DESIGN FOR CHILDREN'S APPS

USAGE DATA & RECOMMENDATIONS FOR THE DEVELOPMENT OF APPS FOR CHILDREN UNDER 2 YEARS OF AGE AND THEIR FAMILIES

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For Georgia

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INTRODUCTION

This publication is a summary of the main results of the doctoral research project *"Diseño de apps infantiles: Consideraciones para el desarrollo de aplicaciones para menores de dos años"* (translation: *Design for Children's Apps : Considerations for the Development of Applications for Children Under Two Years Old*). The research is based on the impact that the rapid spread of mobile devices is having on the way families with babies play and interact with each other (SARACHO, 2015). Despite the plethora of criticisms and concerns that society and experts are raising against the use of mobile applications by such young children, the reality is that smartphones and tablets are currently playing an important role in their leisure time.

The market penetration of mobile applications has been very rapid. The iPad was launched in 2010 and by 2013, 38% of children under 2 years in the United States had used apps (RIDEOUT, 2013). Data shows that these technologies will continue to expand, forming an active part of family life.

In addition, the revolution that is taking place in the development of digital applications is so important that it is influencing different industries (publishing, toys, food, pharmacy, the media, etc.). There is even talk about the birth of a new discipline of design. However, these professionals require specific training, especially as they are designing for such a vulnerable target.

Several analyses are approached in this investigation. In the first place, we carried out research to define the real scope of usage of apps among Spanish children under 2 years old, considering questions such as: How many families are using apps to play with their babies? How are they using them? How often? For how long? With whom? Etc. At the same time, we gathered information about their opinions and concerns regarding their children's exposure to touch screens.

In a second phase, we analyzed the apps that parents are using with their babies, assessing their suitability in terms of recreational, educational, interactive and graphical content. Moreover, based on the available scientific literature, we defined the context in which apps could be most appropriately used with young children.

In addition, we carried out specific research on the evolution of the abilities that children develop in their interaction with touch screens. The collected data represents a first step towards improving knowledge about how to generate fun, educational, interactive well-designed apps, taking into consideration the real capabilities children have for using apps in each developmental stage.

Pediatric associations, research centers, and universities are all engaged in a variety of research to understand the positive or negative influences that exposure to apps is having. Most of this research focuses on assessing the changes that the use of apps might have on children's learning, or on their behavior. This information is of great relevance for parents, educators and, of course, for the entire scientific community. However, to our knowledge, there has not yet been any investigation focused on obtaining information to train designers on how to develop apps for such a vulnerable target as babies.

Faced with the reality of the increase of available apps targeting babies, and the growth in their use, our main objective is to generate quality information that allows the improvement of the creation and design of apps aimed at children under 2 years old. On no account do we intend to promote their use at these ages. Nevertheless, we understand the importance of generating useful data and guidance for all those artists, designers, companies and researchers interested in improving the development of digital applications for babies.

To facilitate the application of the data, the publication is presented in the form of a practical guide.

This document is based on the PhD research "Diseño de Apps Infantiles: Consideraciones para el desarrollo de aplicaciones para menores de dos años". Publication available in Spanish at the following link: https://riunet.upv.es/handle/10251/68500

The three Cs

The publication is based on the idea that an app can be beneficial or harmful depending, to a large extent, on the design, the type of play proposal, and the use made of it in relation to the child's developmental stage. For this reason, the information is divided into three fundamental parts, The 3Cs (GUERNSEY, 2007):

1- THE CONTEXT
2- THE CHILD
3- THE CONTENT

1 **THE CONTEXT**
The use

USAGE DATA

USAGE RECOMMENDATIONS

2 **THE CHILD**
The user

PHYSICAL & COGNITIVE DEVELOPMENT

ABILITY TO INTERACT WITH APPS

3 **THE CONTENT**
The design

INTERACTIVE & GRAPHICAL CONTENT

EDUCATIONAL & RECREATIONAL CONTENT
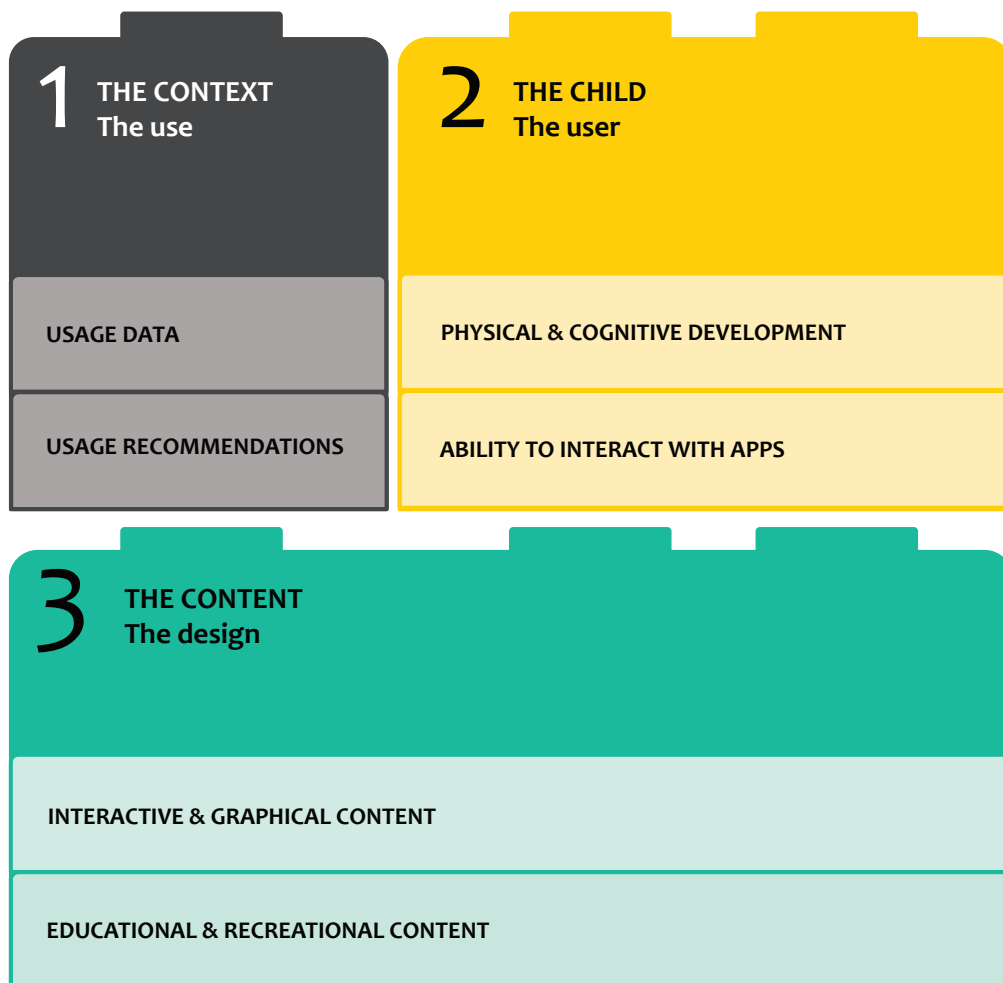
1 THE CONTEXT
The use

USAGE DATA

Are children under 2 years old playing with apps? How? When? How often?

Digital media is expanding exponentially throughout all levels of today's society. Among families with very young children, it is common to hear surprised comments about how early their kids can manage to use touchscreen devices. Going beyond personal anecdotes, this research presents concrete data on the use of apps by children under two years old in Spain. The information is also relevant to better understand the demand of apps and preferences of the current generation of parents with children aged 0 to 2 years.

METHODOLOGY

The methodology used in the research is mainly quantitative, with an online questionnaire. The total sample was of 110 families in Spain with children from 0 to 2 years old. The interview also had questions of a qualitative nature to be able to extract some specific information about personal opinions.

Quantitative survey, online questionnaire.
110 Spanish families with children of 0 to 2 years old.

Most parents participating in the research were from the Panel of Families of the Technological Institute for Children's Products and Leisure (AIJU), interviewed during the months of January and February 2014.

The aim of the research was to improve understanding of the demand parents with babies have for applications. To that end, The opinions of parents on the use of apps and touchscreen devices by babies were analyzed: Where? How? When? With whom? What do they do when they use them? How much time they use them for?

The main characteristics that parents value in applications were also analyzed, drawing conclusions about parents' and children's preferences related to themes, design features and interactive functions.

The interview questions and the analysis were divided into three main blocks according to specific objectives:
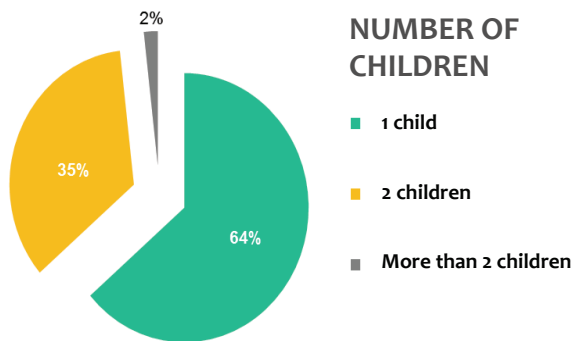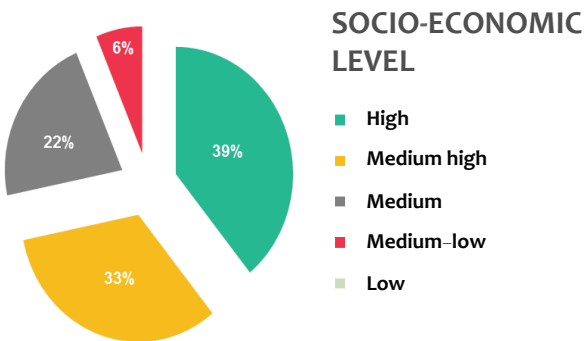
- *App usage*
- *Parents' perceptions of apps*
- *Children's and parents' preferences*

TYPE OF INTERVIEW	Online personal interview
SAMPLE	110 interviews. Families with children 0 to 2 years old in Spain
ERROR	9.34
CONFIDENCE LEVEL	95.5%
VARIANCE	p=50; q=50

PROFILE OF INTERVIEWED PARENTS

Most of the interviewed parents (85%) were mothers, and 15% were fathers, with a high (39%) and medium-high (33%) socio-economic level. Middle class families were well represented, making up 22% of the respondents.

A little more than half of the respondents were adults between 31 and 35 years old (51%), the next largest age group in the study being between 36 and 40 years old (34%).

GENDER
- Men
- Women

15%
85%

AGE
- < 30 y.o.
- 31–35 y.o.
- 36–40 y.o.
- 41–45 y.o.

11%
5%
34%
51%

SOCIO-ECONOMIC LEVEL
- High
- Medium high
- Medium
- Medium–low
- Low

6%
22%
33%
39%

NUMBER OF CHILDREN
- 1 child
- 2 children
- More than 2 children

2%
35%
64%
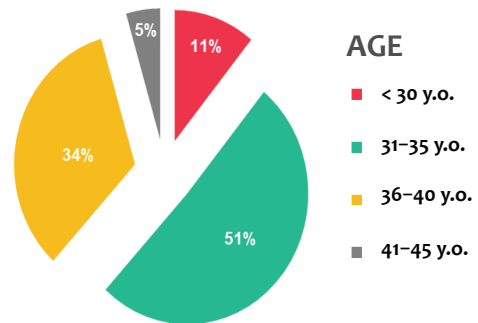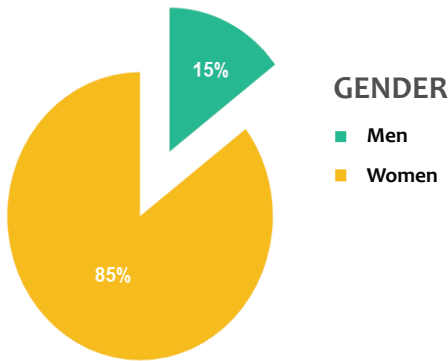
The majority (64%) had one child, 35% had two, and only 2% had more than two children.

As for the characteristics of the children whose families were interviewed, there was a fair sample of boys (49%) and girls (51%).

CHILDREN'S GENDER
- Boys
- Girls

51%
49%
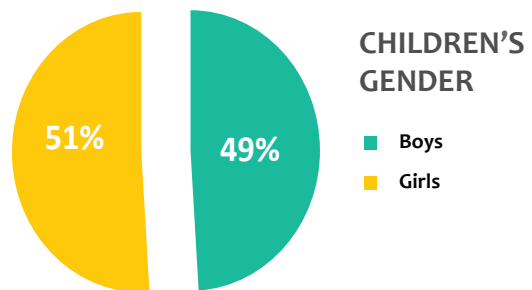
To conduct the research, we classified the answers according to four age groups (0 to 6 months old, 7 to 12 months old, 13 to 18 months old, and 19 to 24 months old). A greater representation of children in the older range was obtained, as they were considered more likely to use apps. Hence, 50% of the children were between 19 and 24 months old and the rest were distributed almost equally among the other age ranges.

CHILDREN'S AGE
- 0–6 months
- 7–12 months
- 13–18 months
- 19–24 months

14%
17%
19%
50%
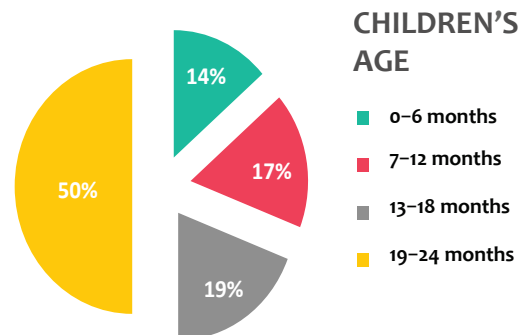
APP USAGE
Do children under 2 years old play with Apps?

In spite of the recommendations of some of the most prestigious pediatric associations, indicating that children under two years old should not be exposed to screens, 50% of Spanish families with children under 24 months of age use digital applications with them.

Yes **No**

50% **50%**
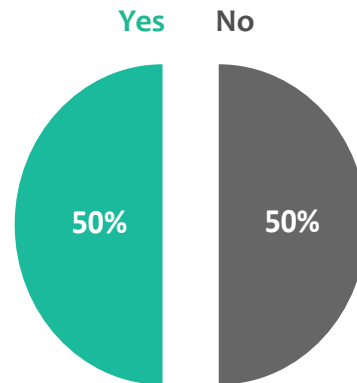
Who plays more, boys or girls?

There are no significant differences in the use of apps by families with infants of both genders.

Parents play apps with their babies in a way free of stereotypes, as it is a form of play they do not relate with a specific gender.

Girls **Boys**

53% **47%**
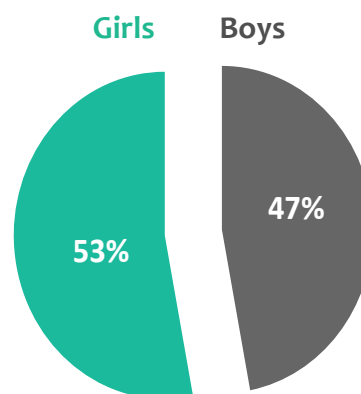
APP USAGE

What is the academic level of parents who play apps with their babies?

The parents who use apps with their children the most are those with the highest level of education, 67% of parents with university degrees use apps with their young children, compared to 33% of parents with primary or high school level education.

University degree

Primary or high school education

33%

67%
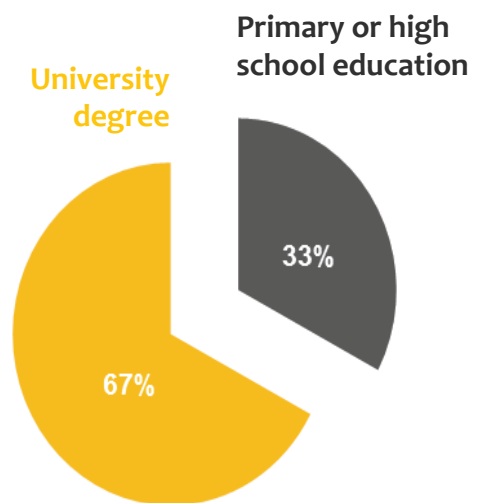
What device do they use?

More than half of the respondents (55%) prefer a tablet to play apps with their kids, versus 45% of parents who use their smartphones.

Smartphone

Tablet

45%

55%
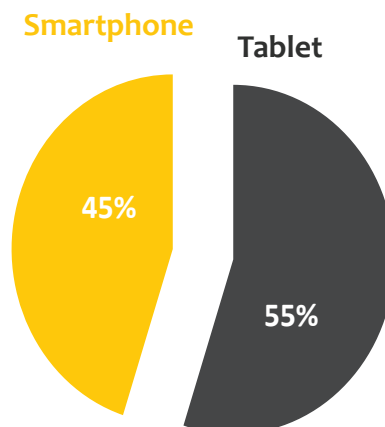
APP USAGE
¿When do babies start playing with apps?

The results highlight that, of the 50% of children that have played apps before the age of two, 13% of them started playing when they were younger than 6 months old, 53% when they were 7 to 15 months, and 35% when they were 16 to 24 months.

A graphic with divided data shows that even children under 3 months old are exposed to apps (4%).

