RELATIONSHIPS AMONG MOTOR FUNCTION, MANUAL ABILITY AND COMMUNICATIVE FUNCTION IN ALTERNATIVE COMMUNICATION USERS

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Abstract

The aim of the study was to investigate the relationship among gross motor function, manual ability, communicative function and the use of augmentative and alternative communication in children and young people with cerebral palsy. The participants were nine children and young people with cerebral palsy aged 8 to 14 years and two speech therapists. Four instruments were used for data collection: 1) Gross Motor Function Measure Classification System (GMFCS), 2) Manual Ability Classification System (MACS), 3) Communication Functioning Classification System (CFCS), and 4) Questionnaire about the use of augmentative and alternative communication (AAC). Qualitative and quantitative analyzes of the data and Spearman's correlation analysis were conducted. The study allowed the characterization of an AAC group of users and the identification of the relationships among the augmentative and alternative resources use with the motor classification, manual ability and communicative function.

Keywords: Special Education. Communication and development. Ability. Children with disabilities.

1 Introduction

Cerebral palsy (CP) is identified as a posture and movement disorder resulting from non-progressive encephalopathy in the pre, peri or postnatal periods, with single or multiple localization in the immature brain. This brain injury may result in varied neuromotor impairments, which are generally associated with the severity of the sequelae and with the child's age (GAUZZI; FONSECA, 2004; GIANNI, 2005).

CP is caused by a brain injury that occurs before two years of age (NOETZEL, MILLER, 1998; SCHWARTZMAN, 2004), and depending on the location and extent of the injury, different parts of the body may be affected (GIANNI, 2005).

The literature of the area has identified that motor disorders from cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, behavior, epilepsy and secondary musculoskeletal problems (SCHWARTZMAN, 2004; GIANNI, 2005).

The main causes of CP are associated with factors such as malformation of the central nervous system, congenital infections (rubella, toxoplasmosis, syphilis,

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herpesvirus), ischemic hypoxic encephalopathy, neonatal encephalopathy, bilirubin encephalopathy, meningoencephalitis, head trauma and semi-drowning (PIOVESANA, 2002; GIANNI, 2005; SCHWARTZMAN, 2004).

Children with CP often have complex communication needs and can benefit from the early introduction of Augmentative and Alternative Communication Systems (AAC) in order to expand the possibilities of communication development, and thus facilitate their insertion in the family, social and educational context (VON TETZCHNER, 2009; DELIBERATO, 2009; PELOSI, 2009).

The term AAC is related to all forms of communication that can complement, supplement and/or replace speech. It is intended to cover the needs of the reception, understanding and expression of language and, thus, to increase the communication of non-speaking individuals (VON TETZCHNER; JENSEN, 1996; VON TETZCHNER, 2009, DELIBERATO, 2009; PELOSI, 2009).

According to Nunes (2001) AAC involves the use of gestures, facial expressions, graphic symbols (such as writing, drawings, prints and photographs) as a way of ensuring the communication of people who are unable to perform it orally. In this context, AAC is able to promote and supplement speech and guarantee an alternative form, in case the individual has no possibility to develop speech, such as some people with CP.

Rocha (2013) identified the need to learn about the specificities of the child in order to facilitate the implementation and the use of assistive technology, among them AAC. The study pointed out that the resources and strategies of an adequate AAC system allow the child with cerebral palsy to broaden the means of communication, i.e., facilitates the child's expression and their understanding by different communication partners.

In order to learn about the specificities of the child and to establish a functional profile of the person with CP and to provide a common language improving the communication among professionals, researchers and family members regarding the objectives and decisions during the interventions, several classification systems are currently being used (ROSENBAUM; PANETH; LEVITON, 2007).

As examples of motor classification scales for children with CP are the Gross Motor Function Measure Classification System (GMFCS) and the Manual Ability Classification System (MACS). These scales were established through standardized studies, which allowed their validity and reliability (STRAUSS et al., 2008, HIDECKER et al., 2012).

The GMFCS classifies the level of gross motor function (PALISANO et al., 1997); and the MACS classifies the manual ability of children with cerebral palsy

(ELIASSON et al., 2006). These instruments are characterized as ordinal scales of five levels that portray, in descending order, the level of independence and functionality of the children.

