



Apps for people with autism: Assessment, classification and ranking of the best

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ABSTRACT

The utilization of apps in mobile devices offers autism professionals a complementary medium with which to strengthen deficient skills. Through a system of previously validated indicators, we have thoroughly assessed 155 apps that are available on the Play Store. To select the apps aimed at people with autism, we used the search term "autism" in English and in Spanish. The chosen apps were then assessed and given a score for their design, content and pedagogic dimension. The assessment concluded by establishing a ranking of the apps. Only 14 apps obtained scores notably higher than the rest.

1. Introduction

Currently, the development of Information and Communications Technology (ICT) is undergoing changes and improvements, offering multiple forms of learning and interaction to diverse sectors of the population. In the case of people with Autism Spectrum Disorder (ASD), the creation of digital spaces focused on their needs has proliferated in recent years. As Guzmán et al. [1] show, research into their relevance in therapy and clinical medicine is beginning.

The DSM-5 defines ASD as a set of "persistent deficits in social communication and social interaction across multiple contexts [... with] restricted, repetitive patterns of behavior, interests, or activities" [2]. In this regard, the technological options available today for working with people with ASD – principally with children – and for helping to improve their quality of life are wide-ranging [3]. In fact, there are numerous studies focused on the benefits of ICT for people with ASD. Authors such as Grandin [4] and Jordan and Riding [5] show that, by using the visual in addition to the auditory code, ICT promotes the processing of knowledge and improves perception. This is possible because it tends to be presented with a visual format that attracts people with ASD, given that they process information in a different way [6]. This idea is also highlighted by García et al. [7], who state that ICT stimulates the senses, particularly sight, the development of which is essential for autistic people, since they process most information through this means. Furthermore, Lozano et al. [8] show that ICT favours personalized

educational care and makes it possible to repeat tasks. In this way, the person with ASD can find a workspace without restrictions of time or space, offering the opportunity to access knowledge, active and interactive learning, and a world of possibilities for developing deficient skills [1].

With the passing of time, the digital divide between certain groups has been diminishing, offering learning opportunities to all types of people. The use of ICT by students with special needs promotes access to understanding the most complex aspects of everyday life, given that their tools come with a multitude of visual and sound features. Burke and Hughes [9] and Regan et al. [10] reinforce the idea that ICTs offer beneficial resources for people with disabilities. Authors such as González et al. [11], Lozano et al. [8], and Tortosa and de Jorge [12] are alike in stating that ICT for people with autism is a motivating medium. At the same time, ICT offers controllable situations and settings for users [3,13], reducing stress and bringing about anticipation in the face of different stimuli. Moreover, as García et al. [7] state, "ICT and, specifically, mobile apps, are multiplying and, educationally speaking, can be a great resource for children diagnosed with ASD, since they can improve communication, language, the emotions, social intervention and vocabulary".

1.1. Use of apps

Currently, the development of web platforms and apps aimed at

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families, specialists and people with ASD and, more specifically, those with autism, is growing, as are the studies concerning what is being offered and how people with this disorder can benefit from them. However, despite there being many apps, there are few publications that show the success or influence they have on their users, and there is a scant bibliography on the use of apps.

In other disciplines, there do exist rigorous studies that address the topic of apps and analyse what is currently offered to users, such as the following: Martínez Gómez [14] on educational mathematics apps for children; Galar [15] on the analysis of the quality of educational apps; García Rico [16], concerning the use of the app “PICAA” in students with special educational needs; Mugarza [17], in which the 50 best health apps in Spanish are put forward; Comín [18] on apps designed for child education; Rico [19], focused on the use of apps that address creative processes in artistic education; Roncandio [20], which analyses educational apps in Early Childhood Education; Natarajan et al. [21], related to mobile shopping apps; Rajak and Shaw [22], focused on the evaluation of health apps; Alam et al. [23], in which the factors that influence the behavioural intention of using mHealth apps are explored; and, lastly, Vaclavik et al. [24], on factors influencing confidence in the use of travel apps. There are even specific disciplines on the use of ICT for specific groups, such as for the visually impaired.