More than half of the children who use apps begin playing with them when they are between 7 and 15 months old.
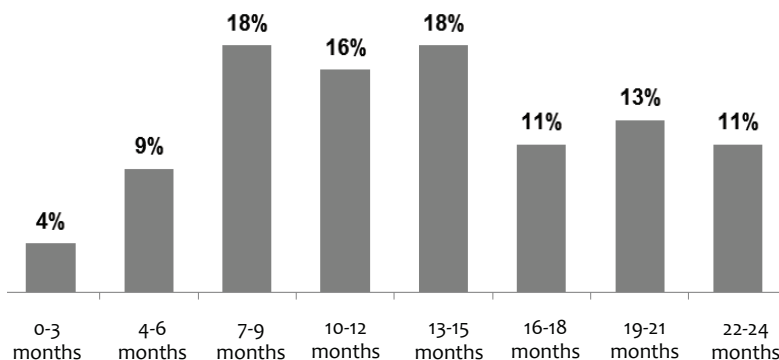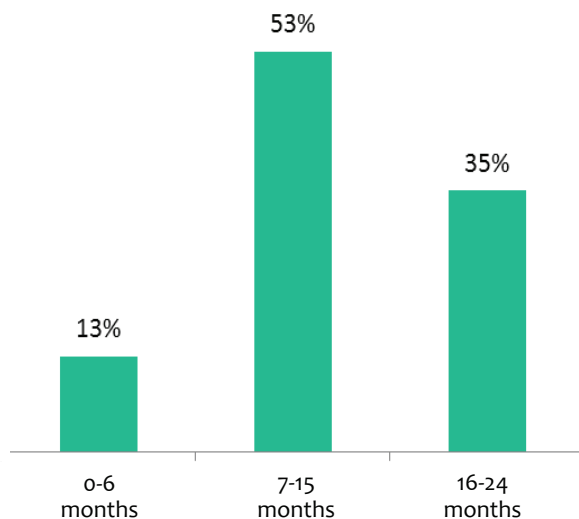
APP USAGE
How often and where?

31%

46% use apps daily

24% use apps occasionally

15%

18%

24%

7%

6%

Once a day | Several times a day | Once a week | Several times a week | Only on the weekends | Occasionally
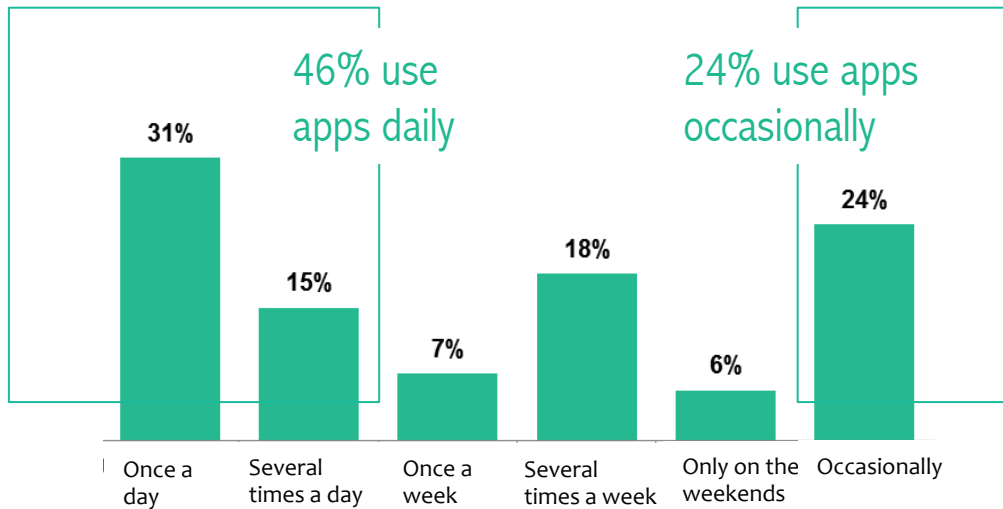
Almost half of babies, 46% use apps daily. Most of them (31%) play with them around once a day, while 15% use them several times a day.

Some parents limit their use, so that children use apps only on special occasions (24%), once a week (7%) or during weekends (6%).

Apps are mainly used in the child's home (86%) or at the home of a relative (35%). Furthermore, 31% of babies use them when they are in bars or restaurants, and 26% in the car. A minority also use them on public transport (11%), in the supermarket (4%), in the nursery (2%) or in the park (2%).

86%

35%

31%

26%

11%

4%

2%

2%

At home | At a relative's home | In bars or restaurants | In the car | In public transportation | In the supermarket | In the nursery | In the park
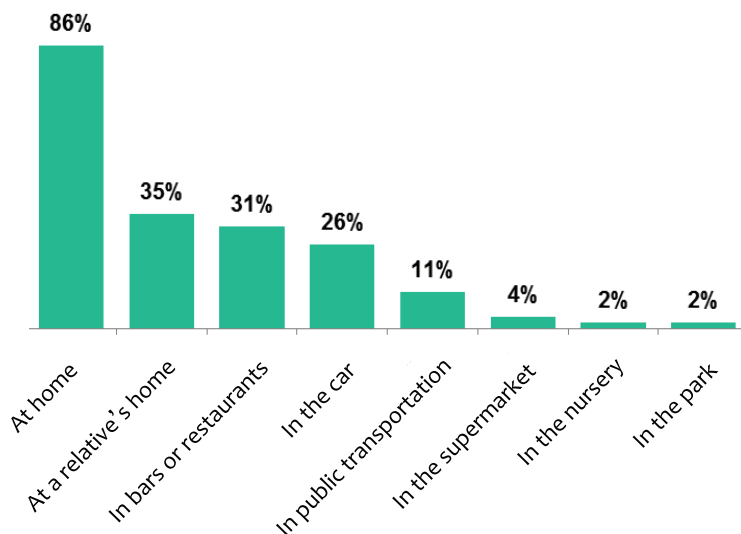
APP USAGE
What are the main reasons and times of use?

The results of the study show that a similar number of parents use apps for both recreational and educational reasons.

Specifically, 53% of parents use apps mainly to have fun with their kids and entertain them, while 47% indicate that the time they use apps with their young children is mainly to focus on stimulating learning.

53% **47%**

Have fun · Stimulate learning

To play with the child **60%**

To keep the child entertained while the parent does something **38%**

At any time **18%**

At mealtimes **13%**

Before bedtime **6%**
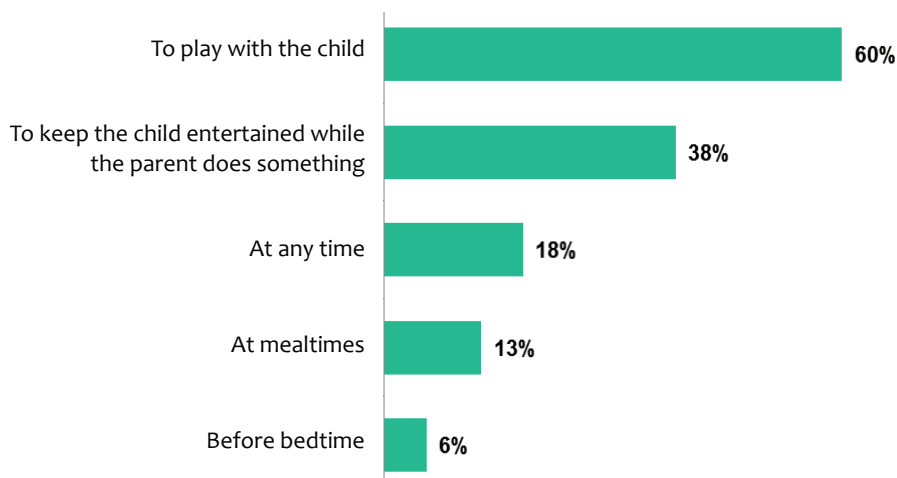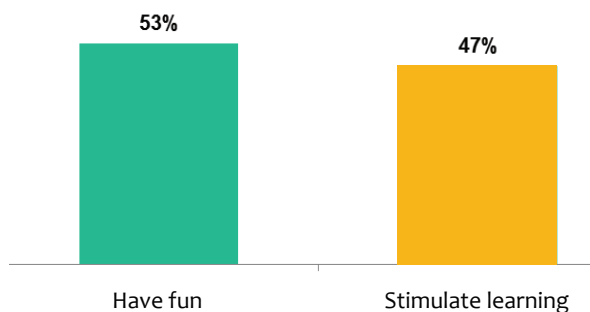
As for the times of use, most of the parents surveyed use applications with their baby during play time (60%). Furthermore, 38% of parents use them to keep their child entertained (near them) while they are doing other activities, such as cleaning the dishes, taking a shower, etc.

On the other hand, 18% of parents indicate that they do not use apps at any specific time, but any time they feel they want use them. At meal times, 13% of parents let their kids play with apps as a way of making them eat "better". Finally, 6% of parents use apps just before putting their kids to bed.

APP USAGE
With what degree of autonomy do children use apps?

According to respondents, 35% of children under the age of 2 years need to play with an adult at all times to be able to interact with apps. Parents indicate that most of them only need some help. Furthermore, 13% can play completely alone since they already know how to use the device by themselves.

Reviewing the information divided by ages, we see a progression towards autonomous use.

Babies who use apps between 0 and 6 months old always need an adult to play with them.

From 7 months on, half of the children still need to play with an adult all the time, while the other half begins to only need some help.

Between 13 and 18 months old, 50% of children still need the full support of an adult, while 10% are very or fully autonomous.

In the range between 19 and 24 months, a third of the children are already very autonomous, 17% are considered fully autonomous, 28% need some help, and 22% still need adult assistance at all times.

The child needs the full assistance of an adult — 35%

The child needs some help — 29%

The child is very autonomous, only requiring help at first — 24%

The child is fully autonomous — 13%

Most children always use apps with an adult

	0–6 months	7–12 months	13–18 months	19–24 months
Fully autonomous, selecting and changing apps, playing, etc.	0%	0%	10%	17%
Very autonomous, only needs some help the first few times	0%	0%	10%	33%
Needs some help	0%	50%	30%	28%
Needs the full assistance of an adult	100%	50%	50%	22%

APP USAGE
What are their favorite themes?

The themes preferred by parents when looking for apps to play with their babies are, in first place, those related to animals (71%) followed by music/songs (62%).

To a much lesser extent (27%), there is a preference for apps with images from the immediate environment, such as cars, clothing, etc. Furthermore, a similar percentage (26%) choose themes related with the human body, such as games with faces and body parts.

There is certain interest in apps to learn languages (20%) and apps that feature children's favorite TV characters (18%).

Themes such as learning numbers (15%), geometric forms (9%), letters or words (9%), healthy habits (6%), and gestures and feelings (4%), do not appear to be very relevant for apps targeting children under 2 years old.

In terms of differences by age, we can highlight that apps with music and songs are those most chosen for younger children

The use of apps with animals and languages increases with age (being practically null before 13 months).

Only after 19 months of age do parents choose apps for their children with their favorite characters, and apps about healthy habits.

71% Animals
62% Music & songs
27% Images & things from their daily lives
26% People: faces, body parts
20% Languages
18% Favorite characters
15% Numbers, quantities, etc.
9% Geometric shapes
9% Letters & words
6% Healthy habits
4% Gestures & feelings
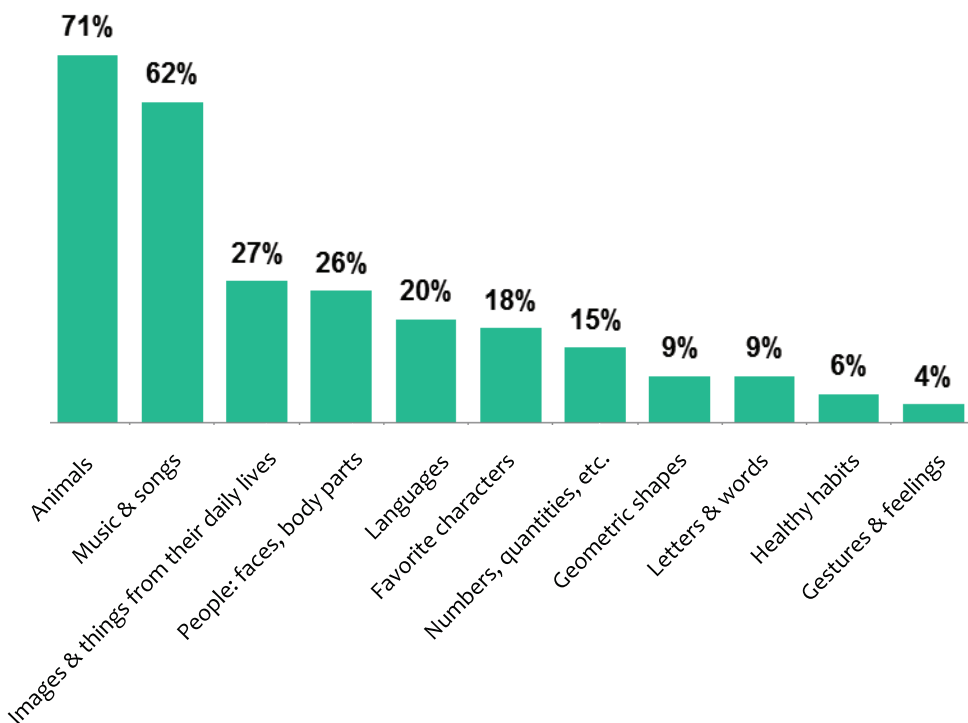
APP USAGE
Are downloaded apps paid for or free?

Of the parents surveyed, only 13% paid to download applications for their babies. Being free, many of the apps that are downloaded feature advertising. Almost half of the parents (47%) indicate that the last app they downloaded had advertising.

A large percentage of the parents (67%) do not mind advertising if the app is free, compared to 33% of parents who prefer to pay a little and not have to worry about the ads.

THE LAST APP USED HAD ADVERTISING

Don't know
Yes
16%
47%
37%
No

DOWNLOADS

Paid
Free
13%
87%
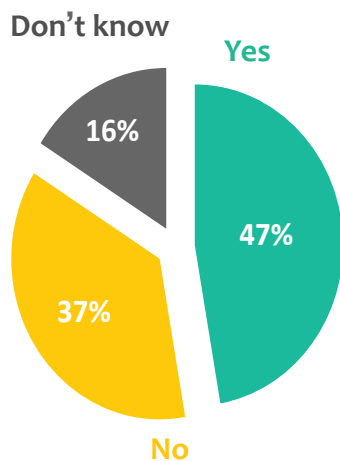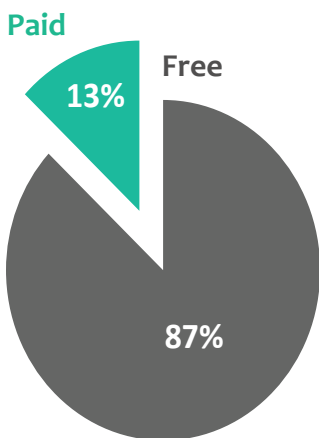
ADVERTISING ACCEPTANCE

I prefer to pay a little bit to avoid ads.
33%
67%
I prefer not to pay, I don't mind the ads.
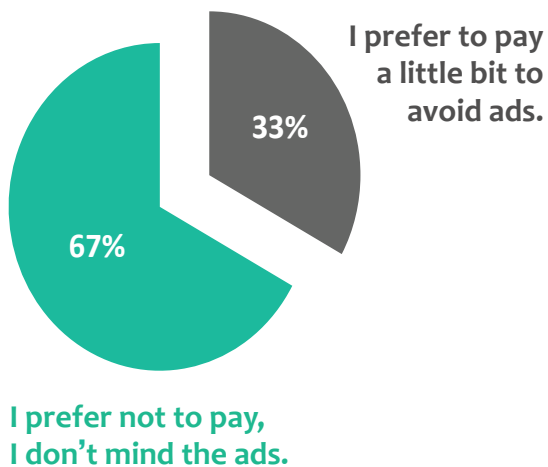
APP USAGE

Do you thing apps are beneficial or harmful for your child?

Most parents, 70%, consider that the use of applications with their babies can be more beneficial than harmful. This may be an indication of the potential increase in the use of apps for babies in the near future.

In addition to obtaining quantitative data about Spanish parents' positive or negative perception of apps for children under 2 years of age, we also collected qualitative data, opinions reflecting parents ideas about the beneficial or harmful effects of exposure to apps.

A summary of some of the most frequent comments are presented on this page and the following one. The comments are divided by color into two groups: green represents positive opinions, and yellow represents negative ones.

Harmful

Beneficial

30%

70%
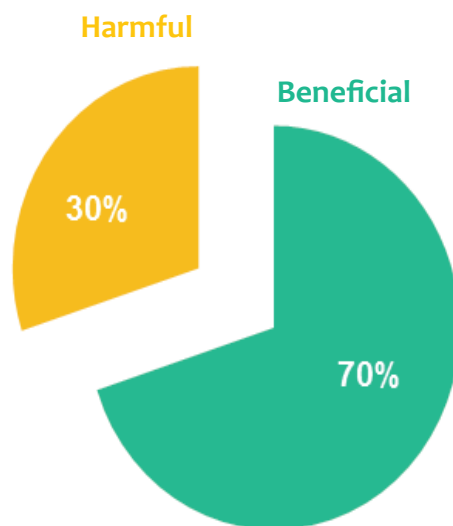
Opinions for and against

It is an activity they enjoy sharing with their children.

