Tablet Use in Young Children is Associated with Advanced Fine Motor Skills

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Tablet use in young children is associated with advanced fine motor skills.

Pablo Hildelbrando S. Souto[1], Juliana Nunes Santos[1], Hércules Ribeiro Leite[1], Mijna Hadders-Algra[2], Sabrina Conceição Guedes[1], Juliana Noguera Pontes Nobre[3], Rosane Luzia de Souza Morais[1,3]

[1] Department of Physical Therapy, Federal University of Jequitinhonha and Mucuri Valleys (UFVJM), Diamantina, Brazil.
[2] University of Groningen, University Medical Center Groningen, Department of Pediatrics, Division Developmental Neurology, Groningen, Netherlands.
[3] Professional Master´s Program in Health Society and Environment, Federal University of Jequitinhonha and Mucuri Valleys (UFVJM), Diamantina, Brazil.

Abstract

Objective: To evaluate whether frequent interactive tablet-use at preschool age is associated with improved fine motor skills and to describe tablet-use in young children.
Method: Cross-sectional study with 78 children, aged 24-42 months: group 1 with previous frequent tablet-use exposure (n=26), group 2 without previous tablet-use exposure (n=52). Fine motor skills were evaluated with the Bayley-III.
Results: Socioeconomic data and home environment quality were similar in both groups. Fine motor skills of group 1 were better than those of group 2 (p=0.013). Most participating children carried out passive and active tablet activities, usually accompanied by parents, not exceeding time recommendations for young age.
Conclusion: We observed a difference in fine motor skills in young children slightly favoring those with tablet-use experience.

Keywords: child development; fine motor skills, touch-screen tablet, early childhood;

Introduction

Child development is influenced by genetic, biological and environmental factors (Black et al., 2016). This is reflected by the well-known associations between higher levels of maternal education and family income and favorable child development. In addition, the environmental resources available for the stimulation of the child - which may range from an adequate space for the development of motor skills to a variety of toys and learning materials available (Black et al., 2016; Neves, Morais, Teixeira, & Pinto, 2016) - are associated with better child development.

Recently, interactive media have been added to the repertoire of learning materials. However, the impact of such interactive devices on child development, such as fine motor development, is not well known (Radesky, Schumacher, & Zuckerman, 2015). Interactive media, such as tablets and smartphones, are defined as a multimedia systems integrating simultaneously visual and audio elements to create programs with e.g., animation, games, graphics and simulations, that promote effective communication and encourage interactive participation (Pinero & Gonzales, 2006). Common Sense Media (2013) pointed to the increasing media use by American children aged eight years and under, with a prevalence of 52% in 2011 and 75% in 2013. The increase occurred at all socioeconomic levels, but a substantial disadvantage for the lower income families persisted. Goh et al. (2016) reported that in Singapore the prevalence of the use of interactive media in children below the age of two years was 30.5%. A French questionnaire study, in which especially highly educated families of young children participated, reported that the use of interactive media increased with increasing child age. The increase was particularly pronounced in the child's second year of life (Cristia and Seidl, 2015). Yet, the fine motor skills applied during interactive

media use, improve especially between the ages of 3 and 6 years (Vatavu, Cramariuc, & Schipor, 2014)

Unlike the personal computer, which requires substantial visual coordination and manual skills to handle the keyboard and mouse, interactive media are relatively easy to use, making them accessible for young children (Lovato &Waxman, 2016). For instance, at age two the child has the ability to make purposeful use of an interactive device, as it has the required fine motor skills needed for the use of touch screen technologies, such as tapping, ticking, pressing and dragging, swiping and pinching (Ahearne, Dilworth, Rollings, Livingstone, & Murray, 2015; Common Sense Media, 2013; Sheehan & Uttal, 2016).