In relation to GMFCS, the classification is made according to the child's age (PALISANO et al., 1997). As for MACS, regardless of the age, children are classified as follows: level I are able to manipulate objects easily; level II are those who manipulate objects with lower quality; level III are the children who manipulate objects with difficulty requiring help or adaptation of the activity; level IV are children who perform manual activities with limited success, requiring continuous supervision; and level V are the children with severely compromised manual skills, requiring total assistance (ELIASSON et al., 2006).

GMFCS has been readily accepted in clinical practice and research and has been directly related to restrictions in activity and participation (MANCINI, 2004). The importance of using these methods jointly has been demonstrated in different studies (PALISANO et al., 1997; MANCINI, 2004; ELIASSON et al., 2006; HIDECKER et al., 2012). Both GMFCS and MACS have been translated into many languages worldwide and have often been used in children with CP by different professionals (ODDING; ROEBROECK; STAM, 2006).

In relation to the communicative function, the instrument Communication Functioning Classification System (CFCS) aims to classify the level of communication performance of the person with CP, regardless of the form of communication used, such as speech, gestures, behavior, gaze, facial expressions and augmentative and alternative communication. The instrument is divided into 5 levels: level I indicates the best functioning and level V the most severely affected communication. At level I, the child can communicate efficiently and at reduced speed with both known and unknown partners, while at level V the child has difficulty being understood by family partners (HIDECKER et al., 2011).

Hidecker et.al., (2012) investigated the relations among the instruments GMFCS, MACS and CFCS in 222 children with CP between the ages of 2 and 17 years in the United States. The systems were evaluated using Spearman's rho, stratifying by age and topographical classifications of cerebral palsy. The results indicated that the correlations among the three assessments were strong or moderate. Levels of GMFCS were highly correlated with MACS's levels ($r = 0.69$, $p < 0.001$) and slightly less correlated with CFCS levels ($r = 0.47$, $p < 0.001$). MACS and CFCS were also moderately correlated ($r = 0.54$, $p < 0.001$). In addition, the results showed that the three classifications provided additional information. The authors concluded that the use of all three systems provides a more complete description of the function of the child with CP in daily life than the use of any system alone.

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Coleman and researchers (2013) conducted a research whose objectives were to explore the communication skills of children with cerebral palsy at 24 months of age and examine the relationship between communication, gross motor function, and other comorbidities. The results indicated that there was a gradual relationship between communication skills and gross motor functioning. Children who had more severe gross motor impairment (GMFCS III-V) had poorer communication skills.

After reviewing the literature and observing in practice the need to standardize procedures for the use of AAC with children and young individuals with CP, the objective of the study was to investigate relationships between gross motor function, manual ability, communicative function and the use of AAC in children and young people with cerebral palsy.

2 Method

Participants were 9 children and young people with cerebral palsy aged 8 to 14 years and two speech therapists attending these individuals in a rehabilitation center linked to a public university in a city in the State of São Paulo, Brazil. Data collection was performed between August 2011 and August 2012.

Centro Escola is where the activities of the Projeto de Tecnologia em Comunicação Suplementar e Alternativa take place with the objective of caring of individuals with complex communication needs. This project aims to provide support for children, young adults and adults with communication impairments, as well as their families and school.

Inclusion criteria for the study were children and youngsters with a diagnosis of CP aged 6 to 15 years served by the Projeto de Comunicação Alternativa for over one year, whose parents accepted participating in the study.

Four instruments were used to perform the data collection:

1) Gross Motor Function Measure Classification System (GMFCS): This instrument was used for gross motor function classification. GMFCS is based on the voluntarily initiated movement, emphasizing sitting position and gait. The distinctions between motor function levels, from I to V, are based on functional limitations and the need for assistive technology (PALISANO et al., 1997).

2) Manual Ability Classification System (MACS): used to classify fine motor function. The instrument considers how children with CP handle objects in daily activities, assistance needs or adaptations (ELIASSON et al., 2006).

3) Communication Functioning Classification System (CFCS): used to classify

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the daily communication performance of people with CP, regardless of communicative modality. The levels of the instrument are based on the way the individuals with CP generally participate in everyday situations that require the use of communication, rather than at their best performance (HIDECKER et al., 2011).

4) Questionnaire on the use of AAC: a questionnaire that covers different aspects about the use of AAC by the person with CP was drawn up from the literature (NUNES, 2001; SORO-CAMATS, 2003; PELOSI, 2009): resource format, types of stimuli and used systems, used strategies, number of used stimuli, participation of the user in the construction of the resource and environments the user uses the resource. This questionnaire was designed to be answered by health and education professionals working with children and young people using AAC.