Children like to play with their younger siblings with something they consider for grown-ups.

It is like a toy, they have fun and learn without realizing.

It is better to interact with other people: caregivers, peers. Apps prevent proper socialization.

It is better to interact with the physical environment and with traditional toys.

APP USAGE

Opinions for and against

Playing with apps improves visual acuity.

They encourage curiosity as they capture the child's attention. They motivate and promote learning, such as the recognition of objects, sounds, numbers, words, or languages.

Apps help to learn cause and effect.

They improve fine motor skills, like the agility with their hands.

They develop cognitive skills: attention, memory, ability to concentrate, and overall intelligence.

They promote imagination and symbolic play as they tend to mimic adults.

Children start familiarizing with new technologies, something they will have to manage the rest of their lives.

Apps are a tool to entertain children at times when they have to be still, while waiting, or in stressful situations (e.g., at the doctors).

Apps are bad for the development of their vision.

Apps overstimulate. They slow down the learning process because they present concepts too fast, too soon.

They limit children's creativity by leading their play too much.

They are addictive.

It damages their socialization.

Children cannot explore with all their senses. Especially with touch, smell and taste.

They are too young to understand how apps work and do not use them well. They may damage the device.

They are used as a substitute for taking care of the child in other ways.

1 THE CONTEXT
The use

USAGE RECOMMENDATIONS

What do experts say about the best ways children can play with apps?

Despite the fact that research is being carried out, there is currently very little conclusive evidence on the best context of use: how, when, where and how long young children should use apps.

However, on the following pages there is a summary of some of the most relevant data available in scientific literature on what might be the most appropriate form to expose children to apps and touchscreen devices.

USAGE RECOMMENDATIONS

Baby 18 months

HOW?

With a screen protector.

Accompanied by family members.

Commenting on what appears on the screen, highlighting things that children can relate to, objects and moments in their daily lives.

Adults should be attentive to children's evolving abilities, introducing appropriate new updates and activities at the right moment.

AVOID:
Using apps as a nanny. Apps should be used sporadically and, where possible, avoid using them as a means to keep children seated and calm in certain situations.

Do not use applications with the television on, since it will be difficult for the child to concentrate with so many stimuli.

HOW LONG?

A limited time compared to other games and activities.

For children younger than 18 months 10 to 15 minutes a day. Children aged 18 months and older, a maximum of 30 minutes a day.

Sporadically and in short sessions

WHERE AND WHEN?

Play in an environment with good lighting, adjusting the brightness of the screen.

AVOID:
Using apps in parks and areas where the child can enjoy outdoor activities.

When the child is tired or within one hour of bedtime.

When you are performing daily habits, like eating together.

OTHER CONSIDERATIONS

Apps can be used to trigger interest in other types of play activities, such as the real versions of digital games (painting, puzzles, etc. can be easier for young children to start achieving in a digital version, avoiding frustration and encouraging them to try in physical ways).

The reactions of the child should be taken into account. If the child experiences a more intense tantrum than usual when the device is taken away, it might be better to reduce its use or even avoid it altogether for a while, until the adult is sure that the child is not acquiring an addiction and also enjoys doing other activities and games, with no obsessive preference for the electronic device.

2 THE CHILD
The user

PHYSICAL & COGNITIVE DEVELOPMENT

How does a baby develop cognitively and physically? How do her play patterns evolve?

In order to determine both the best content and context for the use of apps, it is necessary to consider how the child's physical and cognitive abilities evolve, as well as her possibilities to interact with other people and with the objects in her environment.

The forms of play also evolve in a specific way in childhood. To generate any type of recreational product appropriate to a specific age, it is necessary to understand these changes.

PHYSICAL & COGNITIVE DEVELOPMENT
Methodology, Development and Capabilities in the use of Apps

To develop apps, it is imperative to understand the characteristics of the user in various aspects. It is necessary to consider a specific age, as concrete as possible. A three-month-old child is totally different from a twelve-month-old child, and these differences are fundamental in creating apps that are adapted to his physical and cognitive abilities.

The more appropriate the app is to the child's age, the better chance it will have of appealing to children and adults, and the fewer negative effects it may have on the child's development.

In the research, we made an in-depth analysis of the most important milestones in babies' cognitive and physical development, as well as the evolution of their play behavior, dividing the information into 5 specific age ranges:
0-3 months / 4-6 m / 7-12 m / 13-18 m / 19-24 m.

The following pages summarize the most relevant aspects of children's development, presenting them in an simple and direct way in order to make the data easily available to developers and users. This is relevant information when choosing, or designing, children's products that they can actually use and take advantage of.

Beyond the major milestones in children's development, this research is pioneering in specifying some of the main abilities that babies acquire regarding their play with apps in touchscreen devices and how their interaction with them evolves with age.

It should be noted that the interaction of a baby with apps depends on several factors. A 9-month-old baby who has never touched a cell phone before is not the same as one that has been using the device for some months. Even so, we determined some general skills that babies seem able to perform with such technologies at each specific range of age. This can serve as a basis in the development of apps that could be more appropriate to each stage of the child's development.

The evolving abilities of babies' use of apps and touchscreen devices have been obtained using the following methodology:

- **Observational research:** In-depth observation of 33 cases of babies using apps at different stages of development. Analysis of videos recorded by parents in the child's natural environment.

- **Longitudinal study:** Follow-up of a case from birth to 24 months. Analysis of changes in her capabilities and patterns of play with touchscreen devices.

DEVELOPMENT 0 to 3 months

FINE MOTOR SKILLS

1st MONTH
Babies do not control the movements of their hands, which spend a long time closed. They will put them in their field of vision and bring them to their mouth.

3rd MONTH
They are able to follow their hands and begin to use their hands and eyes in a coordinated way. They start being able to grab what they see.

GROSS MOTOR SKILLS

1st MONTH
They are not able to hold their heads up.

2nd MONTH
Facedown, they can lift their head a little, for a few seconds and turn it around. Their head will still have to be supported when they are picked up.

3rd MONTH
They lift their head and torso at the same time.

They try to reach objects and hit them with their hands or feet. They attempt to reach out and grab things with both arms by starting with their arms stretched out at the sides, then bringing them together in front of them.

COGNITIVE DEVELOPMENT

They discover by chance the cause-effect concept (e.g., if they touch something accidentally it makes a noise).

3rd MONTH
They recognize faces. Above all, they like familiar faces and those of other children.

VISUAL / SENSORIAL

1st MONTH
In the 1st week they can follow a light or bright shape with their eyes, but do not see the range of colors. It is not colors that attract their attention, but strong contrasts. They see blurry images and can only focus their vision at a distance of 20–30 cm.

Babies react to a sound source, such as a rattle or tones of different pitch. They can hear from the 6th month of pregnancy, so they can recognize their mother's voice and some sounds.

They explore their surroundings with their most developed sense, that of touch. They bring their hands to their mouths and very soon, the objects around them.

3rd MONTH
Their vision is increasingly clear and can distinguish colors. They can focus up to a distance of about 3 meters.

They look at faces intentionally and already recognize familiar objects and people at a distance. They can keep track of moving objects.

COMUNICATION / LANGUAGE

1st MONTH
Their means of communication is by crying.

2nd MONTH
They emit guttural sounds.

3rd MONTH
They gurgle and respond to people's voices with spontaneous sounds, possibly their first imitations.

SOCIAL / EMOTIONAL

1st MONTH
They calm down if parents pick them up. They like to look at faces, especially those of their mother or the most familiar caregiver.

They make facial responses to stimuli.

2nd MONTH
Their social smile appears; they smile at the presence of a human face.

They are able to show joy, excitement or displeasure at certain stimuli.

DEVELOPMENT 4 to 6 months

FINE MOTOR SKILLS

4th MONTH
They improve hand-eye-object coordination. They can open their hands enough to grab objects and hold them, usually bringing them to their mouths.

6th MONTH
They grab and release toys easily. They learn to move objects from one hand to another and turn them around.

GROSS MOTOR SKILLS

4th MONTH
They move their legs as if they were riding a bicycle. They can stay seated leaning on something, with help of an adult. They keep their head up.

5th MONTH
Face down, they can support themselves on their hands and turn.

6th MONTH
They sit by themselves with support. They might crawl on their belly pushing themselves with their arms and legs. They move their heads easily in all possible directions.

COGNITIVE DEVELOPMENT

4th MONTH
They develop the notion of anticipation, they feel expectation for what will come next. They believe that the image reflected in the mirror is that of another child.

5th MONTH
They recognize some people.

6th MONTH
They can differentiate and attribute sounds. They turn their heads when they hear something. They begin to understand some things people say to them, such as their name.

VISUAL / SENSORIAL

4th MONTH
Their can focus their vision and they already have depth perception. This improves their ability to grab objects, and to follow things with their eyes, regardless of distance and whether or not its movement is vertical or horizontal.

Their hearing is almost as good as that of an adult. They look for sources of sounds and can distinguish familiar noises: keys, the barking of a dog.

6th MONTH
They can see all the colors. The notion of permanence of objects begins, something exists even if they cannot see it.

COMUNICATION / LANGUAGE

5th MONTH
They imitate sounds, their utter their first vowels in the following order:
1. /a/, and variants close to the phoneme /e/
2. /o/
3. /i/,/u/

6th MONTH
They respond by emitting consonant sounds in this order:
1. Labial: p (pa-pa), m (ma-ma), b (ba-ba)
2. Dental: d (da-da), t (ta-ta)
3. Palatovelar: g (ga-ga), j (ja-ja)

They can recognize a new word if it is accompanied by their name.

SOCIAL / EMOTIONAL

4th MONTH
They show interest and preference for different games and toys.

They perform actions or sounds to initiate their social interaction.

They imitate movements and facial expressions. They exteriorize their feelings: they laugh loudly when they play, they vocalize, they show their anger with changes of expression.

DEVELOPMENT 7 to 12 months

FINE MOTOR SKILLS

7th – 8th MONTH
They start using fine grip (they previously used every finger or the whole hand), picking up smaller objects more accurately. They hold things in both hands and grab oscillating objects. They continue to bring the things they grab to their mouths.

10th – 11th MONTH
They enjoy: turning pages, putting small objects inside others, opening and closing containers and drawers to view their contents, inserting small objects or fingers through small holes.

GROSS MOTOR SKILLS

7th – 10th MONTH
They might start crawling.

8th MONTH
They sit unsupported and lean forward to pick things up.

They change position from sitting, to lying, crawling, and standing. They prefer the standing position. Their legs can hold their bodyweight, but they have no balance.

10th – 12th MONTH
They start walking with support.

COGNITIVE DEVELOPMENT

7th – 8th MONTH
They are interested in how things work, inspecting objects from different perspectives, paying attention to their details. They are not entertained by anything for more than a few minutes, as other things immediately attract their attention.

Buttons are appealing: light switches, television remotes, etc. They start becoming aware of the cause and effect of their actions.

They are able to modify an action if someone shows them how to do it.

They look for where noises come from and study the sounds made by falling objects. They have memory of time and remember past actions, which allows them to be aware of the succession of events and to anticipate them.

9th – 11th MONTH
They understand the meaning of NO.

12th MONTH
They may concentrated on a toy for some time, but they still want to move a lot. They mimic adult actions related to the role of objects, e.g., holding a phone to their ear.

VISUAL / SENSORIAL

Their oral interest decreases, and their tactile and visual interest in things increases .

They have control over their senses, which improves coordination, balance and memory. Their vision and hearing are almost as good as that of an adult.

COMUNICATION / LANGUAGE

7th – 9th MONTH
They imitate sounds and repeat sequences of syllables: pa-pa, ma-ma, da-da, without any meaning. They answer when called by their names. They learn words more easily when they are preceded by their name.

8th – 12th MONTH
They differentiate words and understand more than they can say. Mainly simple commands that they have heard regularly. They can articulate a word or two and communicate with gestures, pointing at whatever they want.

SOCIAL / EMOTIONAL

They like to play accompanied by their parents as well as with other children. They love being applauded for the things they do.

They recognize people, showing distrust if the person is not known. They express emotions and distinguish those of others. They recognize themselves in the mirror.

DEVELOPMENT 13 to 18 months

FINE MOTOR SKILLS

From the 12th MONTH
They release things voluntarily, e.g., a ball with the intention of throwing it. They still like to stick their fingers or objects into holes, stack things and put objects inside other things.

18th MONTH
They are interested in placing objects in a row and fitting them in spaces (puzzles).

They begin to make better scribbles.

GROSS MOTOR SKILLS

12th MONTH
They move quickly by crawling. They walk with the help of an adult or a toy. They try walking alone, but fall frequently.

13th – 15th MONTH
They walk well alone, they like to walk and want to practice. They like to pull toys with wheels while walking.

COGNITIVE DEVELOPMENT

From the 12th MONTH
Their actions are increasingly intentional. They imitate many gestures and movements. They can imitate what they have seen at other times and make their own modifications.

They begin to reproduce actions with dolls, the first signs of role-play.

They say NO, a word that they hear constantly, and repeat it as a process of self-affirmation.

They constantly seek and discover through a process of trial and error, new solutions to reach a goal.

They are interested in everything new. They are drawn to systems or objects which they have not experienced before. They quickly lose interest in a toy and look for another thing.

15th – 16th MONTH
They like to do things for themselves. They are aware of their own abilities and ask for help.

COMUNICATION / LANGUAGE

12th MONTH
They listen carefully and repeat familiar words. In general, they don't say their first word correctly until around the age of one year.

Their comprehension and gestural language is much broader than their spoken language. They continue to point to express what they want.

18th MONTH
They can say around 20 words, but only pronounce 10 to 15 of them well. They begin to link two words together, e.g., "Don't want".

They might give a word a different meaning to that used by adults. There are some words that they give various meanings.

SOCIAL / EMOTIONAL

From the 12th MONTH
They are very sociable, although they play by themselves, they enjoy the company of adults and of other children. They repeat actions that have been made by others.

They are very interested in music and express it with dance and free movements.

15th MONTH
They understand and respond to single-step instructions, e.g., open your mouth, pick up the ball. They give and take what adults ask for and offer.

They perceive the emotions of others, but they do not control their own reactions and emotions well. Temper tantrums begin.

DEVELOPMENT 19 to 24 months

FINE MOTOR SKILLS

From the 18th MONTH
They hold a pencil better. They use the left and right hands without distinction. They make irregular strokes, not only lines, but also loops.

They stack cubes vertically and build towers.

23rd – 24th MONTH
They can place together several pieces of a very simple puzzle.

GROSS MOTOR SKILLS

18th – 19th MONTH
They move quickly with greater skill, but they do not master turns or abrupt stops. They enjoy different types of movements with rolling around and play wrestling.

They are attracted to getting inside boxes or semi-enclosed objects.

24th MONTH
They run. And at the same time their ability to stay still increases. They can sit by themselves in a small chair.

COGNITIVE DEVELOPMENT

From the 18th MONTH
They experience more on the mental level than before. They are capable of imagining and thinking before acting, not using trial and error so much.

They begin to understand symbols: an image that represents a real object. They point out images of some familiar things when asked, e.g., car, dog, body or face parts).

They begin to recognize basic colors. They recognize many shapes, but not letters yet. They do not know how to count, but are interested in grouping and classifying sets of things.

They like painting, music and dancing, repeating everything adults do, looking at books while someone reads them to them.

They do not say much but they understand almost everything, mainly simple and direct sentences. Before the age of 18 months they rarely follow verbal warnings without them being accompanied by an action to show them what the adult means.

24th MONTH
They follow almost all verbal commands without a physical demonstration.

They start being able to make negative assessments, e.g., a table is not a chair.

COMUNICATION / LANGUAGE

19th – 20th MONTH
They know about 50 words. Their learning accelerates and they can assimilate about 9 new words a day. They say sentences of 2 words and use words along with gestures, e.g., they say goodbye by waving their hands with the intention of communicating that they are leaving.

24th MONTH
They have a vocabulary of approximately 200 words and understand many more. They often use words like "I", "you", "mine", "me", "no".

SOCIAL / EMOTIONAL

From the 18th MONTH
They are sensitive to the feelings of adults and other babies. They begin to collaborate with others. They still don't feel comfortable with strangers.

They understand the idea of taking turns.

They are able to amuse themselves for longer.