Therefore, examining everything that technology offers should be the starting point for seeking the medium through which the person with autism may attain functional communication and, with this, develop language, express emotions, understand the emotions of others and, not least, promote social interaction in accordance with their capacities. For professionals, it is essential to find out what is being offered and what resources are currently available in order to work with people with autism and adapt the materials to their characteristics. Having access to attractive tools that encourage learning will help to improve quality of life insofar as their skills are strengthened. As Guzmán et al. [1] state, “the availability of resources such as the mobile telephone, tactile digital devices, virtual personal and community interfaces, opens up the field of interaction and of problem-solving to a universe almost unlimited in possibilities” (p. 252). Thus, coming to the purpose of this study, to learn what is being offered and how to undertake appropriate usage of ICT is vital for achieving the proposed aims for people with autism, both for professionals and family members.

The app market is varied and offers tools aimed at working on different areas that pose a problem for people with autism, such as communication [25–27], emotions [28–31], time management [32], basic instrumental skills – language, mathematics, etc.– [33], executive functions – organization, memory, attention, etc. – [27,32,34], and leisure/entertainment [35,36]. It must be noted that most of the apps do not specify the age of the user they are aimed at. Despite this, following a review of the catalogue of existing apps, we can state that they are mostly designed for children.

Having reviewed the literature, we confirm that, up until now, there has been no rigorous analysis of the apps aimed at people with autism, nor has there been a ranking of the best, which would be of use to families and professionals. Therefore, given the purpose of this study, we set forth the following objectives:

1. To analyse the quality of the free apps for people with autism that are available on the Google Play Store.
2. To assess each app according to its design, content and pedagogic aspects.
3. To establish a ranking of the best apps.
4. To determine what areas the apps assessed work with.

2. Method

2.1. Sample

In order to proceed to the analysis of apps aimed at people with

autism, we took the Google Play Store search engine, available in mobile devices with the Android operating system, as the starting point. Previous studies [7, 38–42] use app stores because they are the most popular and safest platforms for finding and downloading apps, and the professionals and families of people with autism will rely upon them to search for, download, install and later update these apps.

The only filter applied for the search was that the app be free. Chronologically speaking, two searches were made, trying to handle the largest number of apps possible. Using the Spanish keyword “Autismo”, 228 apps were found (January 2019–February 2019), of which 123 were excluded, as per the criteria shown in Table 1, with the final number evaluated being 105. The second search was carried out with the English keyword “Autism”, with 247 apps being found (March 2019–April 2019), of which 192 were excluded according to the exclusion criteria (Table 1) and 50 assessed.

2.2. Instrument

For the assessment of each app, the “System of Indicators and Instrument for the Assessment and Selection of Apps for People with ASD”, designed and validated in Gallardo et al. [37] was used. The use of a system of indicators is a useful resource for assessing the products or services under offer in a tangible way. The aspects that are evaluated are in keeping with the ideal criteria for an app aimed at this community. Hence the indicators, and their consequent explanations, were rigorous and analysed from a psycho-pedagogic point of view. The development of the indicators used was created using previous national and international studies [38–41,43–45].

Three dimensions of each app were evaluated:

- Design/form: availability (languages, updating, identifiable icon), ergonomics (legibility, clarity, use of color, personalization), usability (velocity, browsing), popularity (user rating, number of downloads, prizes) and accessibility (access to the app by users with ASD, use without internet connection).
- Content: audio and narration quality (sounds, music, narration, voice modulation, clarity, neutral intonation), contents (variety of topics, content organization, levels), notifications, help/tutorials (tutorials in written or audio format) and safety (data protection, installation permissions, parental control, blocking of in-app purchases).
- Pedagogic aspects: interactivity (the app allows the uploading of own images or pictograms), appropriateness of pace and learning (content suitable for people with ASD, sufficient time for carrying out activities, different communication codes), monitoring and evaluation of exercises/activities.

The instrument consisted of a total of 14 indicators, subdivided into 46 sub-indicators. The presence of each sub-indicator was given a score of 1 point, so that the scoring of the design/form dimension (D1) ranged from 0 to 22 points; that of content (D2) from 0 to 18 points; and the pedagogic (D3) from 0 to 6 points. The total thus ranged between 0 and 46 points. Lastly, to determine whether each of the apps assessed was deemed recommendable or not for users with autism, the following parameters have been used (Table 2).

Table 1
App exclusion criteria.

Exclusion Criteria	Keywords	
	“Autismo”	“Autism”
Unrelated to the topic	52	92
Aimed at professionals/families but not at people with autism	41	0
They would not open or were not compatible with the device utilized	30	82
Repeated	–	18

Table 2
App classification criteria.