Data collection was divided into three stages:

1) Initial information on the participants was identified in the medical record of the selected institution. The relevant information for this research were: date of birth, school data, diagnosis, type of CP and topographic distribution.

2) Assessment of the selected participants was carried out by the researcher through observation and the instruments: GMFCS, MACS and CFCS. The assessment performed through the observation was performed during the occupational therapy, physical therapy and speech therapy at the institution.

3) The questionnaire was answered by two speech therapists responsible for caring for children and youth in the Projeto de Tecnologia em Comunicação Alternativa.

After the data collection, qualitative and quantitative analyzes of the data collected through the GMFCS, MACS, CFCS and the Questionnaire on the use of AAC were performed. The data were organized into a database using Microsoft Word, which aided their categorization in order to facilitate analysis. Subsequently, Microsoft Excel was used, which helped quantify the results and enabled the creation of illustrative graphs. For the data analysis, the enumeration rule considered was the frequency of occurrence.

In addition, pair relationships among the three systems: GMFCS, MACS and CFCS were evaluated using Spearman's Rho correlation coefficients. These statistical analyzes were conducted using IBM SPSS Statistics, version 22.

Spearman's Rho correlation coefficient strength was interpreted as follows: $|r| \geq 0.8$ very strong relationship; $0.6 \leq |r| < 0.8$ strong relationship; $0.4 \leq |r| < 0.6$ moderate relationship; $0.2 \leq |r| < 0.4$ weak relationship; $|r| < 0.2$ very weak relationship. A probability level of $p < 0.05$ was considered statistically significant (CAMPBELL, SWINSCOW, 2009).

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3 Results and Discussion

The group of children and young people participating in the research was composed of nine subjects: five female and four male individuals. The average age of children and young people was 11 years: the oldest were 14 years and the youngest were 8 years old.

All children and young people attended schools, five of them were enrolled in regular classrooms, three in special classrooms for students with physical disabilities, and one child in a special education institution.

Table 1 shows the children and their ages and the result for the GMFCS, MACS and CFCS instruments for each of them:

Table 1 - Identification of participants

PARTICIPANT	AGE/YRS	GMFCS	MACS	CFCS
P1	14	I	II	III
P2	9	V	IV	V
P3	14	I	I	III
P4	9	V	IV	IV
P5	11	I	I	III
P6	8	V	V	V
P7	12	V	IV	V
P8	10	II	I	IV
P9	12	V	V	V

Source: by the authors

Figure 1 highlights the differences among the different classifications of the instruments GMFCS, MACS and CFCS.

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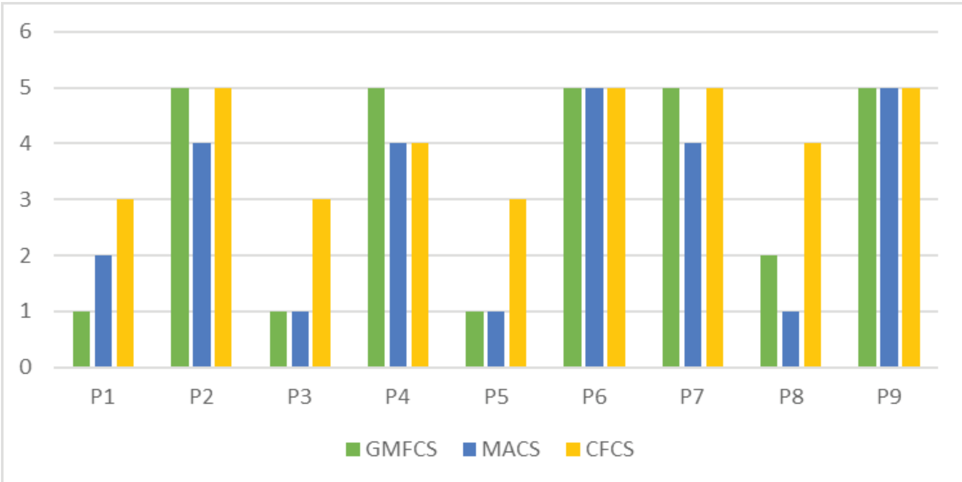
Figure 1 - Distribution of GMFCS, MACS and CFCS levels in the total number of children and young people with cerebral palsy



Source: by the authors

It can be observed that only two participants had the same classification, at level V, in the three systems. In their research, Hidecker, et.al. (2012) identified that only 16% of the 222 children in the study had the same classification level for all three scales. These results corroborate the assertion that these instruments may be complementary to understanding the function of the child with CP.