24th MONTH
They understand two-step instructions: "Find your shoes and bring them here". They have a strong sense of ownership of objects and people: "mine".
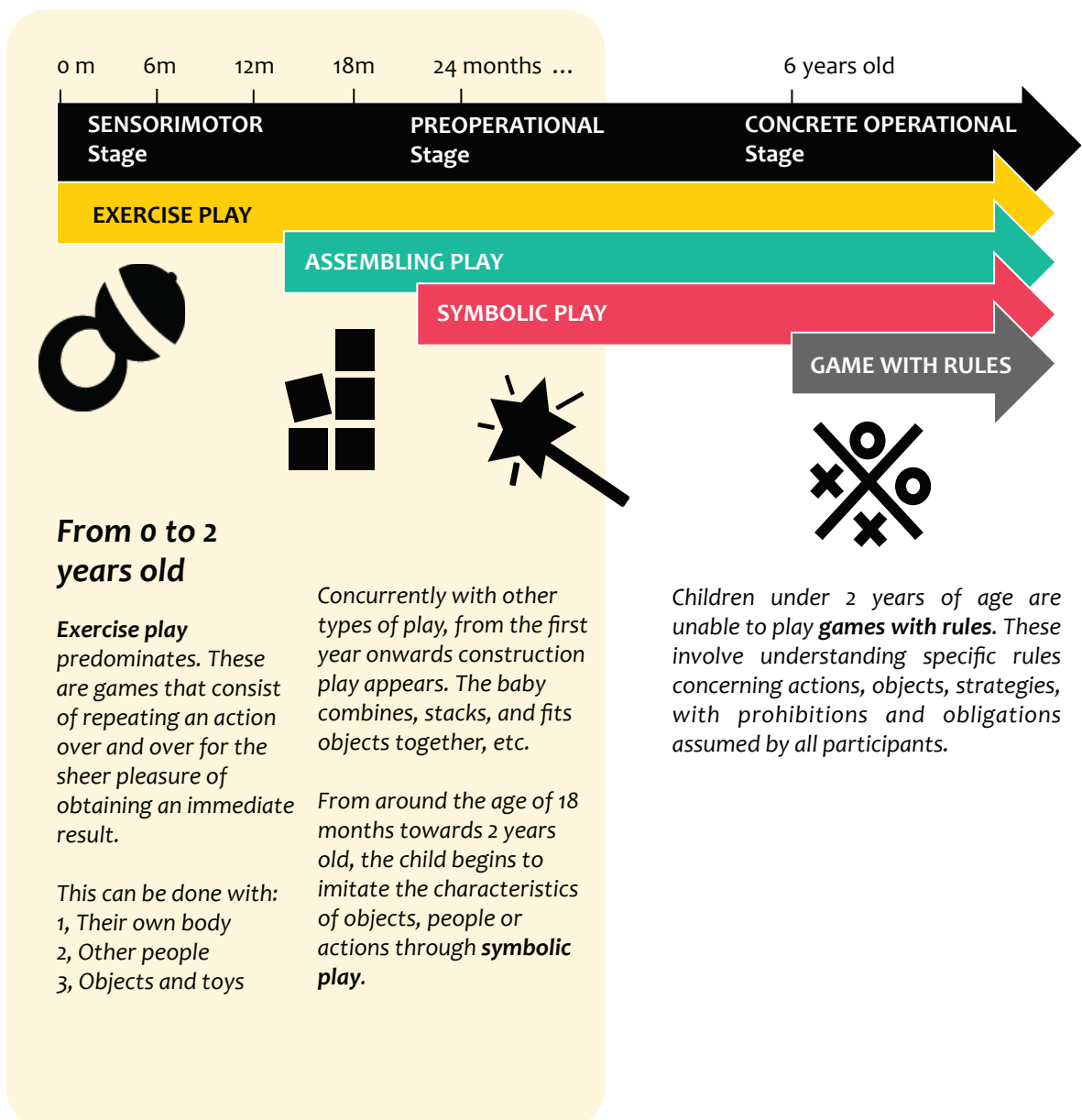
DEVELOPMENT OF PLAY PATTERNS

Play is one of the most important activities in childhood, greatly influencing the development of the child's cognitive, social, emotional and motor skills. Research has shown that babies are happier and develop better if they experience a lot of play. However, to stimulate them correctly it is important to be aware of the different types of games that predominate in each period of childhood.

The following is a summary of the sequence established by the psychologist Jean Piaget and followed by the scientific community, with the main types of games that appear chronologically at each stage of children's development: Exercise play, assembling play, symbolic play and games with rules. Babies begin to develop these games in an intuitive way, manipulating and interacting with their environment.

| 0 m | 6m | 12m | 18m | 24 months … | | 6 years old |

SENSORIMOTOR Stage **PREOPERATIONAL Stage** **CONCRETE OPERATIONAL Stage**

EXERCISE PLAY

ASSEMBLING PLAY

SYMBOLIC PLAY

GAME WITH RULES

From 0 to 2 years old

Exercise play predominates. These are games that consist of repeating an action over and over for the sheer pleasure of obtaining an immediate result.

This can be done with:
1, Their own body
2, Other people
3, Objects and toys

Concurrently with other types of play, from the first year onwards construction play appears. The baby combines, stacks, and fits objects together, etc.

*From around the age of 18 months towards 2 years old, the child begins to imitate the characteristics of objects, people or actions through **symbolic play**.*

*Children under 2 years of age are unable to play **games with rules**. These involve understanding specific rules concerning actions, objects, strategies, with prohibitions and obligations assumed by all participants.*

2 THE CHILD
The user

ABILITY TO INTERACT WITH APPS

What actions can a child younger than 2 years old perform with an application for a touchscreen device?

Just as for years children's development has been studied in terms of cognitive, physical, and playful behaviors, it is necessary to analyze the development of abilities children acquire in their interaction with apps in touchscreen devices. This information is necessary to really design better apps, and also to assess the best content and the context of use for these kinds of games for such young children.

In our research, we carried out a specific study to obtain a first approximation about the evolution of the skills and abilities that children acquire in their play with apps.

METHODOLOGY

OBSERVATIONAL STUDY

In-depth observation of **33 cases** of babies at different stages of their evolution while using apps. **Analysis of videos recorded** by parents in the **child's natural environment**.

LONGITUDINAL STUDY

Follow-up of **a case from birth to 24 months**. Analysis of changes in her abilities and play patterns with touchscreen devices.

From 0 to 15 months, the baby was only exposed to apps during our video recording study sessions. The sessions were recorded in the child's natural environment.

INTERACTION WITH APPS

0 to 3 months

In general, in these first months, it is the parents who carry out the actions in order for play to occur: placing the screen and the child in a specific way and performing most of the interaction.

Babies at this stage does not try to touch the device. They remain where they have been placed. They may listen and look passively at what happens on the device, although in fact they do not really fix their sight on the screen, nor do they focus on it for more than a few seconds.

Baby, 2 and a half months old

Baby, 4 months old

4 to 6 months

In the arms of their parents, they begin to show an interest in touching the screen, but without any control or precision in their movements. They randomly touch any area of the screen with their open hand or fist.

With tablets, having a larger surface, they are more likely to touch something by chance and obtain a reaction from the game than with smartphones.

They only focus briefly on what is on the screen, they are easily distracted and look in other directions.

They may put the device in their mouth.

Some children previously exposed to apps may begin to show anger if the device is removed. This does not seem to be relevant if the contact with the app has been sporadic, and the child has not really become familiar with the device.

INTERACTION WITH APPS

7 to 12 months

They drag their fingers to move the "pages". They are interested in the mechanics of the screen page changing with the movement of their hands. They do not pay attention to the content unless the parent takes control and stops the action to explain.

They touch the screen with all their fingers, hitting it.

They hold the device well. They are interested in analyzing it, turning it, looking at it from different perspectives (especially smartphones that are easier to manipulate). They may hit it or throw it suddenly.

10th – 12th MONTH
They can try to repeat an action carried out by an adult which obtained a reaction from the app. They learn to unlock the screen. They like pressing buttons.

They are able to pay more attention, for a longer period of time, to what is shown on the screen.
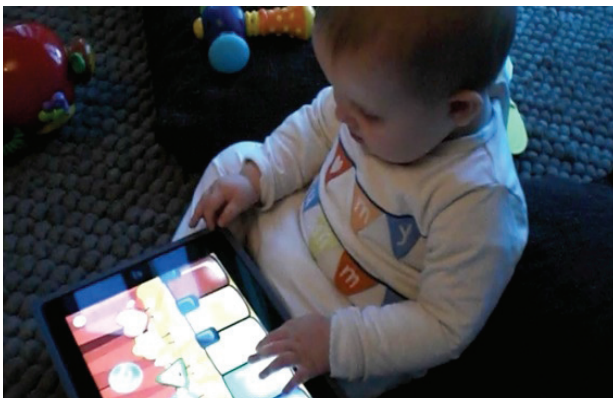
They hold the device with one hand touching the screen with the other, which can be problematic when the hand holding the device prevents the app from working.

Baby, 8 months old, moving pages
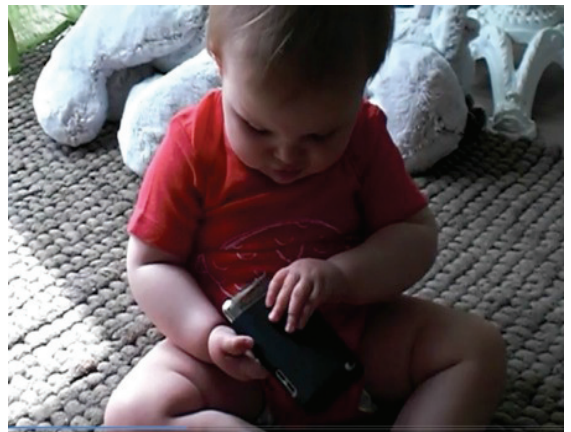
Baby, 10 months old, interested in the device

Baby, 8 months old, touching the screen aimlessly. She stares at the movements of the characters without lifting her hand that is touching the screen

Baby, 10 months old, showing a preference for a virtual rattle over a physical one

INTERACTION WITH APPS

13 to 18 months

They show confusion between what they can do with screens and other real-life objects. For example, they play with books as if they could generate reactions with a tap.

They no longer tap on the screen just by chance, they touch where they know something will happen. They also move from one page to another on purpose. Even so, by chance, they still find ways to use devices that even parents did not know.

They can touch the screen with a finger or with the whole hand. They experiment by tapping on the device with their feet and other utensils.

They keep changing apps constantly. They are interested in manipulating: entering and exiting apps, moving the page on the screen, etc.

They take the adult's finger and guide it to where they want to do something they were not able to do.
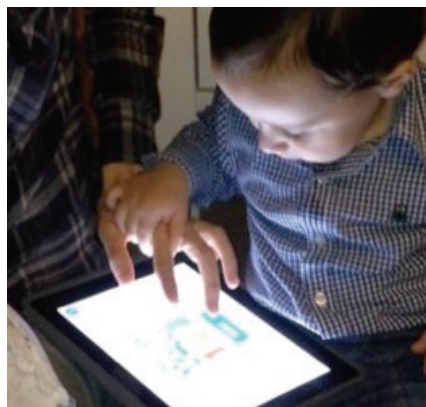
They show preference and interest for touch-screen devices over other toys.

Baby, 17 months old, confused because her finger does not work on the book

Baby, 13 months old

Baby, 18 months old, guiding the adult's finger

INTERACTION WITH APPS

19 to 24 months

They begin to understand when an app works vertically or horizontally.
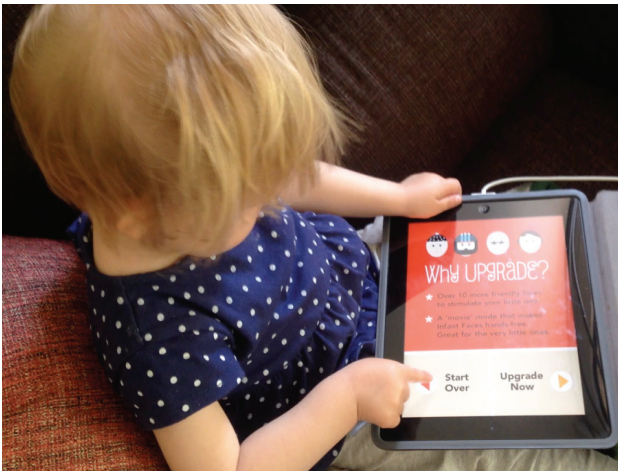
They keep going in and out apps, but they start paying more attention to a specific app for longer periods.

They can drag shapes and place them into a specific area if the path is short and simple.

Tantrums intensify if the device is taken away.

24th MONTH
They know how to manage well in the graphical environment: how to enter and exit apps, where to look for them, etc.

Baby, 24 months old

The manipulative possibilities can vary widely from one child to another, largely depending on the previous contact each child has had with apps. It will also depend on the content and the interactivity characteristics proposed by the game.

3 THE CONTENT
The design

INTERACTIVE & GRAPHICAL CONTENT

EDUCATIONAL & RECREATIONAL CONTENT

What are the features of the apps that are being used by children under 2 years old?
What kind of apps could be most appropriate for them?
How to design them?

In this section, we will analyze the above questions from the perspective of the educational, interactive and graphical content, to conclude with specific information on how these applications could be designed in the most suitable way for children under 2 years of age.
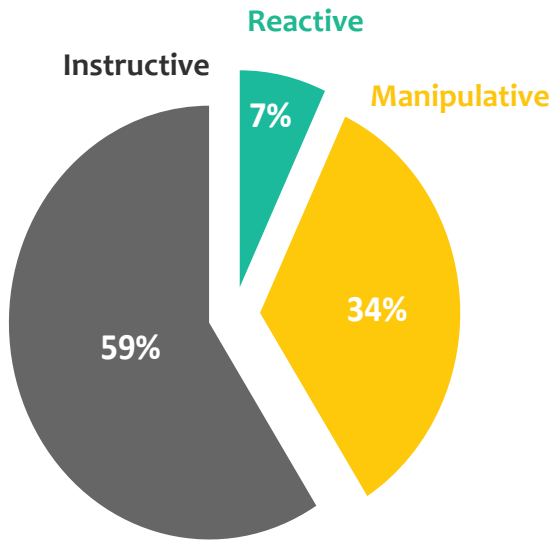
3 THE CONTENT
The design

INTERACTIVE & GRAPHICAL CONTENT: Results

EDUCATIONAL & RECREATIONAL CONTENT: Results

What are the features of the apps that are being used by children under 2 years of age?

METHODOLOGY

This section presents the specific results of the analysis of apps most frequently used by the Spanish parents surveyed.

We assessed 44 apps with a quantitative and qualitative analysis through 3 different aspects:

- Their recreational-educational content
- Their proposals for interaction
- Their graphic design

Visual sample of the data from the quantitative analysis

Sample of the sheets from the qualitative analysis

Apps being used by babies
INTERACTIVE CONTENT

Instructive 59%
Reactive 7%
**Manipulative** 34%

TYPES OF APPS

The analysis shows very few apps (7%) are characterized as reactive, 34% are mainly manipulative, while most applications (59%) respond mainly to criteria that classify them as instructive.

However, the most recommended apps for children under 2 years are reactive. The results show a lack of information on what types of applications are most appropriate for such small children.