Group	Score	Percentage of sub-indicators	Classification
1	≥37 points	80–100	Highly recommendable
2	36–23 points	50–79	Recommendable
3	≤22 points	49–0	Not recommendable

The instrument was validated by 12 judges, comprising: four teachers from the Faculty of Education Sciences of the University of Granada with extensive academic and scientific training in addressing diversity and the psycho-educational care of people with special educational needs; four professionals with ample experience in working with people with ASD; and four experts in the field of computing, ICT and apps. The experts had to validate the indicators and sub-indicators on the basis of the following criteria: clarity (“It is formulated with appropriate and comprehensible language. It is easily understood”); coherence (“It is suitable for the study objective. It has a logical relation with the dimension or indicator that it is measuring”); relevance (“Degree of importance for the dimension. It is essential or important, and, therefore, it should be included”); and objectivity (“It makes it possible to measure observable facts”). They used a scale of 1–4, namely: 1 = Unsatisfactory, 2 = Satisfactory, 3 = Good, 4 = Excellent. As well as this quantitative assessment, the experts were able to make a qualitative evaluation through comments and suggestions for improvement.

Once the judges’ ratings had been analysed, the Intraclass Correlation coefficients (ICC) and Kendall’s W coefficients were calculated in order to determine the degree of agreement between them. The ICC obtained were excellent (0.955 D1, 0.973 D2 and 0.966 D3). The ICC are measured between 0 and 1 — the higher the value the coefficient has, the less the variability is attributable to the difference between the expert ratings (in other words, there is better agreement between them). As these values were higher than 0.750 [46], they indicated that the inter-rater reliability was excellent. It also attained a Kendall’s W inter-rater concordance that is significant and strong (with values between 0.757 and 1.00, $p < 0.001$), and excellent levels of internal consistency (Cronbach’s alpha coefficient above 0.900: 0.955 D1, 0.973 D2 y 0.966 D3), demonstrating that this is a valid and reliable instrument.

2.3. Procedure

Each app was comprehensively assessed following the system of indicators. The apps were installed and assessed during the first quarter of 2019, always using the same device – connected through AC Wi-Fi at a speed of 600 Mb/s – in order to prevent any alteration and to be able to make an assessment under equal conditions. The apps were installed for two weeks on the smartphone, in order to examine the notifications that might be sent to the user, this being one of the sub-indicators under evaluation.

2.4. Design and data analysis

We have carried out a descriptive study, with the aim of learning and evaluating what is being offered to people with autism in terms of mobile apps. We have used a cross-sectional design and a non-experimental quantitative method, since the variables do not undergo any modifications.

In order to undertake the assessment of each app through the system of indicators, the Microsoft Office Excel 2016 program was used. The gathered data were then treated with the SPSS Statistics version 25.0 for Windows pack, with a margin of error of 5% and a reliability level of 95%. Thus, to achieve the proposed objectives, the frequencies and measures of central tendency (mean and standard deviation) have been calculated. And for the comparison between groups, the Kruskal-Wallis non-parametric test for independent samples has been used.

3. Results

After the assessment of the 155 apps, we obtained the following: 9% ($n = 14$) belonged to Group 1, those that were *highly recommendable*; 85.2% ($n = 132$) belonged to Group 2, the *recommendable*; and 5.8% ($n = 9$) to Group 3, the *not recommendable*. Comparing the groups (Table 3), it was observed that the apps in Group 1 attained the highest scores in all dimensions. The apps in Group 3 obtained scores below the mean in all dimensions, while those in Groups 1 and 2 were above. The dimension in which there was the least difference between Groups 1 and 2 was that of design, while the greatest difference was found in that of content. Between Groups 1 and 3, the dimension showing the greatest difference was that of content, and the least, the pedagogic dimension. Lastly, Groups 2 and 3 differed the most in design and the least in pedagogy.

Taking the apps belonging to Group 1 as a reference, we present a ranking of the 14 *highly recommendable* apps, with their respective total and individual scores in each of the dimensions assessed (Table 4) – each app was assigned the name with which it appeared in the Google Play Store search engine. None of the apps assessed reached the maximum possible total of 46 points, with 40 being the highest score obtained and only by two of the apps (25%): “#Soyvisual” and “Otsimo”. Eight (57.14%) of these apps are at the lower limit for forming part of Group 1, with a score of 37 points.