It has been suggested that the use of interactive media, such as electronic games, may increase the efficiency of fine motor skills and improve visual motor coordination, reaction time, processing of spatial visual information and reasoning (Adams, Margaron, & Kaplan, 2012, Price, Jewitt, & Crescenzi, 2015), because they require several activities that encompass manual skills. However, some authors argued that the use of these media may be associated with negative developmental effects, e.g., by generating inadequate physiological adaptations in the wrists and hands muscles (Lin et al., 2017). In addition, doubts have been raised on the capacity to transfer skills learned during screen activities to the context of real life (Lin et al., 2017; Sheeran & Uttal 2016).

Despite the steady rise of interactive media use by children in early childhood (Ahearne et al., 2015) - one of the life periods that is most sensitive to environmental intervention or adaptation (Daelmans et al., 2016) - research on its effect on fine motor skill development is limited. Fine motor skills comprise the use of the small muscles of the upper extremities involved in movements such as grasping and manipulation. Its acquisition throughout childhood allows the child to participate in important activities in self-care, education and social interaction (Gallahue & Ozmun, 2006; Summers, Larkin & Dewey,

2008). This means that uncertainties persist on the appropriate use and the potentially positive or negative influences of interactive media use on fine motor skill development (Christakis, 2014; Lovato &Waxman, 2016; Radesky et al, 2015).

Realizing this gap in knowledge, the objective of this study was to evaluate whether the fine motor skills of young children who frequently use an interactive tablet differs from that of peers who do not use this device. We hypothesized that frequent tablet use is associated with a beneficial effect on fine motor skills. The study's secondary aim was to describe the situations in which young children use the tablet.

Method

Design

This study involved a cross-sectional design. It was conducted with young children attending public and private day care centers in a small city with a high Human Development Index in Brazil. The latter index is a statistical index based on life expectancy, education and income, which is used to stratify developing countries (UNDP, 1990).

Participants

To be included in the study children had to fulfill the following criteria: a) age between 24 and 42 months. This age range was selected as the study of Cristia and Seidl (2015) indicated that in this period the use of interactive media starts to bloom; b) absence of congenital or acquired disease that could affect fine motor performance; c) parents providing informed consent; d) coming from families with socioeconomic levels A, B and C, i.e., the families with a medium and high socioeconomic status (Associação Brasileira de Empresas de Pesquisa, 2015). This inclusion criterion was based on the information that interactive media

use by young children especially occurs in families with a higher socioeconomic background (Common Sense Media, 2013). We also preferred to have a relatively homogeneous social background, as social background has a strong effect on development (Black et al., 2016).

The parents filled out a sociodemographic and interactive media questionnaire. The interactive media questionnaire assessed the use of interactive media (such as tablet and/or smartphone), including information on the frequency and duration (in minutes) per day, and duration of exposure during the preceding period (in months). On the basis of the questionnaire two groups of children were distinguished: children who frequently used a tablet (G1) and children who did not use a tablet (G2). We excluded children from the study who had limited experience with tablet use, either using it less than 10 minutes per day or less than 3 months.

To classify the children's socioeconomic situation, the Brazil Economic Classification Criterion (BECC) of the Brazilian Association of Research Companies (Associação Brasileira de Empresas de Pesquisa, 2015) was used. BECC assigns points according to the assets and the educational level of the head of the family. It results in a classification from E to A1, with A1 being the highest level (Associação Brasileira de Empresas de Pesquisa, 2015). In addition, the Family Environment Resource Inventory (FERI) was used to evaluate the quality of the home environment (Maturano, 2006), with the minor adaptation suggested by Dourado et al. (2015). The FERI is a standardized semi-structured questionnaire with ten topics distributed over three domains: 1) family environment resources; 2) activities that signal stability in family life; 3) parental practices that promote family-school linkage. On the basis of the item scores a total score is calculated, with a higher score indicating a higher quality of the environment (Maturano, 2006).

The study was approved by the Scientific Ethics Committee of the Federal University of Jequitinhonha and Mucuri Valleys (protocol no 1.674.171).