Find the descriptions of each
type of app on page 49
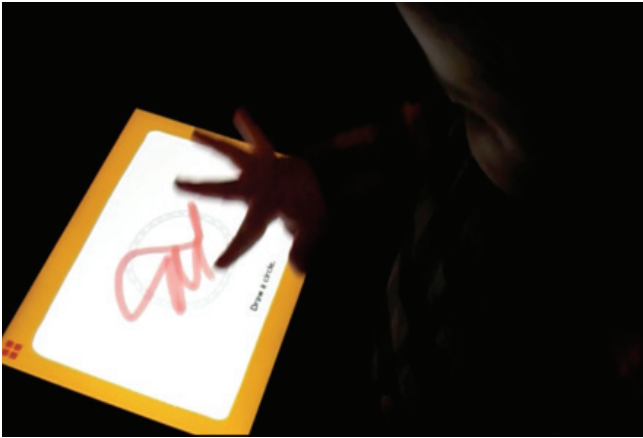
Baby, 24 months old, playing with an instructive app. He cannot trace the circle.
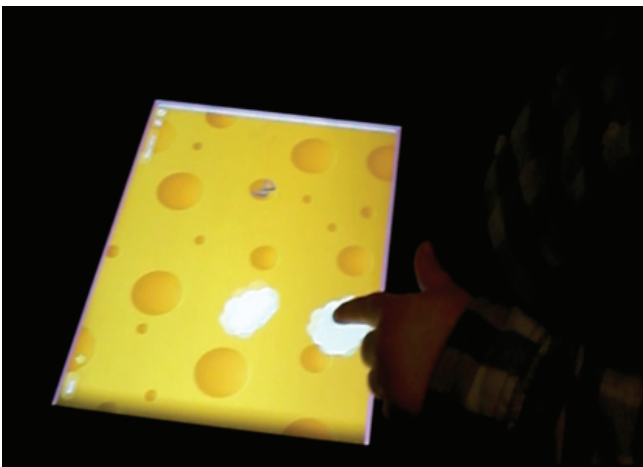
Baby, 24 months old, playing with an instructive app. Every time he taps in a cheese hole the game generates a small cloud. The child plays to tap on the holes to see that reaction, without being aware that there is a hidden mouse that he is supposed to find. He is playing as if the app were actually manipulative.
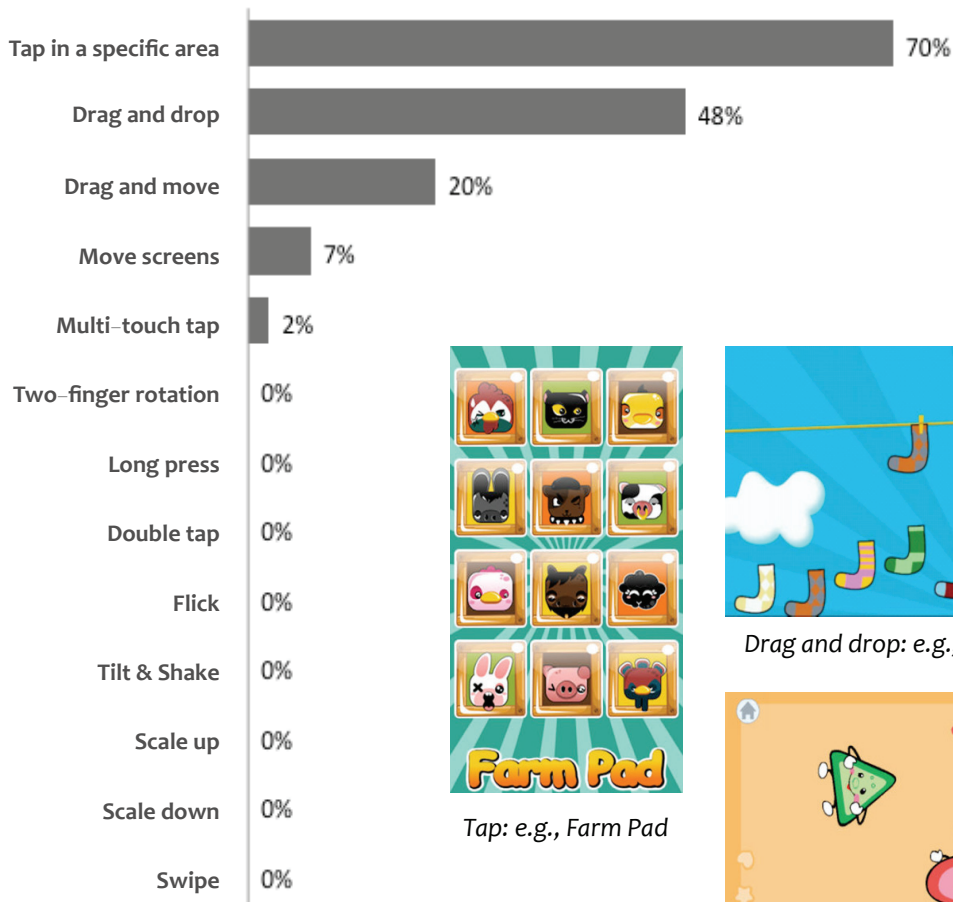
Apps being used by babies
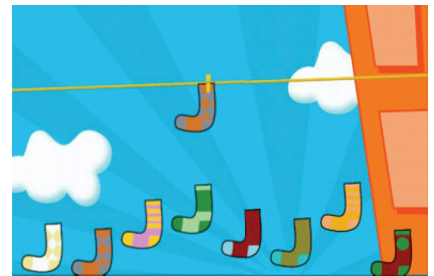## INTERACTIVE CONTENT

REQUIRED GESTURES

The most common gesture in apps that are used by children under 2 years of age is the tap (70%), followed by drag and drop (48%) and drag and move (20%).

To a lesser extent, these apps require the gesture to move the screen from side to side to change what the child see on the screen (7%) and only 2% involve a multi-touch-tap gesture.

Tap in a specific area	70%
Drag and drop	48%
Drag and move	20%
Move screens	7%
Multi–touch tap	2%
Two–finger rotation	0%
Long press	0%
Double tap	0%
Flick	0%
Tilt & Shake	0%
Scale up	0%
Scale down	0%
Swipe	0%

Tap: e.g., Farm Pad

Drag and drop: e.g., Kids Socks
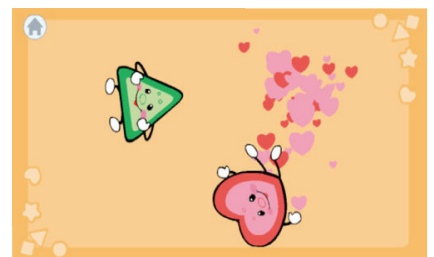
Drag and move: e.g., Fisher price, Laugh & Learn Shapes & Colors

Apps being used by babies
INTERACTIVE CONTENT

LEVELS OF DIFFICULTY

Most apps analyzed (82%) do not have the option to change between different difficulty levels.

18% With difficulty levels

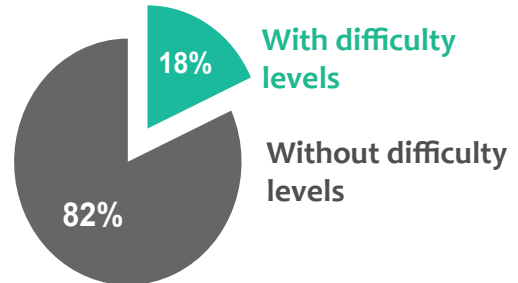**82%** Without difficulty levels

ALLOW CUSTOMIZATION

Although infants mainly like to see familiar faces (e.g., those of relatives) and play with representations of things from their immediate environment, very few applications have the option of allowing parents to customize the game by adding sounds, images, photos or videos made by them.

7% Allow customization

93% Do not have customization options
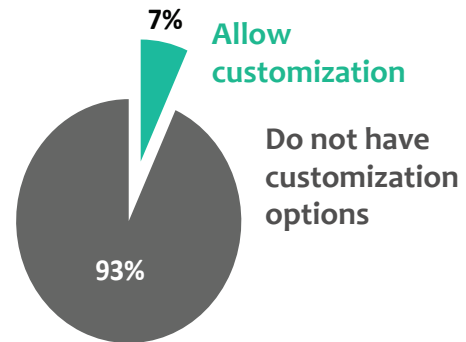
RESPOND WHEN THE DEVICE IS MOVED

None of the apps analyzed have the options to obtain a reaction by moving the device. That is, for example, when the baby turns the tablet sideways the contents or images move towards that side.

2% Respond when the device is moved

98% Do not react to the movement of the device
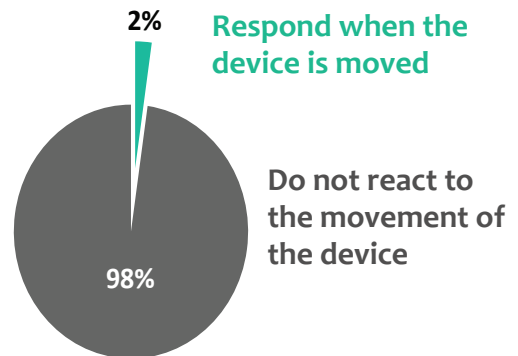
INTERACT WITH PHYSICAL OBJECTS

None of the analyzed apps allow the possibility to play digitally while also interacting with toys or other objects in the child's surroundings.

100%

0%

App interacts with physical objects

No interaction with physical objects
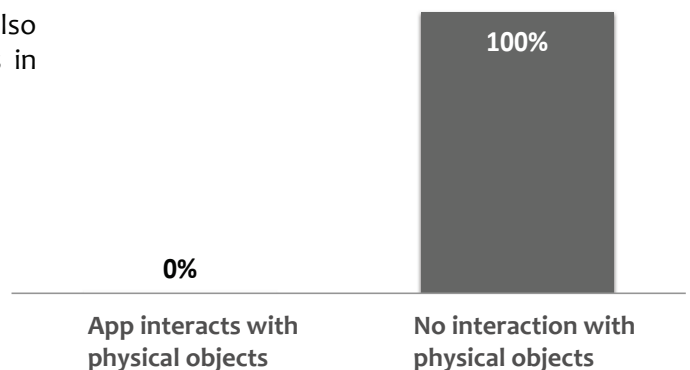
Apps being used by babies
INTERACTIVE CONTENT

FREE OR PAID APPS

The majority of Spanish parents do not pay for the applications that they download for their children. This is not surprising in a society where it is estimated that 86% of the value of digital content (music, movies, books and video games) is pirated (JIMÉNEZ, 2013).

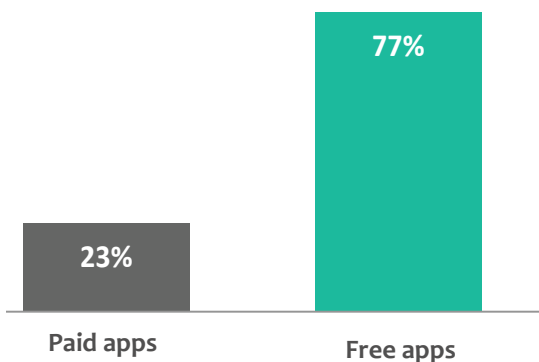However, parents have the perception that they download more free content than they actually do. Only 13% of the respondents acknowledged paying for the apps that they downloaded, but 23% of the applications they use have a cost. Even parents that do not usually download paid apps, when there is a game that really interests them, they pay for it if the cost is low.

INTRUSIVE ADVERTISING

Although most of the apps were free (77%), only 28% showed intrusive advertising such as ad windows that appear during the game.

Most of the free apps are reduced versions of full applications that have greater content and functions. Many of them do not have publicity because they are in themselves the ad for a more complete game. These apps give users the opportunity to test the game and acquire the extended paid version only if it interests them. This is a strategy that responds to the Spanish social reality, in which 6 out of 10 users pirate digital games, in part because of the uncertainty of whether they will like the content or not (JIMÉNEZ, 2013).

Some free apps do not have advertising and, even so, the full content can be accessed. Theses are apps that are usually used as advertising for other applications created by the same developers.

77%

23%

Paid apps

Free apps

Yes

No

28%

72%
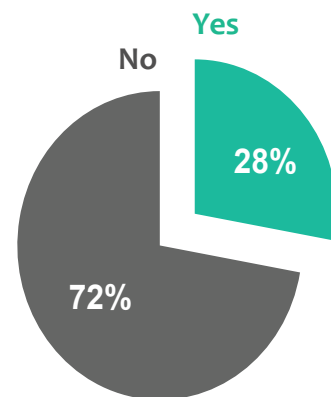
Apps being used by babies
GRAPHICAL CONTENT

COLORS

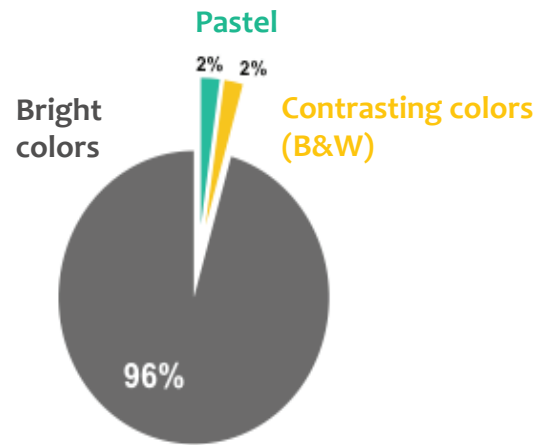Almost all apps analyzed (96%) have designs and images with bright and vivid colors. Only 2% of the apps were made with pastel colors and another 2% with very contrasting colors.

No app was based solely on combinations of pinks or blues, as happens with other products for babies (toys, clothes, etc.)

Pastel

2%   2%

Bright colors

Contrasting colors (B&W)

96%

TYPES OF IMAGES REPRESENTED

In 88% of the cases the studied the apps featured illustrations. Most of them (70%) had 2D illustrations, while 18% had scenarios and game characters developed in 3D.

The types of illustrations were also analyzed, to assess whether they represented realistic or abstract images*. Of these, 76% had illustrations that can be called abstract, that is to say, that do not realistically represent a thing, an animal or a person.

Although experts recommend that for such young ages it is better to present children with realistic pictures and images, most games do not involve such images.

Some of the images that have been considered abstract may not be considered so from the point of view of an older child or an adult. They have been categorized as abstract when a child under 24 months could not relate them to the object or person they represent in the real world.

2D Illustrations   **Photos**

17%   15%

3D Illustrations

68%

76%

24%

Realistic   **Abstract**
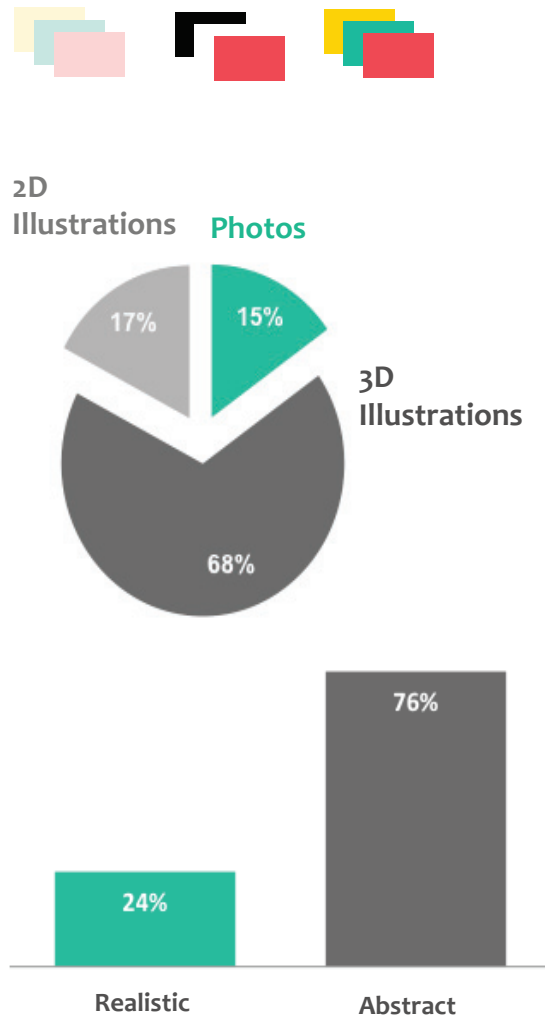
Apps being used by babies
GRAPHICAL CONTENT

APP ORIENTATION

More than half of the apps (55%) are played with the device horizontally, 43% vertically and only 2% allow the change from horizontal to vertical and vice versa depending on how the device is held by the child.

Young children do not yet understand the correct orientation of images.

55%

43%

2%

Horizontal **Vertical** **Both**

INNOVATIVE AND DIFFERENCIAL DESIGN

Even if all apps show certain esthetic differences, very few stand out for their original design. The analysis shows that most apps (73%) are not interesting from a graphical or artistic point of view as their design and appearance do not differ much from that found in other apps, and even from other children's content (videos, books, etc.)

Only 27% of the apps stand out for their innovative and differential design.

Design not differential

Original and unique design

27%

73%
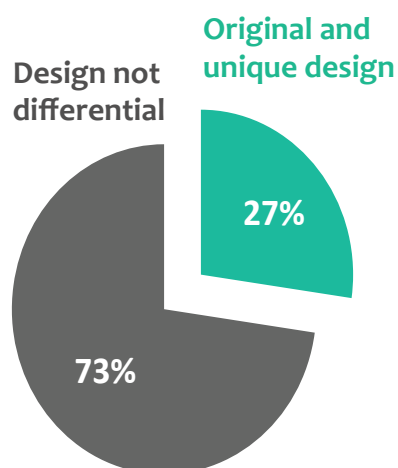
Apps being used by babies
EDUCATIONAL & RECREATIONAL CONTENT

INDICATE AGE RECOMMENDATION

A little more than half of the applications analyzed (52%) recommend the age at which they should be used. However, it is evident that there is a lack of unified criteria about what characterizes a game for each age or developmental stage of the child. On one hand, there is a problem associated with how unspecific age recommendations are. Most indicate a very wide range of age appropriateness such as "for children from 4 months to 6 years old". This is an indicator of how little information developers have about how to determine the age suitability of their apps.

On the other hand, most apps being used by parents with babies that do feature a recommended age, state their suitability for ages over two years (70%). This highlights the lack of information that parents also have about age suitability regarding digital content for babies.

Most apps have age recommendations but they are often too broad and not very specific.