The app “SymboTalk - AAC Talker” obtained the best score in Dimension 1, on design, because unlike the others, it stood out for its variety of useable languages, an aspect that few apps had. The lowest-scoring app in this dimension was “Michelzinho - emoções e autismo”, since it could not be used in different languages and could not be personalized in text or audio.

In Dimension 2, on content, the app “Otsimo” attained the highest score, due to the fact that, as well as having indicators common to its rivals, it presented tutorials in audio and in written form, and sent notifications to the smartphone even when the app was not in use, as well as emails to the address of the registered user, informing about changes or new exercises, which made it even more interactive. In contrast, the apps that gained the lowest score were “SymboTalk - AAC Talker”, “CPA” and “Emociones, sentimientos y expresiones!”, because they had no music, no audio tutorials and did not send notifications to the user.

“CPA” and “Michelzinho - emoções e autismo” were the apps that succeeded in bringing together all of the proposed indicators in the Pedagogic Dimension (D3), as they allowed the user to add their own images or pictographs, offered different codes of communication, sufficient time to carry out the activities, and they monitored and assessed the proposed activities so that the user could receive feedback on their progress. However, the apps “Visual schedules and social stories”, “Juegos de niños para bebés de 2 a 5 años”, “CommBoards - gratis terapia del autismo AAC” and “SymboTalk - AAC Talker” scored the lowest in this dimension, mainly because they lacked any monitoring of the user’s progress.

It is worth noting that in Group 2 some of the apps attained a similar score to those in Group 1 in certain dimensions. For example, four apps from Group 2 scored 20 points in Dimension 1 (design), the same as those from Group 1 (Table 5).

In contrast, with Dimension 2 (content), not one app scored as well as the best app from Group 1. However, there were two apps that obtained 15 points and nine that obtained 14 points (Table 6).

Regarding Dimension 3 (pedagogic), 74 apps from Group 2 obtained a score that was higher than the mean. To further refine the search, Table 7 shows the seventeen apps that scored 5 in this dimension.

Concerning which areas the 155 apps worked with, it was observed that most of the apps addressed several (Table 8). Thus, 95.5% ($n = 148$) focused on the executive functions, 58.7% ($n = 91$) worked on language, 50.3% ($n = 78$) addressed leisure and entertainment, 46.5% ($n = 72$) communication, 40% ($n = 62$) dealt with the basic instrumental skills, 14.2% ($n = 22$) focused on the emotions, and, lastly, 11.6% ($n = 18$) on

Table 3
Statistically significant differences in the dimensions according to the app groups.

Dimension	Groups									Kruskal Wallis		
	3 (n = 9)			2 (n = 132)			1 (n = 14)			χ^2	df	p
	M	SD	AR	M	SD	AR	M	SD	AR			
D1	10.89	3.37	8.33	17.03	1.46	80.01	17.85	0.94	103.82	27.60	2	.000*
D2	6.11	2.84	23.67	10.42	2.66	74.48	15.14	0.86	146.14	46.76	2	.000*
D3	2.33	0.70	32.39	3.38	0.95	75.33	4.85	0.66	132.50	32.86	2	.000*

Note: D1 = Design/form dimension; D2 = Content dimension; D3 = Pedagogic dimension; Group 3 = Not recommendable apps; Group 2 = Recommendable apps; Group 1 = Highly recommendable apps; M = Mean; SD = Standard Deviation; AR = Average Rank. Statistically significant: *p < 0.001.

Table 4
Ranking of highly recommendable apps according to scores obtained.

Name of the app	Total Score	D1	D2	D3
#Soyvisual	40	19	16	5
Otsimo	40	18	17	5
Autism language and cognitive therapy with MITA	39	18	16	5
Smile and Learn: juegos educativos para niños	39	18	16	5
SymboTalk - AAC talker	38	20	14	4
CPA	38	18	14	6
Visual Schedules and Social Stories	37	18	15	4
Juegos de niños para bebés de 2 a 5 años	37	18	15	4
CommBoards - gratis terapia del autismo AAC	37	18	15	4
Emociones, sentimientos y expresiones!	37	18	14	5
LEA, Lecto Escritura para Autismo	37	17	15	5
Autastico	37	17	15	5
Terapia z tabletem	37	17	15	5
Michelzinho - emoções e autismo	37	16	15	6

Note: D1 = Design/form dimension; D2 = Content dimension; D3 = Pedagogic dimension.