In the statistical evaluation using Spearman's Rho correlation coefficients, it was possible to identify strong correlations and statistically significant between the three evaluations. Levels of GMFCS were highly correlated with MACS levels ($r = 0.852$, $p < 0.01$) and slightly higher with CFCS levels ($r = 0.926$, $p < 0.01$). MACS and CFCS were also highly correlated ($r = 0.824$, $p < 0.01$). Thus, classification levels from these three systems should be considered separately and jointly (HIDECKER et al., 2012).

Regarding the questionnaires, the respondent speech therapists were 25 and 30 years, respectively, the first one was a Masters' degree student in Education and had 3 years of experience in AAC, and the second respondent had a PhD in Education and 11 years of experience with AAC.

Several studies have highlighted the need to assess motor skills in order to determine more functional and efficient movements for AAC resources (BERCH, 2006; PELOSI, 2008, 2009; BRACCIALLI, 2009; ROCHA, 2010).

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Regarding the resources used by children and youth, nine formats were mentioned by the professionals. Table 2 identifies the resources used by AAC users.

Table 2 - Augmentative and Alternative Communication Resources

Resources	P1	P2	P3	P4	P5	P6	P7	P8	P9
Computer	X	X	X	X	X	X		X	X
Phrase board		X					X		
Removable stimuli board	X	X		X			X	X	X
Speech generating device		X		X	X	X		X	
Photo album with symbols	X		X					X	
Intellikeys Keyboard		X				X			
Thematic board							X		
Wall Chart							X		
Communication board		X		X	X	X	X		X

Source: by the authors

As a main communication resource, professionals pointed out the computer used by 88% of the participants, followed by removable stimuli boards and communication boards with 66%, speech generating devices (55%), photo albums with symbols (55%). Intellikeys keyboards (22%), phrase boards (22%) and finally the thematic boards and wall charts both cited by only 1 user (11%).

AAC resources may be high or low technology, and the literature has identified that high technology instruments can bring greater autonomy, but they are not always sufficient for all the needs of the individual and for all the contexts in which they should be to communicate. Thus, the studies identified the possibility of the concomitant use of high and low assistive technology resources (BULTÓ, 2003; SORO-CAMATS, 2003; PELOSI, 2008; ROCHA, 2013).

It is possible to identify that the computer used in conjunction with the Intellikeys keyboard was used by participants P2 and P6, both with a greater impairment of fine motor coordination and gross motor coordination.

All participants in this study using high technology (such as the computer, the Intellikeys keyboard, and the vocalizer) also make use of one or more low-tech resources concomitantly.

The literature identifies that the use of low-technology communication boards may require a little more effort by both partners and has limitations such as the need for a closer approximation for the identification of symbols (SORO-CAMATS, 2003). One of the advantages of the low technology resource such as folders and boards is that they are customized according to the user's physical, visual and cognitive needs (PELOSI, 2009, ROCHA, 2010, ROCHA, DELIBERATO 2012, ROCHA, 2013).

In the statistical evaluation using Spearman's Rho correlation coefficients, it was

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possible to identify that the GMFCS classification system had strong and significant correlations only with the resources in photo albums and boards (both r = 0.714, p <0.05). The other variables were not correlated with GMFCS, MACS and CFCS classification instruments. New analyzes with a larger number of participants would be needed to conduct a more thoughtful discussion on the subject.

The use of different types of AAC resources is favorable, since each of them can be useful in a given context (BULTÓ, 2003). The use of AAC resources will only be successful if it expands the user's functional capacity, so it is necessary to know their needs and potentialities (COOK; HUSSEY, 2002; ROCHA, 2013).

The process of selecting AAC resources should take place with care and have the active participation of the user and the family. The success in the selection and implementation of these resources can guarantee the effectiveness of the AAC user's communication and his/her interaction in different contexts (DELIBERATO; MANZINI, 1997; SORO-CAMATS, 2003; DELIBERATO, 2009; ROCHA, 2010).