Evaluation of fine motor skills

Fine motor development was evaluated with the Bayley Scales of Infant Development, Third Edition (Bayley III) (Bayley, 2006). This test is considered as the gold standard in the evaluation of child development (Corsi, Santos, Marques, & Rocha 2016; Santos, Corsi, Marques, Rocha, &, 2013). The test's main objective is to identify in the age range of 1 to 42 months children with developmental delay in the various domains. In the present study, we only used the fine motor scale. Each scale of the Bayley III is scored based on the sum of tasks carried out by the child, generating raw scores, that may be converted to scaled scores. We used the fine motor scaled score, that has a mean score of 10 and a standard deviation of ± 3 points (Bayley, 2006). The Bayley III assessments took place at the day care centers and were carried out by one of a team of four assessors who were blinded to the child's group allocation. The assessors' interrater reliability was assessed prior to study onset and shown to be good (Intraclass Correlation Coefficient 0.95).

Statistical analysis

Sample calculation of the study was based on Lin et al. (2017). The calculation, based on the use of the unpaired t-test, a significance level of 5%, a study power of 80%, and a test effect of 80%, revealed that at least 52 children should participate, 26 in each group. The sample calculation and study power were calculated using G Power 3.1.9.2.

The collected data were analyzed with the help of the *Statistical Package for the Social Sciences*, version 19.0. Preliminary analyses showed that the data were not normally distributed. Hence non-parametric descriptive and analytic statistics were use. To compare background factors and Fine Motor Scaled scores the Chi-square and the Mann-Whitney U Test were used, where appropriate P-values of < 0.05 were considered statistically

significant. The *QuickCalcs GraphPad* software, website https://www.graphpad.com/quickcalcs/Grubbs1.cfm was used to verify the existence of significant outliers; also here a significance level of 0.05 was applied.

Results

Characteristics of the participants: age, gender and social background

Seven public and four private day care centers in the city of Diamantina, Brazil took part in this study. From April to August 2017, 129 parents (out of 172, 75%) returned the signed consent and assent forms. Seventy eight children met the inclusion criteria for attending the study (see flow chart, Figure 1). Exclusion from the study was mainly based on socio-economic status (classifications D and E) and in five children due to limited experience with tablet use.

Insert figure 1

Of the 78 participants, 26 fulfilled the criteria for frequent tablet use at home (G1) and 52 had no experience with tablet use (G2). The median age of the children in G1 was 36.5 months (range 26-42 months), that of the children in G2 36 months (range 27-42 months). This implied that the groups' ages were not statistically significantly different (Mann-Whitney, p=0.566). Also the proportion of girls and the use of smartphone in both groups was similar (Table 1).

Table 1 summarizes the information on sociodemographic background and the environmental resources of the families of both groups. The groups were similar in terms of

maternal education, economic level, quality of the domestic environment (FERE) and type of school (private or public).

Insert table 1

Tablet use

Tablet use was by definition only present in group G1. The children of this group used the tablet for 60 minutes per day (median value), with a minimum of 10 and a maximum of 120 minutes. The period during which the children had been using the tablet varied from 3 to 24 months (median: 9.5 months).

Details on the children's tablet use are provided in figures 2, 3 and 4. Figure 2 shows that most children performed passive activities on their tablet, such as watching videos, but they also performed active activities, such as playing games. Figure 3 indicates that most children used the tablet while being accompanied by their parents.

Figure 4 illustrates the parents' attitude regarding tablet use. Most parents limited the time spent with the tablet and the content of the tablet. Most parents stimulated the child during tablet use, and they believed that the tablet is beneficial for child development. Just over half of parents admitted that they used the tablet to entertain the child at home or in public.

Insert figures 2, 3 and 4

Fine Motor Skills

Figure 5 compares the two groups regarding their performance on the Bayley-III Fine Motor Scaled scores. The median value in G1 was 12.0 (ranging from 9.0 to 19.0), that in G2 11.0

(ranging from 7 to 15). Two children in G1 were considered as outliers. However, as the data of these two children did not differ significantly from the others ($p>0.05$), they were not excluded from the analysis. The difference in Fine Motor Scaled scores between G1 and G2 was statistically significant ($p=0.013$), implying that the G1 children performed better than the G2 children. The effect size of the difference was 0.66 (at a power of 70%; $p <0.05$), indicating a moderate difference between the groups.