Table 5
Apps from Group 2 that scored well in Dimension 1.

Name of the app from Group 2	Total Score	D1	D2	D3
aBoard CAA	36	20	13	3
ISECUENCIAS LITE	35	20	11	4
Asistente de voz ACC	35	20	12	3
LetME Talk	33	20	9	4

Note: D1 = Design/form dimension; D2 = Content dimension; D3 = Pedagogic dimension.

Table 6
Apps from Group 2 that scored highly in Dimension 2.

Name of the app from Group 2	Total Score	D1	D2	D3
Speech Blubs: Language Therapy	36	16	15	5
SocialSkills for Autism Kloog2	36	16	15	5
Proyecto Emociones	36	17	14	5
Quien en quien pictogramas	36	17	14	5
Jose aprende	35	18	14	3
Teacch.me	35	16	14	5
ABA DrOmnibus for parents	35	14	14	4
Diegosays autiso habla	34	17	14	3
Horsy	34	17	14	3
Autism help	33	16	14	3
El oledor	32	15	14	3

Note: D1 = Design/form dimension; D2 = Content dimension; D3 = Pedagogic dimension.

time management.

Focusing on the highly recommendable apps, we found that the areas that were most common in each of the apps were the executive functions, communication and language, whereas the emotions and time management were the least addressed.

Table 7
Apps from Group 2 that scored highly in Dimension 3.

Name of the app from Group 2 (Recommendable)	Total Score	D1	D2	D3
Proyecto Emociones	36	17	14	5
SocialSkills for Autism Kloog2	36	16	15	5
Preescolar juegos en Spanish	36	19	12	5
Quien en quien pictogramas	36	17	14	5
Speech Blubs: Language Therapy	36	16	15	5
Teacch.me	35	16	14	5
Vi.co Hospital Lite	35	17	13	5
Visual reading - educacion especial	35	19	11	5
Proyecto retratos	34	17	12	5
Autimo	34	16	13	5
Emoplay	33	15	13	5
Tarjetas educativas en Spanish	33	16	12	5
Daily tasks	32	17	10	5
AJEDREZ NIÑOS INFANTIL GRATIS	32	17	10	5
Dictapicto	31	18	8	5
ABA Kit	31	15	11	5
El viaje de Elisa	31	18	8	5

Note: D1 = Design/form dimension; D2 = Content dimension; D3 = Pedagogic dimension.

On the basis of the results shown above, in Table 9 each of the fourteen highly recommendable apps are presented, according to language, areas dealt with, target user, total score obtained, description, advantages and disadvantages, and global assessment.

4. Discussion and conclusions

The app review has made it possible to observe the great variety of existing educational tools for promoting the integral development of people with autism. The catalogue offered by the Google Play Store covers a broad range of essential aspects that make up the psycho-pedagogic intervention in ASD.

It should be noted that this study aimed to show those apps that, due to their design, content and pedagogic dimension, proved to be the most enriching for people with autism. Hence, the didactic application this study focuses on is to provide specialists and family members with those apps that are best adapted for people with autism.

Having reviewed every one of the apps offered for free on Google Play Store, it could be seen how many of them are not aimed at people with autism but solely for families or professionals. Thus, it is essential to be able to select those apps created exclusively for people with ASD, since there are more than 450 apps on offer (using the descriptors “autismo” and “autism”). Likewise, many of the suggested apps do not focus on the needs of people with autism, but appear randomly in the search results, which means that an arbitrary search would result in hundreds of apps, few of which would be those designed exclusively for users with ASD.

Furthermore, most of the apps do not specify the age group they are aimed at. This may either be because the app can be used at any developmental stage, or because this information was overlooked. It is relevant for information of this type to be shown, as it helps in the

Table 8
Areas addressed by the highly recommendable apps.