Regarding the type of used stimuli and systems, Table 3 identifies which stimuli and systems were used by children and young people with CP.

Table 3 - AAC Stimuli and Systems

Stimuli and Systems	P1	P2	P3	P4	P5	P6	P7	P8	P9
PCS Graphic Symbols	X	X	X	X	X	X	X	X	X
Symbols with letters	X	X	X		X	X	X	X	
Photos	X		X		X	X	X		
Concrete Objects				X					X
Drawing			X						

Source: by the authors

In this study, it was possible to identify that the nine participants (100%) used Picture Communication Symbols (PCS) graphic symbols, followed by 77% of participants who used symbols with alphabet letters, 55% photos, 22% concrete objects and 11% used drawings.

In addition to the resource, it is important to consider the strategies used for information selection, that is, the way the user chooses a symbol in their AAC resources.

The decision on the used strategies and systems can be linked to different aspects of the user and involves the use of objects, figures, photos, gestures, sign language, writing and even the systems of symbols already organized (MANZINI, DELIBERATO, 2004).

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All children and youth in the study, regardless of the classification on the GMFCS, MACS and CFCS scales, used PCS graphic symbols to communicate. The PCS system is basically composed of designs that indicate nouns, pronouns, verbs, and adjectives. The level of difficulty of abstraction of this system by the user is lower, therefore it is also indicated for smaller children. The iconicity level of this instrument is greater in relation to other systems, as it presents a dialogical and continuous relationship with its referents, communicating concrete and imaginable concepts in an unambiguous way. This allows the sender and receiver to speak the same language (JOHNSON, 1992).

It is possible to identify that P3 uses, in addition to other communication strategies, drawing as a form of expression. Regarding the classification of P3 in the GMFCS, MACS and CFCS instruments, it is observed that the participant is at level I in the first two scales, and level III in the CFCS. This classification allows to identify a greater functionality in the routine tasks, among them a greater possibility of developing the drawing and the writing in a conventional way (PALISANO et al., 1997, ELIASSON et al., 2006). His/her communication is effective with known partners, but it is not consistent with most unknown partners. This may be the reason why the participant uses various communication resources.

Spearman's Rho analysis resulted in no statistically significant correlation between the stimuli and AAC systems with the GMFCS, MACS and CFCS classification instruments.

Regarding the strategies adopted by children and young people in order to use AAC, Table 4 identifies the strategies used by the study participants to use AAC.

Table 4 - AAC strategies

STRATEGIES	P1	P2	P3	P4	P5	P6	P7	P8	P9
Facial Expressions	X	X	X	X	X	X	X	X	X
Direct Point Gaze	X	X	X	X		X	X	X	X
Direct Point Hand	X	X	X	X	X		X	X	
Indicative Gestures	X		X		X		X	X	
Visual Scanning		X				X			X
Switch		X				X			X

Source: by the authors

It was possible to conclude that 100% of them used facial expressions to communicate, followed by 88% of participants who used direct point gaze, 77% direct point hand, 55% indicative gestures, 44% visual scanning, and 33% the switch. Figure 2 shows the distribution of the strategies used by the participants.

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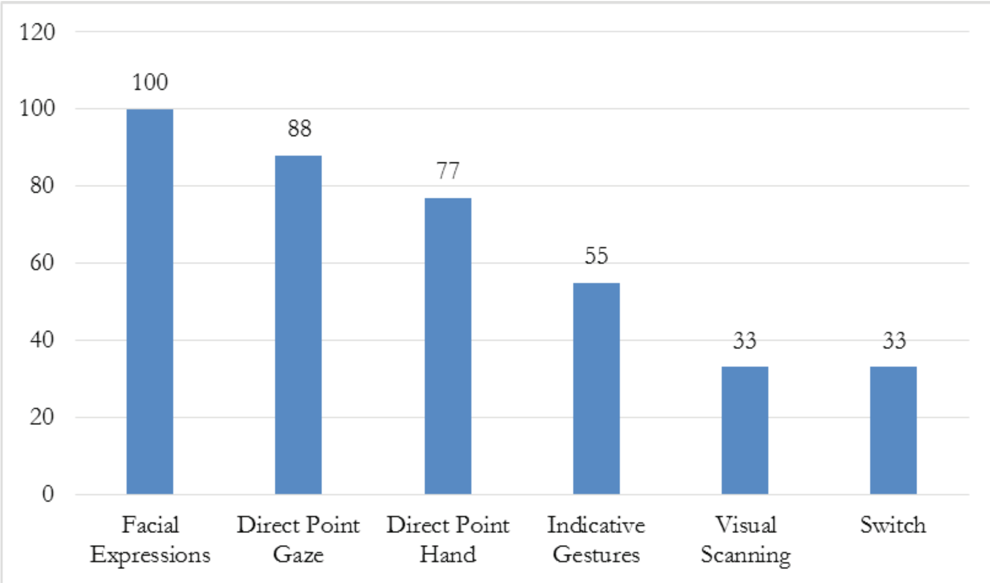
Figure 2 – Percentage of AAC Use Strategies