Insert figure 5

Discussion

Main Findings

Our data showed that children aged 24 to 42 months who had frequently used interactive tablet media had slightly but significantly better fine motor skills than their peers without tablet experience. Our study also indicated that the participating children carried out both passive and active activities on the tablet, and that they usually were accompanied by their parents. Tablet use was restricted in time, and this time in general did not exceed the recommendations for young children.

Interactive media use and development of fine motor skills

We previously mentioned that child development is a multifaceted process that is strongly influenced by environmental factors (Black et al., 2016; Comuk-Balci, Bayoglu, Tekinda, Kerem-Gunel, & Anlar, 2016; Corsi et al., 2016; Neves, et al., 2016; Santos et al., 2013), such as the quality of the home environment and socioeconomic factors (e.g., maternal educational status and economic level (Black et al., 2016; Comuk-Balci et al., 2016; Neves et

al. 2016). Also, the quality of the day-care environment matters (Corsi et al., 2016). For instance, Santos et al. (2013) reported that the fine motor and cognitive development of children aged 13 to 41 months attending public day-care centers was worse than that of children attending private day-care centers of similar socioeconomic background. Thus, knowing that our two study groups were similar in socioeconomic status, quality of home environment and type of day-care, makes it unlikely that the differences in fine motor skills between our two groups may be attributed to differences in these social background characteristics.

Our results are in line with those of Bedford et al. (2016), who collected information on tablet use and development by means of an online survey of parents of young children. In the 366 children, aged 19 and 36 months, a younger age at onset of tablet touchscreen use was associated with better fine motor skills, i.e., ability to stack blocks. Price and colleagues (2015) studied in 2-to-3-year-olds differences in free finger painting activity and coloring performed a) on a tablet and b) with paper and ink. They found that tablet use was - on the one hand - associated with an increase in the speed and continuity of the drawing movements, which resulted in more drawings, but also – on the other hand – in a reduction of the number of fingers used, and more uniform final compositions. The authors suggested that the latter possibly could be attributed to the lack of sensory experience with paint in the tablet situation. Despite their mixed findings, the authors concluded by suggesting that the tablet could be used as a complementary learning tool in preschool children (Price et al., 2015).

A third study, however, reported results that were at variance with our findings. Lin et al. (2017) assessed fine motor performance with the Bruininks-Oseretsky Motor Proficiency Test in two groups of 4-to-6-year-old children. The study group consisted of 40 children who had at study onset tablet experience for at least more than 60 minutes per week for at least over a month. They received a fine motor skills training program consisting of fine motor

tablet activities for 20 minutes per day during 24 weeks. The control group (n=40) had less tablet experience than the study group at study onset. They also received a fine motor skills training program for 20 minutes per day during 24 weeks, consisting of non-screen activities, such as using scissors, drawing, play dough, threading and lacing. At study onset both groups had similar fine motor skills, but after the 24 weeks of fine motor training, the fine motor skills of the control group, especially their fine motor precision and integration and their manual dexterity was better than that of the children of study group. It is possible that the advantage of the control group could be attributed to this group being more trained in the activities that were similar to those of the test.

The transfer of learning from a symbolic object depicted on a television screen or from real-life book figures is a complex and difficult process for young children (Sheeran & Uttal, 2016). However, we think that it is conceivable that the interactive nature of the tablet's touch screen may facilitate the transfer of learning from the symbolic objects of the screen to the child's experiences in the real world. This suggestion is supported by the study of Huber et al. (2016) in 4-to-6-year-old children. This study demonstrated that children's learning on the touchscreen of how to solve the problem of the Tower of Hanoi smoothly transferred to a subsequent attempt on the physical version. Also, the tablet's virtual environment and the physical environment may elicit similar types of movements (e.g., tapping, circular strokes, and straight lines), where the virtual environment provides a greater opportunity for repetition and continuity of movements (Price et al., 2015).