App	CO	LA	EM	TM	SK	EX	LE
#Soyvisual	X	X			X	X	X
Otsimo	X	X			X	X	X
Autism Language and Cognitive Therapy with MITA		X	X		X	X	X
Smile and Learn: Juegos educativos para niños		X	X		X	X	X
SymboTalk - AAC Talker	X	X			X	X	X
CPA	X	X			X	X	X
Visual schedules and social stories		X		X	X	X	X
Juegos de niños para bebés de 2 a 5 años		X		X	X	X	X
CommBoards - gratis terapia del autismo AAC	X	X			X	X	X
Emociones, sentimientos y expresiones!	X	X	X		X	X	X
LEA lecto escritura para autismo	X	X			X	X	X
Autastico	X	X			X	X	X
Terapia Z tabletem	X	X			X	X	X
Michelzinho - emoções e autismo	X	X			X	X	X

Note: CO = Communication; LA = Language; EM = Emotions; TM = Time management; SK = Basic Instrumental Skills; EX = Executive Functions; LE = Leisure/entertainment

process of app selection. And given that the age of the target user is not indicated, it would be useful for the app to indicate certain competences that the user should possess in order to use it, since some of them only contain reading and do not include audio narration or sounds that would enable the user to continue using them even if they have not yet attained the skill of reading. Many apps include stories, which means that, if they are not given voice narration by the app itself, their use will be limited even though the content is suitable for people with autism.

It should not be forgotten that the ultimate purpose of the educational apps is to reinforce the daily work carried out by families and professionals in autism. Hence their use should be framed within a specific programme in which the activities complement each other; they should not make an arbitrary use of them.

Currently there are studies focused on the assessment of websites and apps, but not exclusively for the autism community. There are many disciplines that can benefit from these studies, but in the field of autism we have not been able to find studies of this type. Therefore, given that there are no known investigations that evaluate apps specifically for autism in depth, it is difficult to make a comparison of the results. This thus entails a limitation, given that a proper assessment in comparison with other studies cannot be undertaken. However, this is an opportunity for innovation for professionals in the field to make appropriate and responsible use of resources of this type, at the same time offering researchers enriching results of this topical subject area.

It is curious that, after examining the 155 apps, the area of the emotions is that which features the least. ASD presents a symptomatology precisely with deficiencies in social relations, very closely related to the emotions. In fact, despite the fact that this incapacity to recognise the emotional states of other people and to understand their own emotions is the main trait of the disorder, there are few apps that aim to deal with these skills (which, if they are worked on, can be seen to improve). Fortunately, the apps linked to communication and language feature frequently on the Google Play Store catalogue, which is good news as communication (the communicative intention in itself) is the basis upon which developing the other skills can be achieved.

It is noteworthy that, despite there only being 14 apps in the *highly recommendable* group, the large majority of the remaining apps are recommended for therapy with autism, with only 9 in the *not recommendable* group. Thus, even though some apps are less complete than others, the development of apps focused on ASD is obtaining high scores and users can make an optimal use of them.

Regarding the pedagogic dimension, only the apps “CPA” and “Michelzinho - emoções e autismo” from those ranked *highly*

recommendable attain the maximum score (6 points). In this regard, it is important to work on helping the other apps in the catalogue to achieve essential aspects of this dimension, whereby they can manage to wholly adapt criteria that are key to the development and strengthening of the teaching-learning process. This requires the collaboration of teachers and educators with programming engineers to build accessible pedagogic software.

Aside from this, routines and time management are also areas that need emphasising, because, as is well detailed in APA [2], this disorder presents restrictive patterns in terms of behavior and activities. The apps that deal with these issues organize the way to set out time to perform routine tasks very well, such as brushing one’s teeth or to manage what one is going to do throughout the day. However, these apps are given less space. It is essential that, if ICT and apps are going to be utilizable as resources complementary to education and therapy for people with ASD, they be easy to find by families and specialists, and that they be of good quality.

Regarding future research, it would be worthwhile to enhance the system of indicators by expanding those that refer to the pedagogic dimension, for they only make up 13% of the total score of an app. Additionally, there should be an assessment of the quality with which the apps address the areas where people with ASD present most difficulties. It would also be of value to assess and evaluate the apps that appear when using search terms such as “Pictograms”, “Pictographs”, “Augmentative and Alternative Communication (ACC)” and “Visual Schedules” in Spanish and in English. This would enable a complete survey of all the material that is offered to people with autism and to distinguish those apps that better adapt to the areas that need to be worked on.

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Author statement








Carmen del Pilar Gallardo Montes: Term, Conceptualization, Methodology, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization. **Antonio Rodríguez Fuentes:** Term, Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project

Table 9
Description of the best apps.