No **Yes**

48% **52%**

WIDE RANGE OF AGE RECOMMENDATION

6 months – 3 years old
4 months – 6 years old
1–3 years old
1–4 years old
5 years or less

RECOMMENDED FOR OLDER CHILDREN
(70% of apps used)

2–6 years old
Older than 3 years old

30%

70%

For 2 years old or younger

For kids older than 2 years old
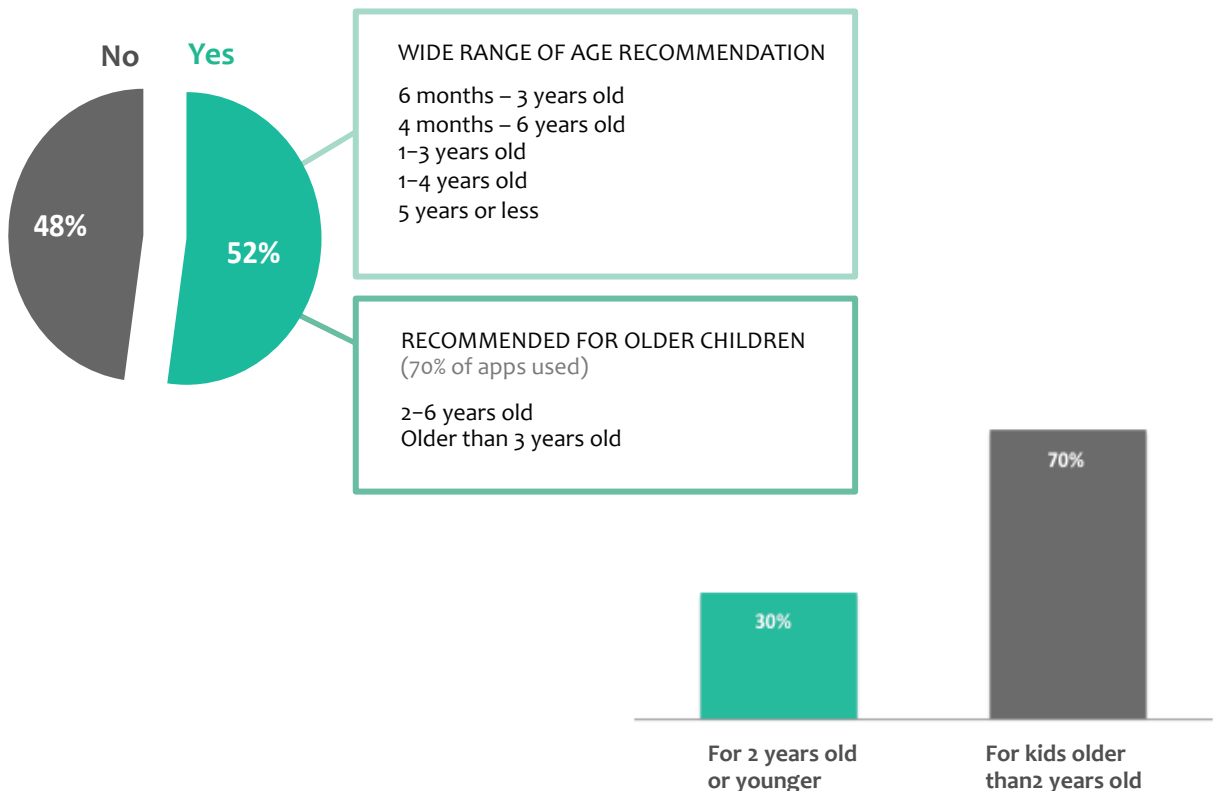
Apps being used by babies
EDUCATIONAL & RECREATIONAL CONTENT

GENDER TARGETED

None of the applications downloaded by parents had recommendations about the app being designed for any particular gender.

The literature indicates that boys often acquire skills related to gross motor development before girls, while girls might get improve their fine motor skills more quickly. However, the first research in the topic is not showing real gender diffe- rences in the way children's skills develop in relation to their interaction with touchscreens. Boys and girls of the same age interact in a similar way.

Do not suggest a targeted gender

100%
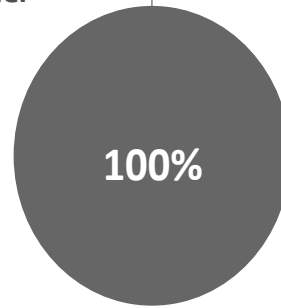
The development of apps for young children is, for the moment, not focused on gender differences

Compared to other industries, such as those related to content (TV, video games, etc.) or children's products (toys, fashion, etc.), for the time being, apps offer a positive way to present games to children beyond gender stereotypes.

Apps being used by babies
EDUCATIONAL & RECREATIONAL CONTENT

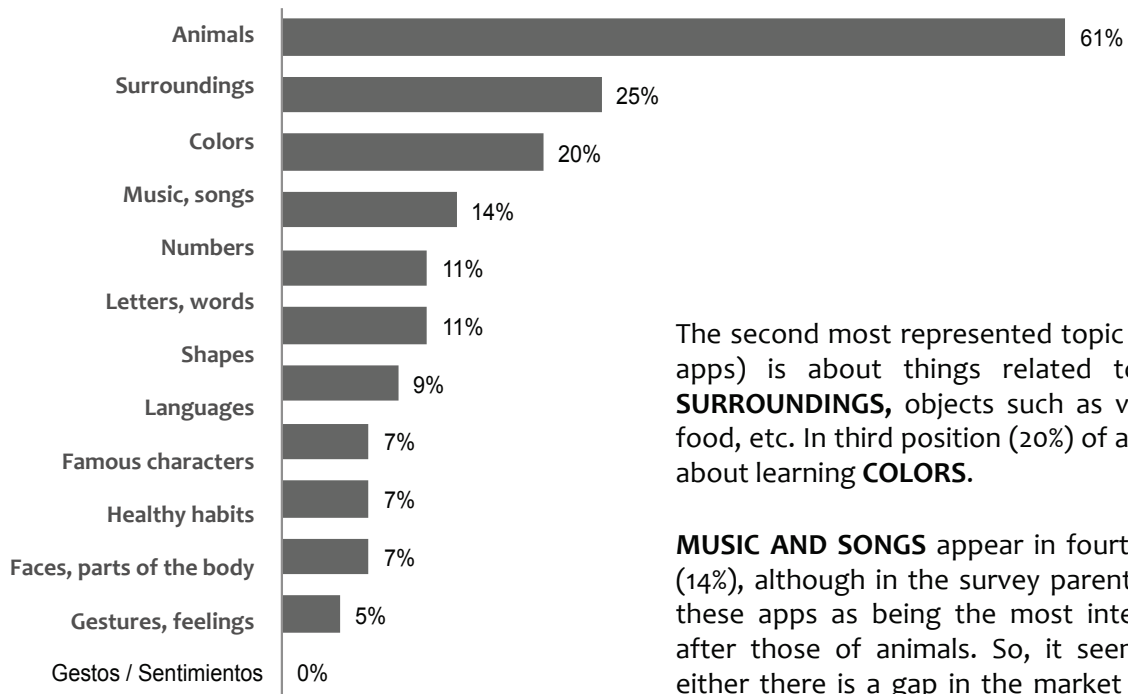| Topic	Percentage
Animals	61%
Surroundings	25%
Colors	20%
Music, songs	14%
Numbers	11%
Letters, words	11%
Shapes	9%
Languages	7%
Famous characters	7%
Healthy habits	7%
Faces, parts of the body	7%
Gestures, feelings	5%
Gestos / Sentimientos	0%

TOPICS

By far the most commonly represented theme featured in the apps analyzed is that of **ANIMALS** (61%). Some of these apps are focused on children learning and becoming familiar with animals, others present different types of play with characters that represent animals. The high number of apps featuring animals responds to the demand parents have for this subject (71% of the respondents).

However, there is also a saturation of applications with the same theme, which makes it difficult to market a new apps about animals.

The second most represented topic (25% of apps) is about things related to their **SURROUNDINGS,** objects such as vehicles, food, etc. In third position (20%) of apps are about learning **COLORS.**

MUSIC AND SONGS appear in fourth place (14%), although in the survey parents rated these apps as being the most interesting after those of animals. So, it seems that either there is a gap in the market or that parents play music to their children, but also through other platforms, such as YouTube. As they are viewed on the same device, they consider these videos as being apps.

Learning **NUMBERS** represents a very advanced level for children of this young age, even so, various apps being used (11%) are related to learning mathematical concepts.

The use of apps to learn **LANGUAGE/S,** those with **FAMOUS CHARACTERS,** or those about **HEALTHY HABITS** are not being played much (7%) by such small children and their families.

Almost no apps feature topics about **BODY PARTS** (5%) and none about **GESTURES AND FEELINGS.**

Apps being used by babies
EDUCATIONAL & RECREATIONAL CONTENT

TYPES OF GAMES

Analyzing the results of the types of applications that parents are using with babies, the lack of information on what types of games are suitable for this age group is again evident.

Games with rules, suitable for children over 6 years of age, are the most represented (38%), followed by applications with exercise play (30%), assembling play (23%) and symbolic games (16%).

Half of the apps used by children under two years of age correspond to games that require users to meet or exceed specific goals, while the other half are "never-ending" games, which are more free and flexible in terms of how to play with them, and for how long.

Game ends when certain goals are reached | **Never–ending game**

50% | 50%

32% | 30% | 23% | 16%

Games with rules | Exercise play | Assembling play | Symbolic play
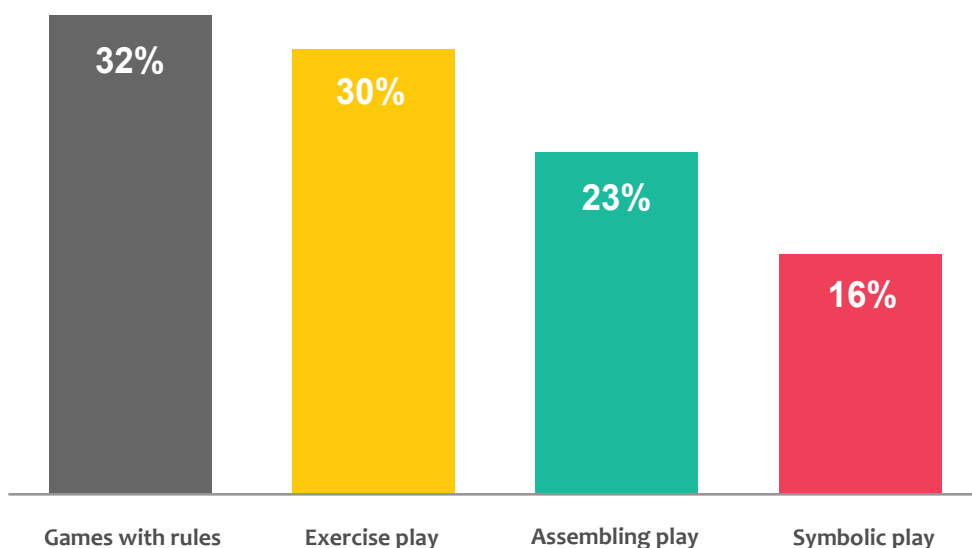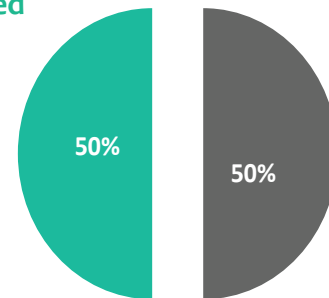
3 THE CONTENT
The design

INTERACTIVE & GRAPHICAL CONTENT: Recommendations

**What kind of apps would be most appropriate for babies?
How to design them in terms of their interactive and graphical content?**

INTERACTIVE CONTENT
Most suitable types of apps

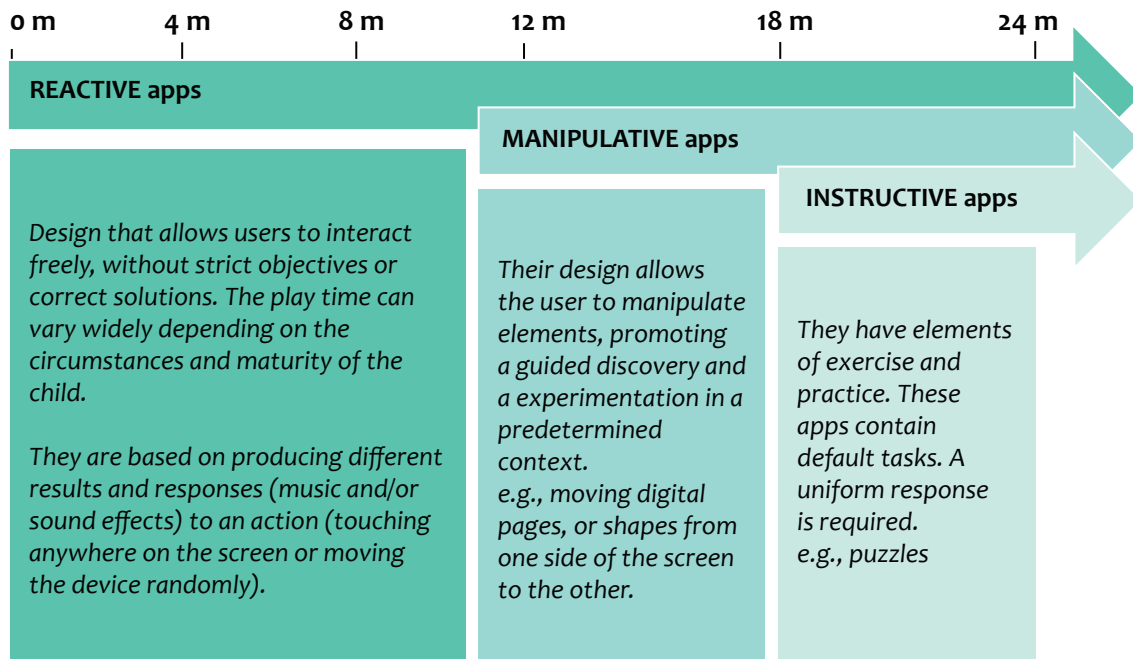| 0 m	4 m	8 m	12 m	18 m	24 m

REACTIVE apps

MANIPULATIVE apps

INSTRUCTIVE apps

Design that allows users to interact freely, without strict objectives or correct solutions. The play time can vary widely depending on the circumstances and maturity of the child.

They are based on producing different results and responses (music and/or sound effects) to an action (touching anywhere on the screen or moving the device randomly).

Their design allows the user to manipulate elements, promoting a guided discovery and a experimentation in a predetermined context.
e.g., moving digital pages, or shapes from one side of the screen to the other.

They have elements of exercise and practice. These apps contain default tasks. A uniform response is required.
e.g., puzzles

MORANTE, M. 2016*
*Adapted and modified proposal, based on research by HIGHFIELD, K., y GOODWIN, K. (2013).
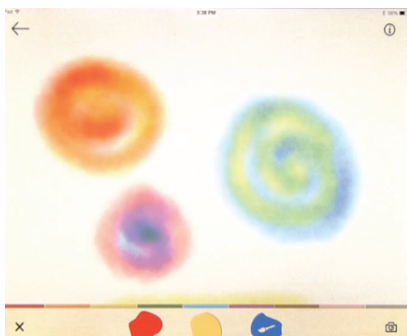
Example of a Reactive app
Intro to colors, Montessori
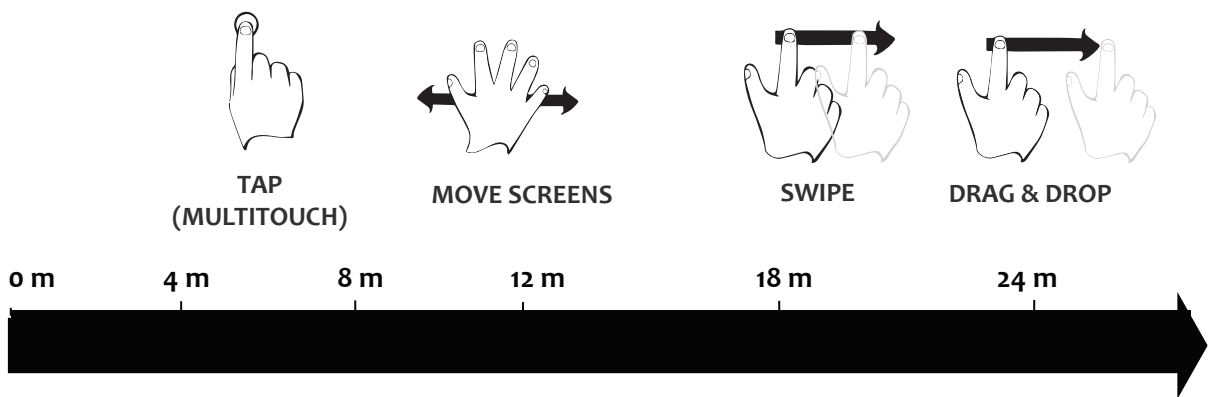

Example of a Manipulative app
Eggzoo

Example of an Instructive app
Lily and the animals

Apps for children under two should be mainly reactive.

INTERACTIVE CONTENT
Gestures they may be able to perform

TAP (MULTITOUCH)	MOVE SCREENS	SWIPE	DRAG & DROP

0 m	4 m	8 m	12 m	18 m	24 m

TAP is the most intuitive and natural way for the child to interact with a touchscreen (SESAME WORKSHOP, 2012).

Around the first year of age they might be able to tap in a specific place.

MOVE THE SCREEN PAGE to the left or right. Before one year of age, they will put their whole hand on the screen and move it from one side to the other, initially without any intention and then without much precision. Changing pages is itself a playful action.

SWIPE to the left or right. From the first year they begin to make the movement of moving from one screen to another with one finger.

MULTI-TOUCH. Young children have limited dexterity and usually involuntarily place multiple fingers on the screen at once. Games should not involve correct answers requiring a tap in a specific place. They should present some kind of reaction by touching the screen in any way, anywhere, and without much precision.

During the first months of life, the multi-touch tap is the most realistic way for the child to touch the screen and generate some kind of interaction with the game.

DRAG & DROP. Children do not usually understand where to drop the object until they are almost 2 years old. They have difficulty in keeping their finger touching an element with the continuity necessary to drag it to a specific place. The route should be simple, close, direct and should not require much accuracy.

