Autism', *Autism Behavior Analytic Perspectives* Ghezzi, P. Williams, W. & Carr, J. (eds.) Context Press: Nevada.

## **JOURNALS & EJOURNALS**

Alper, M. Hourcade, J. P. & Gilutz, S. (2012), 'Interactive Technologies for Children with Special Needs', *IDC '12 Proceedings of the 11<sup>th</sup> International Conference on Interaction Design and Children*: pp. 363- 366, [online] available from <http://dl.acm.org/citation.cfm?id=2307169&bnc=1> [last accessed 26.02.2013].

Baron-Cohen, S. (1991), 'The Development of a Theory of Mind in Autism: Deviance and Delay?' *Psychiatric Clinics of North America* Vol 14(1) Mar 1991: pp. 33-51.

Bondy A. & Frost, L. (2001), 'The Picture Exchange Communication System' *Behavior Modification*, 25 (5), pp. 725-744.

Charlop-Christy, M.H., Carpenter, M., Le, L., LeBlanc, L.A., & Kellet, K. (2002), 'Using the Picture Exchange Communication System (PECS) with children with autism: assessment of PECS acquisition, speech, social-communicative behavior, and problem behavior' *Journal of Applied Behavioral Analysis* 35: pp. 213-231.

De Leo, G. Gonzales, C. Battagiri, P. & Gondy L. (2011), 'A Smart Phone Application and a Companion Website for the Improvement of the Communication Skills of Children with Autism: Clinical Rationale, Technical Development and Preliminary Results' *Journal of Medical Systems* 35: pp. 703-711.

Flippen M. Reszka, S. & Watson, L. (2010) 'Effectiveness of the Picture Exchange Communication System (PECS) on Communication and Speech for Children with Autism Spectrum Disorders: A Meta-Analysis' *American Journal of Speech Language Pathology* Vol 19: pp. 178-195.

Kaghora, D. Van Der Meer, L. Achmadi, D. Green, V. O'Reilly, M. Mulloy, A. Lancioni, G. Lang, R. Sigafos, J. (2010) 'Behavioural Intervention Promotes Successful Use of an iPod Based Communication Device by an Adolescent with Autism' *Clinical Case Studies* 9 (5) pp. 328-338.



Porayska-Pomsta, P. Frauenberger, C. Pain, H. Rajendran, G. Smith, T. Menzies, R. Foster, M. E. Alcorn, A. Wass, S. Bernadini, S. Avramides, K. Keay-Bright, W. Chen, J. Waller, A. Guldberg, K. & Good J. (2012), Developing technology for autism: an interdisciplinary approach. *Personal and Ubiquitous Computing* 16 (2): pp. 117-127.

Wing, L. Gould, J. Gillberg, C. (2011) 'Autism Spectrum Disorders in the DSM-V: Better or Worse than the DSM-IV?' *Research in Developmental Disabilities* 32 (2011): pp. 768-773.

Yoder P.J., Stone W.L.(2006), 'A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD', *Journal of Speech, Language, and Hearing Research* 49(4), pp. 698-711.

### **ELECTRONIC RESOURCES**

Apple.com (2013a), *Apple Store* [online] available from [http://store.apple.com/ie/browse/home/shop\\_ipad](http://store.apple.com/ie/browse/home/shop_ipad) [last accessed 26.02.2013].

Apple.com (2013b), *Apple Updates iOS to 6.1* [online] available from <http://www.apple.com/pr/library/2013/01/28Apple-Updates-iOS-to-6-1.html> [last accessed 26.02.2013].

Apple.com (2010), *Apple Launches iPad* [online] available from <https://www.apple.com/pr/library/2010/01/27Apple-Launches-iPad.html> [last accessed 26.02.2013].

Austismirelandphones.ie (2013), *Ipod Scheme* [online] available from <http://www.autismirelandphones.ie/> [last accessed 26.02.2013].

Biao, J. (2012), *Prevalence of Autism Spectrum Disorders — Autism and Developmental Disabilities Monitoring Network* [online] available from [http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6103a1.htm?s\\_cid=ss6103a1\\_w](http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6103a1.htm?s_cid=ss6103a1_w) [last accessed 26.02.2013].

Cosman, S. (2008), *Critical Review: Language Outcomes for Children with Autism: A Comparison Between PECS and Sign Language*, University of Western Ontario [online] available from <http://www.uwo.ca/fhs/csd/ebp/reviews/2007-08/Shaw-Cosman,MA.pdf> [last accessed 26.02.2013].

Department of Children and Youth Affairs (2011), *Guidance for Developing Ethical Research Projects Involving Children* [online] available from [http://www.dcy.gov.ie/documents/Publications/Ethics\\_Guidance.pdf](http://www.dcy.gov.ie/documents/Publications/Ethics_Guidance.pdf) [last accessed 26.02.2013].

Gibbs, N. (2012), 'Your Life is Fully Mobile', *Time Magazine Online* [online] available from <http://techland.time.com/2012/08/16/your-life-is-fully-mobile/> [last accessed 26.02.2013].

Government of Ireland (2001), *The Report of the Task Force on Autism*. Dublin: The Stationary Office [online] available from <http://www.sess.ie/sites/default/files/Autism%20Task%20Force%20Report.pdf> [last accessed 26.02.2013].

Graceapp.com (2013), Official Website for the Grace Application [online] available from <http://www.graceapp.com/> [last accessed 26.02.2013].

Hilyard, S. (2011), 'Mother sets out to buy iPads for other autistic children', *timesreporter.com* 28 Mar 2011 [online] available from [http://www.timesreporter.com/archive/x1234548026/Mother-sets-out-to-buy-iPads-for-other-autistic-children?zc\\_p=0](http://www.timesreporter.com/archive/x1234548026/Mother-sets-out-to-buy-iPads-for-other-autistic-children?zc_p=0) [last accessed 26.02.2013].

Jobs, S. (2010), *iPad Introduction (27 Jan 2010)*, [online video] available from [http://www.youtube.com/watch?v=jj6q\\_z2Ni9M](http://www.youtube.com/watch?v=jj6q_z2Ni9M) [last accessed 26.02.2013].

Jobs, S. (2007) *Steve Jobs - 2007 iPhone Presentation (Part 1 of 2)*, [online video] available from <http://www.youtube.com/watch?v=Etyt4osHgX0> [last accessed 26.02.2013].

Polles, A. (2010), *Turning on “The Light for Communication”*; *Intervention Using the Picture Exchange Communication System (PECS) for Children with Autism*, Senior Thesis, Department of Linguistics, Bryn Mawr College, [online] available from <http://www.swarthmore.edu/SocSci/Linguistics/2011thesis/PDFs/PollesBMC.pdf> [last accessed 26.02.2013].

Researchautism.net (2012), *Picture Exchange Communication System (PECS) and Autism*, [online] available from [http://researchautism.net/autism\\_treatments\\_therapies\\_intervention.ikml?print&ra=36&infolevel=3](http://researchautism.net/autism_treatments_therapies_intervention.ikml?print&ra=36&infolevel=3) [last accessed 26.02.2013].

Siliconrepublic.com (2010), *Irish Autism App Wins International Award* [online] available from <http://www.siliconrepublic.com/start-ups/item/18945-irish-autism-app-wins/> [last accessed 26.02.2013].

Trinity College Dublin (2013), *Ethics* [online] available from <https://www.scss.tcd.ie/postgraduate/ethics/> [last accessed 26.02.2013].

University of Lancaster (2012) *Vulnerable People and Groups* available [online] available from <http://www.lancs.ac.uk/researchethics/4-1-intro.html> [last accessed 26.02.2013].