App	Language	Areas	Target Users	Score	Description	Advantages	Disadvantages	Global Assessment
 #Soyvisual	Spanish	Development and promotion of language	–	40	It works in a progressive way: oral comprehension, vocabulary, word articulation and sentence construction. It has a space for profile management.	It combines numerous visual aids with their corresponding written expression and audio verbalization. It sends notifications to the user about newly available material.	Only available in Spanish	The design is appropriate and the areas that it works on are set up to stimulate the user through an augmentative system of communication with colours and sounds appropriate to the set of activities.
 Otsimo	English and Turkish	Association and recognition of forms, colours and numbers	–	40	Association games with different themes (meals, feelings, numbers ...). It includes an area specifically for parents	The activities undertaken are evaluated so that the user can see the progress they have made.	It is not available in other languages and some contents can only be accessed through purchase.	The contents and the catalogue of activities are displayed in a clear way, with all the games accessed in an intuitive way.
 Autism language and cognitive therapy with Mental Imagery Therapy for Autism (MITA)	English	Attention, memory, association, language and visual skills	5 years old and under	39	Games are organized into a <i>tour</i> . Each activity has to be successfully completed to be able to go on to the next. The exercises increase in difficulty as the user goes on. The activities require attention, and visual and auditory discrimination.	Many areas are worked on to foster different skills in a way that is visual and attractive for the child. If a level is not successfully completed, the child cannot discover the rest, which is motivating and encourages learning.	The section for parents, where the child's progress can be observed, is not free.	This is a good app that promotes learning through play. The scenes are visually appealing. The child is congratulated when they have done an activity well, which also motivates them to continue.
 Smile and Learn: Juegos educativos para niños	Spanish, English, French, Portuguese and Italian	Comprehension, attention, creativity and language	6–12 years old	39	The app is navigated via "islands", each of which is dedicated to a subject, such as the sciences, the emotions, the arts, logic, etc. It contains activities such as puzzles or pairing.	Diversity of languages available. The game is very interactive and includes pictographs that facilitate the assimilation of concepts. It includes three levels of difficulty.	There are sections that are not free.	The variety of games and the form in which they are presented to the child make a very motivating medium. The images, stories and sounds are suitable and the format is presented in a clear and intuitive way.
 CPA	Spanish	Communication	–	38	It makes it possible to construct sentences that facilitate communication through ARASAAC pictographs (Aragon Centre Augmentative and Alternative Communication Systems).	It contains a series of settings to fit the content to the user. It includes a section with password to access content editing.	Only available in Spanish	The variety of pictographs, along with the combination of the visual and written format, facilitate the user's interaction and communication.
 SymboTalk - AAC Talker	49 languages	Augmentative and Alternative Communication (AAC)	–	38	Many panels with ARASAAC pictographs with their corresponding verbalization. A range of sentences can be created relating to the themes offered (fruits, toys, places, etc.).	Creation of personalized panels with images uploaded by the user.	It does not include sounds when clicking on the panels, only narrations.	It enables working on a multitude of areas through the variety of pictographs included. Adding images stimulates the user and promotes meaningful learning.
 Michelzinho -	Portuguese	Emotional and social skills	–	38	It asks the user to express an emotion such as joy or surprise and through	It offers a way of learning that is more interactive for the child.	It is not available in other languages.	The app stands out for due to its originality. By including music and sounds during


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Table 9 (continued)