This information serves as a general reference, but the actions children are able to carry out depend heavily on many factors, such as their previous experience with apps.
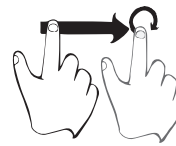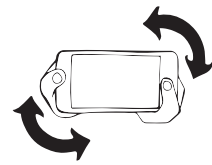
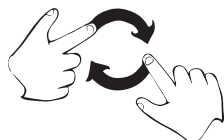# INTERACTIVE CONTENT
Difficult gestures to perform

FLICK   **DOUBLE TAP**   **DRAG AND MOVE**   **TILT & SHAKE**
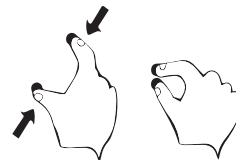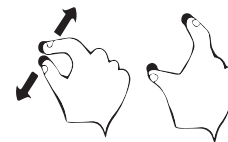
LONG PRESS   **TWO-FINGER ROTATION**   **SCALE DOWN**   **SCALE UP**

Gestures that are too difficult to perform (AZIZ, 2013):

FLICK or FLING. Click on an image to launch it virtually with a fast finger movement.

DOUBLE TAP. Quick tap twice in a row. Babies and toddlers expect immediate feedback so they do not understand that a second or a third touch is required. To perform this gesture they need to have learned the concept of counting.

LONG-PRESS. Touch the surface for a long time. Children show a wide variation in times to perform tap actions and do not understand how long they have to press. The app has to be able to detect the action with great variations in time, or should include some mechanism to provide audible and/or visual feedback to let the child know when he can remove his finger from the screen, which would only be understandable for children around two years of age in any case.

TWO-FINGER ROTATION. Rotate two fingers clockwise or counterclockwise. Rotations are the gestures that require the highest level of cognitive effort, as they involve some of the more complex motor skills for the most common multi-touch gestures.

Among the gestures that have been observed to be too difficult for children under two years of age to perform, there are some that can be achieved when the child is almost two years old and there is an adult or an older child playing with them, as some learning and practice will be required.

DRAG & MOVE. This is the movement required to drag an item to an area, not to drop it, but to move it to perform an action. E.g., Holding a bar of soap (element) in the hands of a character to simulate washing them.

PINCH/SCALE DOWN. Bring two fingers together for example to make an image smaller.

SPREAD/SCALE UP. Separate fingers that were together, for example, to expand the size of an image.

2-year-olds can perform the scale up gesture better than the scale down one.

TILT & SHAKE. A gesture that requires moving the device to the left or to the right. This option can be performed by some children when they can grasp the device well, and it is easier to achieve on small devices, such as smartphones, that are lighter and more manageable for babies.

INTERACTIVE CONTENT
Design & Gestures

UNIQUE AND CONSISTENT GESTURE TO ACHIEVE AN ACTION.
Children tend to perform one gesture per task. A single gesture must generate a specific reaction that cannot be achieved with other finger movements.

**COHERENT GESTURES THROUGHOUT THE APPLICATION.**
Children are able to use an app much more efficiently if the interactions that are generated require the same gestures throughout the application.

ONE GESTURE ON EACH SCREEN. Children are confused when there are elements on the same screen that react to the use of different gestures.

IMMEDIATE FEEDBACK. The action should be programmed to start when the child touches, not when he raises his finger. Children tend to tap on the screen too hard, for too long, too many times in a row. An immediate reaction to the contact must be generated.

DIFFERENT WAYS OF CONTACT. Apps for such young children should support different ways of touching the screen. For example, using two or more fingers for drag and drop should have the same effect as if the gesture was made with a single point of contact. Otherwise, the child is prevented from performing certain actions, leading to frustration, especially since they cannot understand what they are doing wrong.
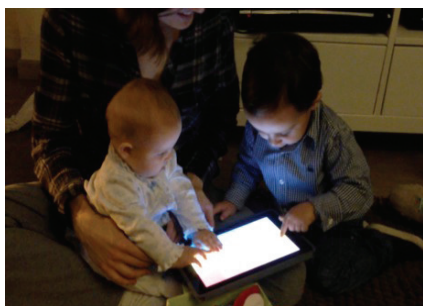
Babies aged 6 and 18 months. The youngest prevents the game from continuing by not lifting her hands off the screen.

Baby, 11 months old, leaning on the screen and touching the edges.

Baby, 13 months old, trying to play by tapping with a finger but she is touching the screen with her other hand.
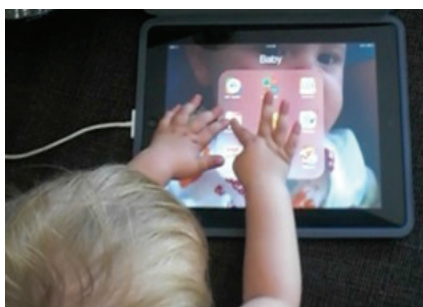
Baby, 14 months old, touching the screen with both hands and two fingers at the same time at the same point.

Baby, 14 months old, unintentionally touching the screen, which opens an ad.
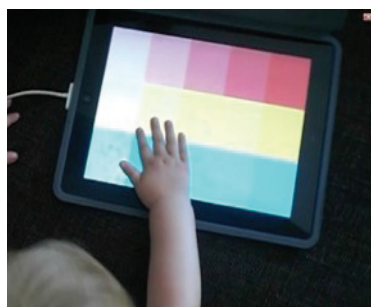
Baby, 14 months old, touching the screen with her open hand.

INTERACTIVE & GRAPHICAL CONTENT
Design of interactive elements

LARGE ELEMENTS. Interactive elements must be large in order for young children to interact with them. The most common usability problems occur when users try to select elements that are too small to touch comfortably, or that may be unfavorably positioned among other potential targets, leading to erroneous selections.

Early studies indicate that interactive elements should not be smaller than 10mm for children aged 3 years old. *The user interface design guidelines for IOS or Android are for an adult audience, as they recommend using interactive elements of 7mm.*

**INTUITIVE AND RECOGNIZABLE INTERACTIVE ELEMENTS.**
They should be highlighted by differing in appearance.

ELEMENTS WITH THE SAME FUNCTIONS SHOULD HAVE A SIMILAR APPEARANCE.

EASILY CLICKABLE ELEMENTS. WIDE ACTIVE ZONE to also register touches that are made around the interactive element.

AVOID

HIDDEN ELEMENTS such as color palettes. All elements of the game must be visible.

ELEMENTS THAT ARE NOT INTERACTIVE SHOULD NOT LOOK LIKE THEY ARE. Children want to interact with anything that appears on the screen. Non-interactive elements should not be highlighted, and if possible should be avoided.

PICTURES or BACKGROUND ELEMENTS. Children will try to interact with them, since they treat the background like any other image on the screen.
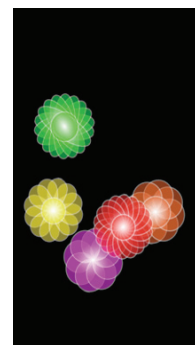
Baby, 15 months old, she sometimes taps on the interactive element but often touches around it. She has intention, but lacks the necessary accuracy. The app continues to react because it has a fairly wide margin of registration.

My baby fireworks App, with recognizable interactive elements, and a black background without any images.
However, it produces flashes of light, which are not recommended.

INTERACTIVE & GRAPHICAL CONTENT
Design of interactive elements

Buttons

0 m	3 m	6m	12 m	18 m	24 m

Avoid buttons
Children have no control over where they touch on the screen, if they press a button it will be by chance.

Buttons WITHOUT specific functions in the game.
If there are buttons with features like *Home*, you have to prevent them from being visually highlighted or children will tap on them constantly.
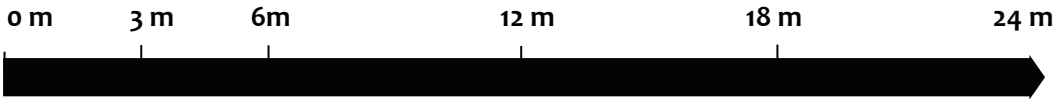
They love to tap on buttons randomly for the pleasure of generating a sound or a visual effect.

Buttons WITH or WITHOUT specific functions.
They begin to understand that each button responds to a specific function. These elements should be designed to stand out from the rest of the things that appear on the screen, to draw the child's attention.

AVOID
Pursue specific goals such as tapping on buttons following instructions or a sequence.

Buttons that have other functions beyond those of the game itself (advertising, shopping, etc.)

Buttons targeted at parents or the *Home* button should not be visually highlighted.

Baby, 13 months old, tends to touch the buttons on the screen, instead of the characters that are actually the interactive elements of the game.

Text

Babies cannot understand that text is a symbol that relates to an image. Text is only relevant if it assists parents, e.g., consistently describing what is happening in the app, using the same words every time, or giving parents ideas on things to talk to their children about that are related to what they are seeing and experiencing in the game.

AVOID instructions. The goal of the game should be understood immediately and intuitively.

INTERACTIVE & GRAPHICAL CONTENT

Colors

0 m **3 m** **6m** **12 m** **18 m** **24 m**

Strong contrasts such as white and black, white or pale yellow with bright red, etc.

Red is the color that most attracts their attention.

Strong contrasts with bright and vivid colors.

Bright colors can be combined with light ones, creating contrast.

Pastels and combinations of light colors can be used without the need to create a big contrast.

AVOID
Colors related to gender stereotypes. Young children are using apps the same way, no matter their gender. Let's not enforce differences at such early stages of their development.

There is a wide color spectrum, children appreciate the complexity of good design. Do not only think about primary colors when designing the esthetics of the app.

Images

0 m **3 m** **6m** **12 m** **18 m** **24 m**

VISUAL STIMULATION

+ LEARNING CONCEPTS

Simple patterns and basic shapes: wide parallel lines, polka dots, checks, spirals, schematic faces, etc.

Images of objects, people and animals in their environment

Photos

Realistic illustrations

Basic shapes with colors

Illustrations with a variety of esthetics are interesting to provide visual stimuli and foster the appreciation of different esthetics. Young children will not understand the meaning of an image that represents something unless it is very realistic and similar to what they see in their everyday environment.

AVOID
Flashes can dazzle and affect babies because of the low adaptive capacity of their pupils.

Fast animated images. Animations should simulate a similar speed to how things happen in reality.

INTERACTIVE & GRAPHICAL CONTENT
Layout of elements

COHERENT AND SIMPLE throughout the application. (AZIZ, 2013). E.g., if all items are placed at the top of each screen from the beginning, they should not be placed at the bottom, or arbitrarily, on other screens.

At THE TOP IN THE MIDDLE OF THE SCREEN. This is the area where children do not usually lean or place their fingers when holding the device.

SMALL NUMBER OF COMPONENTS. Simplify the number of objects that appear on the screen to the minimum necessary for the functionality of the game. By reducing the number of elements, the size of the interactive elements and the spaces between them may be increased.

One problem of usability is that of **HOLDOVERS** (ANTHONY et al., 2014), referring to when the player touches the screen in the same place where an interactive element had been placed and touched before. When the child successfully touches an interactive element, she tends to tap repetitively on the same spot, even if the screen changes and the interactive element is placed in a different area. It is important to consider whether the interactive element on new screens can be placed in the same position.
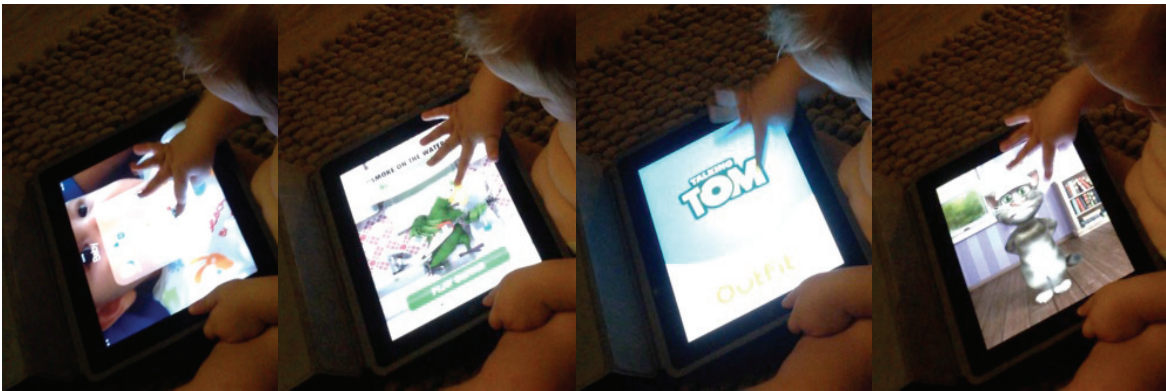
Baby, 15 months old, having problems with holdovers. At first she taps in a place where something happens. She keeps tapping in the same area, even when the images on the screen have changed several times.
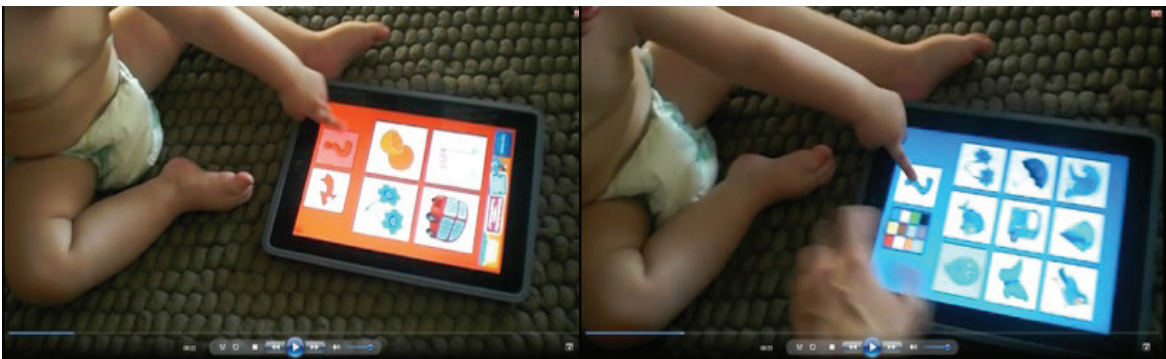
Baby, 14 months old, playing an app where the holdover does not represent a problem, as all the elements are distributed in the same way on different screens. Even though the child keeps tapping in the same place, the game reacts properly.

INTERACTIVE & GRAPHICAL CONTENT

App orientation

0 m	3 m	6m	12 m	18 m	24 m

The orientation of the app is not relevant. The adult places the device in the correct position.

Without specific orientation. The app should be the same regardless of the orientation in which the device is being held.

The app can have a specific orientation The child initially holds each device in the most common position:
- Tablet horizontally
- Smartphone vertically

The child will begin to understand the orientation of the images especially if he can see familiar things (faces, pets).
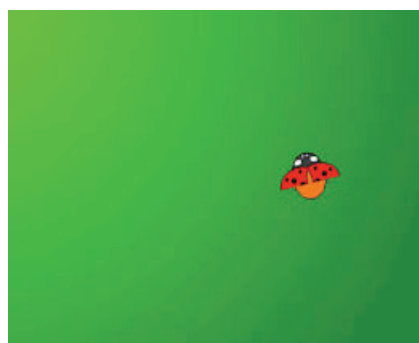
"Touch the ladybug" app by David Herrera Solas

"Peppi bath" app by Peppi Play

Other relevant factors for design

WITHOUT INTRUSIVE ADVERTISING. The impact of advertising on babies is very negative. The game must only display objects that are functional for it, everything else has to be eliminated. Many parents prefer not to pay for apps, so developers have a great challenge to make money from their work without using advertising. Parents appreciate free lite versions which they use to test if the app is suitable for their children. In general, if they like the app they will pay to get the extended version.

WITH LOCK FOR BABIES. Babies will play in any area of the screen without discrimination. Not all parents have a device that allows a *Kid's Mode*. Parents appreciate apps with the possibility to easily prevent access to options such as advertising, external links, shopping, etc.

3 CONTENT
The design

EDUCATIONAL & RECREATIONAL CONTENT: Recommendations

What kind of apps would be most suitable for them?
How to design them in terms of their educational and recreational content?

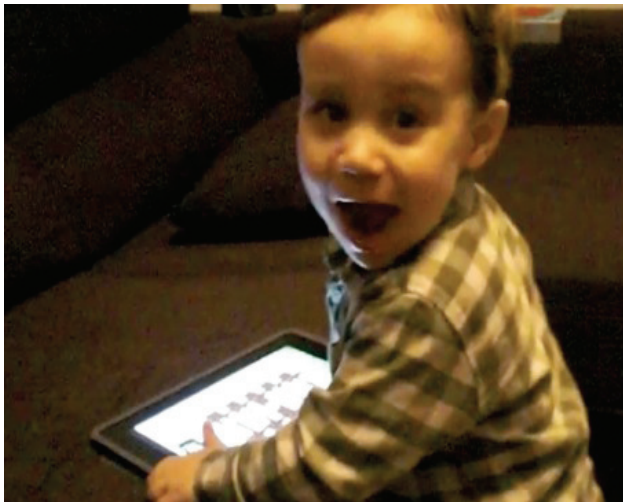# EDUCATIONAL & RECREATIONAL CONTENT Open-ended/Specific target

One of the necessary factors for learning to occur is motivation. Babies are motivated to see what happens on screens; a multitude of studies have provided evidence of very young children showing signs of sustained attention to television (RICHARDS, 2001). It is not known if babies are engaged for cognitive reasons and extract information from it, or whether they simply look at it because it triggers an automatic instinct to look at what is new and changing.