Yet, being able to manipulate the screen does not necessarily mean that children can learn from it (Sheeran & Uttal, 2016). In the screen activities of young children, the role of parents is extremely relevant. The learning from a screen and its transfer to the real world improves significantly when parents actively participate in the media use and help the child in the symbolic understanding (Lovato &Waxman, 2016). The importance of the interaction

with real persons was also demonstrated by the language experiments of Kuhl, Tsao and Liu al. (2003): they demonstrated that infants in the second half of the first year learned language significantly better when provided in sessions including interaction with real persons than when the sessions with identical learning contents were provided by means of audio-visual presentations only. In our study, most parents not only accompanied but also encouraged children during media use. The need of parental presence during tablet use, is supported by the study of Hiniker et al. (2015). They reviewed 100 touchscreen apps for preschoolers and evaluated the prompts that children were likely to encounter. They concluded that children under three were not able to understand the instructions by themselves; the children only were able to interpret the instructions when they came from an adult model.

In order to learn from interactive screen activities it is necessary to consider daily usage time. It has been reported that, according to their parents, children begin to perform several new finger-on-screen movements during interactive media use; however, the effect depended on media exposure time (Cristia & Seidl, 2014). This may suggest that more is better, however, life is not so simple. The American Academy of Pediatrics (2010) and the Sociedade Brasileira de Pediatria (2016) both recommend that average daily tablet use in young children should not exceed one hour per day. The parents in our study had implemented this recommendation. Doing so, offers children also the opportunity to play real life games and to carry out real life fine motor activities during the day (Ahearne et al., 2016; Christakis, 2014).

Radesky et al. (2015), warned for the abusive use of the media as a distracting tool for the child, as tablets are increasingly being used to keep children busy during daily routines, such as car rides and eating outdoors. The tablet has become a common behavioral regulation tool (Radesky et al., 2015). This was also reported by about half of the parents of our study. Bentley, Turner, & Jago (2016) described that some mothers of preschoolers had concerns

about their children's use of interactive media. Yet, other mothers believed that the interactive media were important and useful educational tools. Most mothers, however, recognized the need to establish rules and restrictions on the use of interactive media (Bentley et al., 2016).

Practical Implications

The easy access to interactive media has changed the way children play in their infancy, a trend that is associated with a certain societal unease (Huber et al., 2016). Some prior studies have been pointing out the negative impact of interactive media on fine motor development. They discouraged the use of these media (e.g., Lin et al., 2017). However, our study suggests that the use of a tablet may function as potential tool to facilitate the development of fine motor skills in typically developing toddlers - which is practical information for parents, educators and therapists. However, - and this is equally important - proper tablet use in young children means that it fulfills some criteria, such as adult monitoring and mediation, limitation of the duration, avoidance of inappropriate contents, and exposure to interactive (i.e., non-passive) tasks such as educational or recreational games. In addition, it is important to note that interactive media do not replace the need for fine motor playv in the real-life context. Last, but not least, we suggest that the tablet could be applied in clinical practice to improve fine motor skills in children with fine motor skill impairments. However, future studies are needed to investigate whether tablet use in children with atypical development indeed enhances their motor skills and results in better participation in daily life.

Limitations and future directions

The use of a parental questionnaire may be considered as one of the study's limitations, as it may lead to bias of memory and social desirability. However, most other studies measured media use in children in a similar way (Duch, Fisher, Ensari, & Harrington, 2013).

Another limitation of the study is that it studied associations, not causations. This means that studies with an experimental design are needed to test the association between tablet use and fine motor skills in young children. These studies should not restrict themselves to evaluation of the effect on the fine motor domain, but they should extend the evaluation to other domains, such as the cognitive, language and psychosocial domains.

Conclusion

Our study indicated that frequent tablet use in young children is associated with slightly better fine motor skills, i.e., with an improvement in the order of a third of a standard deviation. This also means that tablet use in young children in the frequency of the present study (about one hour per day) is not associated with a disadvantage in fine motor development as previously had been suggested. In addition, we observed that most children participating in the study carried out both passive and active activities on the tablet; that they usually were accompanied by their parents, and that they used the tablet during restricted time, that did not exceed the recommendations for young age.