App	Language	Areas	Target Users	Score	Description	Advantages	Disadvantages	Global Assessment
 <p>emoções e autismo</p>	English	Communication through stories	6–12 years old	37	the camera they can recognise their face. It tells stories and daily tasks through which the child can come to understand each of the processes and assimilate them.	Colours and themes suitable for children. The content is very visual and appealing.	Only the one language. It only uses written format.	facial expression, it holds the attention of the user. If offers excellent visual aid to encourage communication. It has an area for parents in which their own photos and videos can be added so that the interaction with the child can be more rewarding.
 <p>Visual schedules and social stories</p>								
 <p>LEA lecto escritura para autismo</p>	Spanish	Reading and writing	No age is specified, but the user is required at least to know their letters to be able to interact with the app's exercises.	37	The user can create a profile and access a variety of reading and writing exercises and activities on the emotions, the body, the family and the alphabet.	The stories include audio narration so that the user can read or listen to them.	It does not allow the user to add their own images, and neither does it include other languages.	It is very visual and enables the user to interact through the different spaces designed in an interactive way. The content is clearly organized, as each area is identified by an image and its corresponding written expression.
 <p>Autastico</p>	English	Emotions, numbers and shapes	8 years old and under	37	The user can create a personalized character, draw or do puzzles. The activities include music, sounds, assessment of the games undertaken and congratulations after completing the proposed tasks.	Images are combined with sounds, music and narrations	Not available in other languages, and neither does it allow uploading of personalized images.	The colours and way of organizing the content are suitable and adapted to the age and the users.
 <p>Juegos de niños para bebés de 2 a 5 años</p>	Spanish	Association, coordination, logical thinking	5 years old and under	37	It has a menu from which the child can choose the game they want to play, such as association games of fruits, vegetables or animals.	It includes an area for parents where they can consult information about the game. It does not include that much dialogue in Spanish, meaning that it could be used by people with other languages.	The section for parents is in English	The app is in general very eye-catching and makes playing the games appealing to the child. The colours and way of organizing the different sections are presented in a clear and intuitive way.
 <p>Terapia Z tabletem</p>	English, Polish and Swedish	Emotions, communication, classification, differentiation, etc.	From 3 years old and up	37	The user can only access the app by registering beforehand with an email. The app contains different games. It includes a section where the child's progress can be consulted.	It works on different areas at a cognitive level and the activities undertaken are assessed.	It has a free trial period, after which the user must pay.	All the content is organized in a very visual way and the drawings and animation are adapted to the users.
 <p>Emociones, sentimientos y expresiones!</p>	English, Russian, French, German and Lithuanian	Emotions and feelings	–	37	It has two sections. The first shows images of people or drawings expressing an emotion, and by clicking on them a voice says what the feeling is. The second section shows images of a person and asks the user how they feel, having to indicate it	The images of people express the feelings in a much closer way, apart from including drawings. It assesses whether the user identifies them correctly.	It contains advertising.	The app has different levels, which the user reaches progressively, by understanding every one of the emotions and feelings expressed. The app is very intuitive and it is easy to navigate.

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Table 9 (continued)

App	Language	Areas	Target Users	Score	Description	Advantages	Disadvantages	Global Assessment
 CommBoards - gratis terapia del autismo AAC	Spanish, English, Hebrew, Russian and Chinese	Communication	8 years old and under	37	by clicking on the correct drawing. It enables making panels with pictographs or own images to promote communication and express the needs of the child.	It can be personalized and is interactive, it allows the uploading of own images, voice recording and the editing of the panels to the user's taste.	Different communication codes are not offered, only written format.	It encourages the child's communication since it presents the different pictographs in a very organized way. The audio verbalizations play correctly and enhance understanding of the pictograph.

administration. **María Jesús Caurcel Cara:** Term, Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration

Declaration of competing interest

We have no known conflicts of interest to disclose.

Appendix

System of Indicators and Instrument for the Assessment and Selection of Apps for People with ASD.

Name:				
Age of Target User:		Date of Assessment:		
Area(s) addressed/developed (communication, emotions, time management ...):				
Design/Form Dimension				
Indicator	Sub-indicator	No (0)	Yes (1)	Observations
Availability	Languages			
	Updates			
	Identifiable icon			
Ergonomics	Legibility			
	Clarity			
	Use of color			
	Personalization			
Usability	Speed			Changes in the text
	Browsing			Changes in the audio
				Quick opening
				Absence of dead time
				Simple and intuitive
				Quick
				Correct functioning
		Buttons identifiable		
		Buttons the correct size		
		Buttons well placed		
			Access to the menu from all screens	
Popularity	User rating			
	Number of downloads			
	Prizes/Acknowledgements			
Accessibility	Access to the app by users with ASD			
	Use without internet connection			
Content Dimension				
Quality of audio	Sounds			
	Music			
	Narrations			
Quality of the narration	Voice modulation			
	Clarity			
	Neutral intonation			
Contents	Variety of topics			
	Content organization			Distribution
				Visualization
Notifications	Different levels			
	Sending of notifications			
	Written format			
Help and Tutorials	Audio			
	Data protection			
Safety	Necessary installation permissions			
	Parental control in the app itself			Access to internet

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	Content settings
Pedagogic Dimension	<i>Blocking of in-app purchases</i>
Interactivity	<i>It allows the user to add images or personalized pictographs</i>
Adaptation to pace and learning	<i>Content suitable for the users</i> <i>Sufficient time to complete tasks</i> <i>Different codes of communication</i>
Monitoring/ Assessment	<i>Progress is monitored</i> <i>The activities done are assessed</i>
TOTAL SCORE:	

Note: authors' design.

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