Source: by the authors

When assessing the form of indication of AAC signs, it is necessary to consider the mobility and type of resource that will be available (SORO-CAMATS, 2003). In this study it was possible to conclude that all children and young people used facial expressions to communicate. In this context, Bultó (2003) highlights the need to be attentive to the different signs, in addition to being inserted and knowing the child's routine.

The selection through gazing and pointing is considered a technique for direct selection, being the fastest for the identification of the information (COOK; HUSSEY, 2002). Selection through gaze is generally efficient for children with severe physical impairment (PELOSI, 2009).

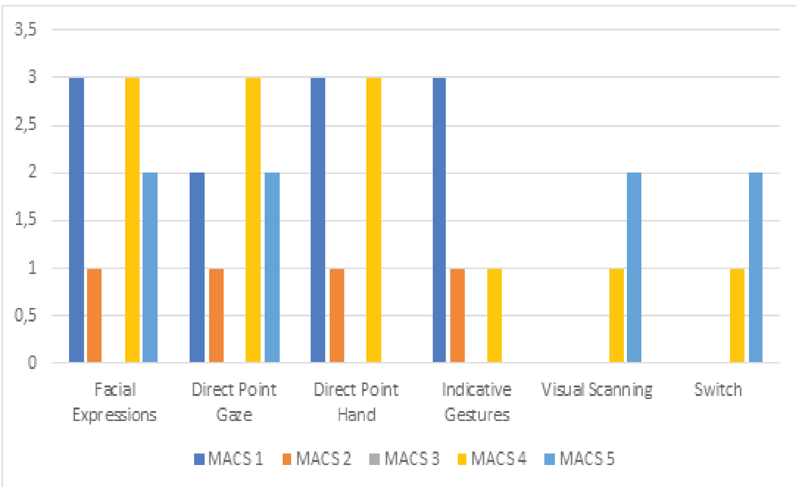
In this study, gazing and pointing had an important representativeness, being used by the majority of the participants as a way of selecting the resources.

The scan, used in this study by 44% of users, is a selection technique used by individuals who cannot directly point the information through pointing or gazing. It is possible to observe that the participants who used scanning in this study (P2, P6 and P9) presented classification IV and V in GMFCS, MACS and CFCS, presenting serious motor impairment and rarely effective communication.

In the statistical evaluation using Spearman's Rho correlation coefficients, it was possible to identify that the MACS classification system had strong and significant correlations with the scanning strategy ($r=0.759$, $p<0.05$), pointing ($r=0.753$, $p <0.05$), switch ($R = 0.759$, $p <0.05$) and very strong correlation with the strategy of indicative gestures ($r = 0.810$, $p <0.01$). The GMFCS classification system had a strong and statistically significant correlation with the strategy of indicative gestures ($r = 0.775$, $p <0.05$). However, the CFCS classification system had strong and significant correlations with the scanning strategies and the use of the switcher (both $r = 0.732$, $p <0.05$).

Figure 3 represents the relationship of the MACS with the strategies for the use of AAC. According to the results, this classification instrument had more correlations in the statistical analysis.

Figure 3 - AAC Use Strategies according to MACS levels in the total group



Source: by the authors

Regarding the number of stimuli used by the participants to transmit information, it was possible to identify that seven, that is, 77% of the participants used several stimuli in a communication resource and two participants (22%) used only two stimuli at a time.

Participants P4 and P9, who used only two stimuli, presented severe impairment in fine and gross motor coordination.

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The choice regarding the arrangement of the symbols in the communication resource should consider the motor, visual and communicative aspects. Thus, before inserting communication symbols, it is necessary to understand the user's situation and to define specific strategies for the best use of the AAC (MANZINI; DELIBERATO, 2004; ROCHA, 2013).