Nevertheless, considering that the use of apps may motivate some type of learning, it has been demonstrated that learning on screens produces a "Video Deficit", that is, that it takes much more time to learn a concept through a screen than through direct interaction with people and objects in the immediate environment (SARACHO, 2015). However, there are several factors that, when taken into account in designing apps, could boost their educational potential.

DESIGNED FOR A VERY SPECIFIC TARGET

Children experience great changes in their physical and cognitive development from birth to 2 years of age. The mechanisms for play and interaction must be appropriate to their possibilities at each stage. In general, even older kids will not be able to learn if the app is too difficult for them to manipulate, and it will not motivate them if it is too easy. It is important that the child can overcome a challenge that is appropriate to their possibilities.

OPEN–ENDED PLAY

Apps that allow free play, without specific goals, for a period of time that can vary widely, depending on the circumstances and the maturity of the child.

Baby, 23 months old, excited after performing an action that led to a reaction on the screen.
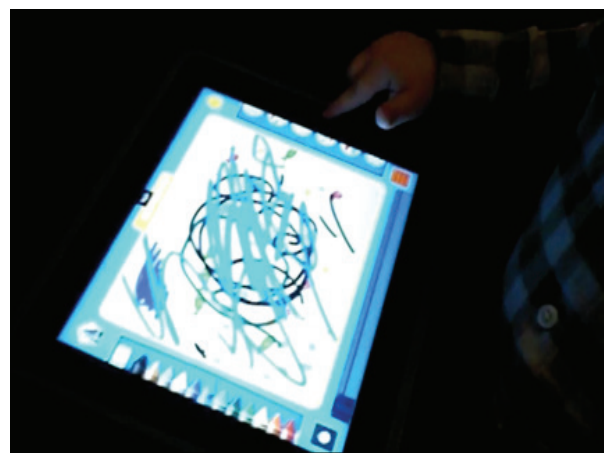
An example of an open–ended app

EDUCATIONAL & RECREATIONAL CONTENT Customizable

CUSTOMIZE CONTENT WITH INFORMATION FROM THEIR EVERYDAY ENVIRONMENT

Photos, sounds and videos: Allow familiar elements to be incorporated in the game, such as photographs of family members, or objects and sounds from their everyday environment.

Other ideas to customize:
e.g., offer a wide range of images and sounds to make it easy to personalize the game with options that are as similar as possible to the child's environment.
e.g., provide the possibility to customize the colors of the objects that come preset and / or allow the variation of some of their characteristics to make them resemble the objects the child is surrounded by.

Words and short phrases that the child hears in his daily life, reinforcing learning through repetition in the physical and virtual world. E.g., with specific messages using the child's name according to the time of day: John, it is time to go to bed.

CUSTOMIZE THE DIGITAL AND REAL CONTENT

Incorporate information from the real environment in the digital game. Global Positioning Systems (GPS) on mobile devices allow us to develop a new way of interacting with the environment, by combining virtual information with real-world experiences.

Incorporate objects in the game, which the child has in his environment. There are technologies that allow interaction with any object in a way that is reflected on the screen with some kind of action. E.g., *moving his favorite teddy bear generates a digital illustration of the route, or a sound according to the intensity and type of movement.*

LEVELS OF DIFFICULTY allow the game to be better adapted to the characteristics of each child. A game that evolves with the child gradually provides a tool for the progressive improvement of their abilities and learning.

Apps with difficulty levels can be used for longer as they can be used by a wider age range. They also make it easier for siblings of different ages to play the same game.

EDUCATIONAL & RECREATIONAL CONTENT Games that allow interaction with the physical world

GAMES THAT PROMOTE SOCIAL INTERACTION

To encourage joint play, parents have to be considered as users. The proposals have to involve them and also provide fun experiences for them.

Apps should be thought of as a tool to provide parents with resources to generate interactions that are verbal, gestural, etc.

If parents are actively involved in the game, 15-month-olds are 22 times more likely to transfer learning from the device in real time (ZACK, 2016).

ORIGINAL AND DIFFERENTIAL GAMES

Children confuse the properties and functions of toys or books with digital versions. Unique proposals have to be created: new games that are not a direct transfer of traditional products.

DIGITAL GAMES THAT INVOLVE MANIPULATING PHYSICAL OBJECTS

It is essential to provide children an environment rich in sensory experiences that allow exploration with physical objects. Digital games have many restrictions in this regard, especially at such early ages. Experts recommend that the best way to learn (about numbers, sizes, words, etc.) is to manipulate objects.

Tiggly Shapes

For this reason, it is necessary to generate game proposals that require interaction with specifically made toys, or objects that the child has in his environment.

Children of 12 and 23 months old playing next to each other.

APP PROPOSALS BY AGE

On this page and those following, we present specific suggestions to consider when developing games according to each evolutionary stage.

APP PROPOSALS 0–3m

AUDITORY STIMULATION: MUSIC & SOUNDS
- Sounds with calm and repetitive rhythms to simulate the sounds the baby heard in the womb: the mother's voice, heartbeat (close to 60 beats per minute), breathing, environmental noises.
- High-pitched sounds (amniotic fluid allows the passage of relatively high-pitched sounds, over 1500 hertz).
- Babies prefer the human voice to any other sound, above all, they like the higher-pitched voices of women, preferably the voice of her mother. Allow familiar voices to be recorded.

AUDITORY AND VISUAL STIMULATION
- They are attracted to unpredictable and random movements. Generate apps based on the traditional function of a rattle: moving the device generates a sound or a musical and/or visual variation.
- Calm melodies and slow, rhythmic movements of simple contrasted images.
- Generate images that move horizontally to favor eye movements on both sides. They will only be able to see large objects moving slowly.
- Encourage them to touch the screen with their hands open. Children this young usually tend to close their hands into a fist.

Games should not require correct answers, they should be based on proposals of actions that generate reactions by simply touching the screen anyhow, anywhere.

NOTE: The listed proposals will not be repeated on the following pages, even if they can also be implemented in apps for older children.

APP PROPOSALS 4–6m

AUDITORY AND VISUAL STIMULATION
- Simulate random movements with sounds from nature and their environment: leaves in a tree, birds singing, the rain, a candle flame , windmills, swimming fish of contrasting colors, etc.
- Create musical combinations with simple screen taps. Young DJs who create melodies by chance.

VISUAL AND SOCIAL STIMULATION
- Relaxing soft voices of women, especially the voice of the mother.
- Images that promote vertical and horizontal visual tracking. They gradually perceive circular movements better and can see smaller images moving a little faster.
- Images with bright colors.
- Simulate a mirror (they think it is the image of another child).
- The face of the mother, father or other relatives or acquaintances.
- Faces with exaggerated gestures.

LANGUAGE STIMULATION
- Apps that repeat onomatopoeias: ma-ma, pa-pa ...

FINE MOTOR SKILL STIMULATION
- Apps responding (visual or audibly) to a touch on the screen or the movement of the device in the most casual way possible. A simple and random touch generates a sound or a variation of a melody or image projected on the screen. Even though the app responds to this kind of interaction, it should allow the generation of quality responses, e.g., a good melody.

PROPOSALS FOR IMPLEMENTING THE DIGITAL GAME WITH PHYSICAL TOYS
- Apps incorporated into play mats, gyms and activity centers promoting feet and hand movements. E.g., a piano for their feet.
- A case for the device with different finishes and textures enabling tactile experiences, even to be bitten.

Cases should be able to be held easily by small fingers. They should not involve any dangers when children put them in their mouths (they must not be toxic or damaging for the gums). They should be washable.

NOTE: The listed proposals will not be repeated on the following pages, even if they can also be implemented in apps for older children.

APP PROPOSALS 7–12m

AUDITORY STIMULATION
- Apps that simulate musical instruments. Options that work when you touch them with your hand or fingers, such as drums or keyboards.
- Melodies or notes with highly contrasting audible tones very: high-low, fast-slow, etc.
- Different types of music: classical, modern, etc.
- Sounds from the familiar environment: doorbell, dogs, cars, etc.
- Songs to reproduce simple gestures, like clapping, saying goodbye or not.

VISUAL AND FINE MOTOR SKILLS STIMULATION
- Tap images that move around the screen to encourage eye tracking of a movement towards both sides. With difficulty levels that show ever smaller objects, with faster movements.
- Scribble with your finger/s without aiming to paint anything specific.
- Games that encourage the action of pointing.

He is attracted by the mechanics of changing pages, which becomes a game in itself.

LANGUAGE STIMULATION AND CONCEPT LEARNING
- Find a hidden object when it is named.
- Proposals incorporating the child's name.
- Apps that repeat common simple words the child might hear daily: mom, dad, cat, dog, etc.
- Very simple commands: eat, come, etc., or short, simple repetitive sentences. Let's go!
- Options that detect when the baby makes a *recognizable* sound, and repeat it with simple words. E.g., if he says "mo" he would be answered with the word "mommy".
- Apps that encourage sign language and gestures:
    - Associated with verbal concepts, such as: I've finished, I want more, etc.
    - To encourage social practices, such as saying goodbye, giving a kiss or a hug.
    - Containing the concept of "No" to stop doing something, accompanied by gestures with the finger or head.

PROPOSALS FOR IMPLEMENTING DIGITAL GAMES WITH PHYSICAL TOYS
- Covers with different finishes, textures and materials, like soft rubber, cloth, wood, plastic. Materials to experience through touch and allowing them to bite.
- Wobble toy to put the smartphone in.
- Toys that move to encourage crawling.
- Toys that change height to promote postural changes.

NOTE: The listed proposals will not be repeated on the following pages, even if they can also be implemented in apps for older children.

APP PROPOSALS 13–18m

AUDITORY AND FINE MOTOR SKILLS STIMULATION
- Music with rhythmic sounds that promote dancing and/or play with gestures and sounds.
- Songs accompanied by lyrics and images with gestures parents can reproduce as well.
- Buttons with sounds. E.g.,-simulate a phone.
- Apps to scribble. As a complement it could generate musical effects.

NOTE: Musical proposals are interesting in all developmental stages.

LANGUAGE STIMULATION AND CONCEPT LEARNING
- Associate spoken words with actions and objects.
- Identify:
    - Things from the child's everyday life: food, toys, things in the park, home, clothes, etc.
    - Sounds: transport, animals, etc.
    - Parts of body and face.
    - Things with basic colors.
- Simple songs in which a word is missing, the music stops and the parents say the word encouraging the child to do it too.
- The concepts "yes" and "no"
- Imitate and reproduce gestures
    - Related to the function of objects in the child's environment. E.g., putting your hand on your ear as if you were talking on a phone.
    - Related to everyday actions depending on the moment of the day. E.g., "Time for bed" putting both hands under your cheek and tilting your head.

NOTE: Avoid topics, things or stories related to fantasy, at this age it is better to play with realistic and familiar themes.

PROPOSALS FOR IMPLEMENTING DIGITAL GAMES WITH PHYSICAL TOYS
- Walkers, wheeled toys and pull-along toys that incorporate a device. E.g., the child walks while listening to his favorite music. E.g., if the toy simulates an animal the app can generate related sounds.
- Apps that detect when a 2–4-piece tower is stacked.
- Place and remove real pieces with simple shapes in their respective space on the screen.

NOTE: The listed proposals will not be repeated on the following pages, even if they can also be implemented in apps for older children.

APP PROPOSALS 19–24m

AUDITORY STIMULATION
- Instruments and musical proposals.
- Interactive stories with rhymes.
- Songs and stories with sign language. E.g., clapping in time with the music.

FINE MOTOR SKILLS AND COGNITIVE STIMULATION
- Apps to scribble using basic colors and original effects.
- Puzzles with 2–3 pieces.
- Objects appear when the screen is tapped.
- Objects can be dragged around the screen (randomly or short routes) generating sounds or other visual effects.

LANGUAGE STIMULATION AND CONCEPT LEARNING
- Games that promote the knowledge of:
    - Colors and simple shapes.
    - The first numbers.
    e.g., Apps that count up to 3 while showing 3 spoons (show objects related to the child's real experiences). Parents should be able to customize the numbers depending on their child's development.
    - Things, people and places from the child's daily life:
    Everyday objects (chair, table, spoon, glass) / food (water, banana, biscuit) / clothing (jacket, shoes, hat) / toys (ball, stuffed animal, doll) / areas of the house (room, kitchen) / places of their environment (park, nursery) / animals the child can see in real life (dog, cat, bird), body parts (hand, eye, foot) / relatives (grandfather, aunt) / other children.
    - Familiar sounds. E.g., animals and vehicles.
    - Activities and actions
    Activities (eat, sleep, dance) / daily habits (getting dressed, brushing teeth) / day-to-day parent-child actions (games from the park, picnics) / actions related to roles (mommy working, daddy cooking) / actions (go up or down) / social gestures (waving hello).
- Classify images and objects freely or by specific characteristics, such as: colors, shapes, or sizes.
- Direct questions that encourage simple answers. E.g., Characters who speak directly to them responding to the child's gestures and interaction in real-time.
- Play proposals repeating what the child says.

SOCIAL STIMULATION
- Play with concepts: me, you, mine, yours.
- App with individual game mode, and a mode to play the game with another child or adult.

PROPOSALS FOR IMPLEMENTING DIGITAL GAMES WITH PHYSICAL TOYS
- Complete very simple puzzles with real pieces to be placed on top of the screen.
- Real pieces of different size, shape and color to place and interact with the images that appear on the device.

CONCLUSIONS

CONCLUSIONS

The results of the research demonstrate that children in Spain under 2 years of age are playing with apps on touchscreen devices, such as tablets or smartphones. An large amount of parents in our study say they really enjoy playing with apps with their children.

Apps are a low-cost resource that seem to appeal to children, which can present a world of recreational and educative opportunities. If they are well designed, apps can be a tool to support parents or older siblings in a variety of interactions they can have with young children (interactions that should involve people, objects, and the environment), as long as children are not left alone in front of the screen.

However, after analyzing the apps that babies and toddlers are exposed to, an important conclusion of the research is that these games are not adequate for these stages of children's development.

It becomes clear that developers do not have enough data on how to create appropriate material. Concrete information on the design of children's apps is necessary for the industry, as well as for the educational centers specialized in the development of apps.

Faced with this reality, this publication provides companies, developers and designers with relevant information to take into account when creating apps for young children. Data that addresses issues related to the context of use, the content and the development of the user's capabilities.

The data represents a step forward into expanding the small amount of scientific research that exists on the subject today, serving as a bridge to new studies that could answer questions about the correct use and development of apps for such small children.

The technology is very new and scientific research has not yet been able to determine its effects, nor the characteristics required in order for them to be suitable for children. The research presented in this publication is not intended to promote the use of touchscreen devices with babies, its goal is to provide a better knowledge of the subject in a way that helps to improve the quality of the apps that reach such vulnerable children.

Apps can present a great opportunity for parent-child play time, if their use and design is correct

Much research is needed to determine how to design and use apps with babies

It is necessary to inform designers, the industry, educators, and parents about key features to consider when developing and using apps

CONCLUSIONS

THE BEST APPS FOR CHILDREN UNDER 2 YEARS OLD

Promote joint parent-child interaction and foster mutual interest in the activity.

Are developed taking into account both the child and the adult.

Are tools that generate game and activity proposals that lead to talking, singing, making gestures, dancing together, etc.

Are free, recreational, open-ended proposals. They allow children to experiment without pursuing a specific goal of play.

Can be used without following specifically allotted time span.

Allow action-reaction by chance.

Allow visual and sound repetition.

Allow interaction and learning of the child's environment.

Have options for personalizing sounds and images.

Allow interaction with real objects and toys.

Are designed for very specific developmental stages: they present images and ways of interaction (such as gestures) appropriate to their developing cognitive and motor skills.

Animations move at a slow pace.

Are differential and original recreational proposals.

With simple screens (but esthetically rich and well thought out), that allow the child to focus his attention on the interactive elements.

No advertising banners that would create interference in the game.

Despite all these recommendations, it is of great relevance to limit the time children play with apps. They should occupy very little of their time compared to other play activities and interactions.

The information presented in this guide are general recommendations. However, each child is different, has different interests, different rhythms of development and learning acquisition patterns, so the type of app and play proposal has to be adapted to each individual and each situation.

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DESIGNING CHILDREN'S APPS. Usage data & recommendations for the development of apps for children under 2 years of age and their families

Miriam Morante Bonet; María Costa Ferrer; Nuria Rodríguez Calatayud

Are children under 2 years old exposed to apps? Which ones? How often?

What kind of apps would be best suited for small children based on their physical and cognitive development, the evolution of their play patterns and their ability to interact with mobile devices?

How to design apps as appropriate as possible for children under 2 years old?

These are some of the main questions that are answered through the research presented in this publication. An investigation that demonstrates that children under 2 years of age in Spain are playing with apps and highlights the relevance of generating supporting documentation, for improving the use and the design of apps for such a vulnerable target.

The research presents pioneering information for the industry and developers with specific proposals on how to design children's apps taking into consideration children's development and their possibilities in terms of recreational, educational, graphical and interactive content.

The information also supports educators and parents when it comes to choosing apps and defining the ways of use that may be most appropriate for each child in each age group.

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