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TABLE 1

Background information in both groups: sociodemographic information and home environment resources.

Variable		G1	G2	X^2 or M-W	*p*
Gender	**Male**	15 (57.7)	29 (55.8)	0.026	0.872
n (%)	**Female**	11 (42.3)	23 (44.2)		
School	**Public**	13 (50.0)	37 (71.2)	3.37	0.066
n (%)	**Private**	13 (50.0)	15 (28.8)		
Maternal age in years median (full range)		30 (21-41)	31(17-40)	631.00	0.730
Mother's schooling	**< High school Full,**	4 (15.4)	8 (15.4)	632.00	0.834
n (%)	**High School Full**	19 (73.1)	35 (67.3)		
	>Higher Education Full	3 (11.5)	7 (13.5)		
Economic Level	**A**	1 (3.8)	5 (9.6)	618.00	0.329
n (%)**	**B1 and B2**	13 (50.0)	15 (28.8)		
	C1 and C2	12 (46.2)	32 (61.6)		
FERI Gross score median (full range)		58 (35-74)	54 (23-79)	374.00	0.363
Use of smartphone n (%)		20 (76.9)	38 (73.0)	0.134	0.714

Remarks: G1: Group tablet; G2: Group no tablet; X^2: Chi-square statistics; M-W: Mann-Whitney U test; *: statistically significant at 0.05; **Economic level A: family average income R$ 20.888; Economic level B1-B2: family average income R$ 4.852 up to 9.254; Economic level C1-C2: family average income R$ 1.625,00 up to 2.705,00; FERI: Family Environment Resource Inventory.

Figure 1 Flow diagram

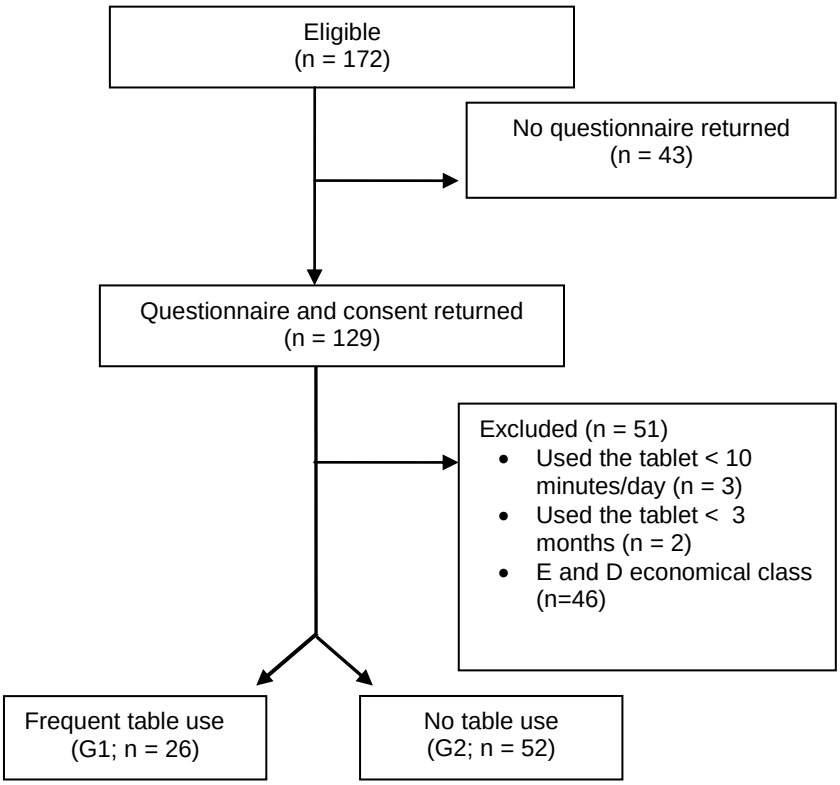

Figure 1