Spearman's Rho correlation analysis resulted in no statistically significant correlation between the number of stimuli used for AAC use with the GMFCS, MACS and CFCS classification instruments.

Regarding the participation in the construction process of the technology resource, Table 5 identifies the involvement of each study participant in this process.

Table 5 - User participation in the construction of the resource

STRATEGIES	P1	P2	P3	P4	P5	P6	P7	P8	P9
Stimuli Selection	X	X	X	X	X	X		X	
Elaboration of resource	X		X	X	X	X		X	
Organization of resource	X	X	X	X	X	X	X	X	

Source: by the authors

The study allowed to identify that no therapist mentioned the participation of the users in the identification of their needs; it was mentioned that 77% participated in the selection of the stimuli, 66% in making the resource and 88% in the organization of the material to be used. It is important to note that P9 did not participate in the construction of the resource at any time, and his/her family collaborated in the process.

The need to use the resources in different environments should be highlighted, thus, Table 6 identifies the use of AAC by study participants in different environments.

Table 6 - Use of AAC in different environments

Environments with AAC use	P1	P2	P3	P4	P5	P6	P7	P8	P9
Therapy	X	X	X	X	X	X	X	X	X
School	X	X	X	X		X	X	X	
Family setting		X	X		X	X	X	X	
Leisure activities						X	X		
Outings						X	X		

Source: by the authors

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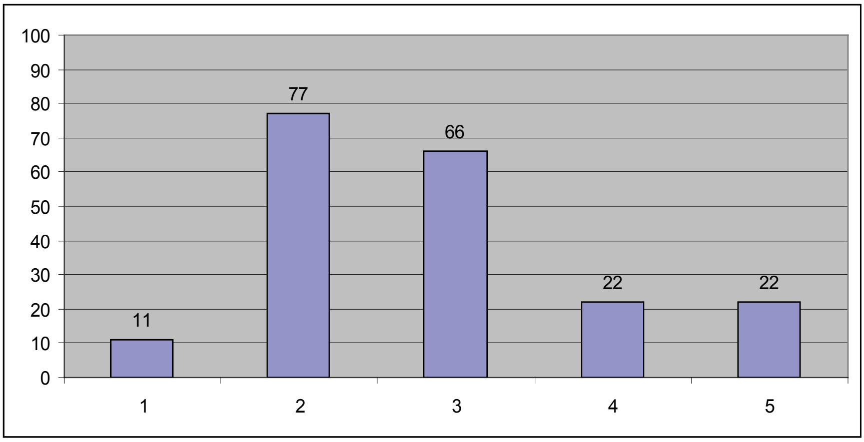
After answering to the questionnaire, it was possible to identify that one of the participants (11%) used the AAC only during the therapies. It was identified that among the other participants 77% use the CSA in school, 66% in the family environment, 22% in leisure activities and 22% during outings. Figure 4 shows the use of AAC in different environments.

Figure 4 - Use of AAC in different environments



1	Therapy
2	School
3	Family setting
4	Leisure activities
5	Outings

Source: by the authors

It is possible to identify the most frequent use of AAC in different settings among children and youngsters with greater motor impairment and rarely effective communication as receiver and sender, even with known partners, as in the case of participants: P6 (MACS V, GMFCS V and CFCS V) and P7 (MACS IV, GMFCS V and CFCS V). This data may be related to the greater need of different AAC means by the user, since the use of the AAC provides this group with optimization of their functional communication skills in different contexts (SORO-CAMATS, 2003, ODDING, ROEBROECK, STAM, 2006).

4 Conclusions

The study allowed the characterization of a group of children and youngsters using AAC and the relationship of their practices of use with the GMFCS and MACS

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motor classification instruments and the CFCS communicative performance. It was possible to identify some relationships between the motor impairment of children and young people with cerebral palsy, the communicative function and the type of resource, the strategies and systems they use, the type of adopted stimuli, the participation in the construction of the resource and the use in different environments. This study needs to be reapplied in different groups of AAC users to obtain more precise results regarding the use of AAC and the motor and communicative impairment of the users.

The use of GMFCS, MACS and CFCS instruments along with a profile of the use of augmentative and alternative communication can help clinic and school staff think about the relationships between participation and mobility activities, object manipulation and communication of children and youth with CP.

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