The Role of Screen Time and Screen Activity in the Non-Verbal Reasoning of 5-year Olds: Cross-Sectional Findings from a Large Birth Cohort Study

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Abstract

Family and home environment factors have been outlined in previous literature as important variables that affect early reasoning development. However, little research has focused on the association between screen use in the home environment and non-verbal reasoning ability. The aim of this cross-sectional study is to examine the role of both screen time and various screen activities (e.g., television, video or educational games) in non-verbal reasoning ability in 9,001 5-year-old children using a large birth cohort study (Growing Up in Ireland). Interviews conducted with parents related to the children's screen use and various family factors, while reasoning ability was measured using a standardised task (Picture Similarities Task, British Ability Scales II). A hierarchical multiple regression examined the role of screen use in non-verbal reasoning, while also statistically controlling for family factors such as parental education and employment status. Screen use variables made a significant contribution to the regression model, even after family factors were accounted for, although the effect sizes were very small. Playing educational games, video games or engaging in over three hours screen use per day were all significant predictors of non-verbal reasoning scores in the final adjusted model. The results of this study suggest that screen use may play a small role in the development of non-verbal reasoning in young children. The findings highlight the need for further studies in this area and may have implications for current debates in screen time research.

Keywords: Early childhood; Screen Time; Non-Verbal Reasoning; Video games; Growing Up in Ireland

Introduction

In early childhood, reasoning ability is a necessary prerequisite for the development of logical thinking and problem solving in novel situations.[1] The ability to reason enables people to draw inferences, reach conclusions[2] and is supported by many cognitive skills, such as attention, processing speed, and working memory.[3,4] Reasoning ability is also a good indicator of future academic success, and the development of higher order cognitive skills,[5-7] with research suggesting that reasoning ability between the ages 5 and 10 years is a stronger predictor of scholastic achievement than reasoning ability at any other age.[8] This highlights the period relating to early childhood as particularly important for the development of reasoning ability.

Previous research shows that a number of factors in a child's environment influence the development of reasoning and other cognitive abilities. These factors include maternal education levels,[9,10] the socio-economic status of the family,[11,12] and the parent-child relationship.[13,14] The home learning environment and activities within the home, such as reading to infants or the number of books in the home, also play a role in the development of reasoning and other cognitive abilities.[15,16,17] However, relatively little research has examined the role of screen time in the development of reasoning abilities in early childhood. With digital devices such as smartphones and tablets becoming more prevalent in children's early home learning environment[18] it is important that the use of screen devices is also examined as a potential factor influencing aspects of cognitive development, namely reasoning ability.

Screen Use and Psychological Development

Research on screen time in early childhood has focused on a number of aspects of psychological development such as attentional ability, vocabulary, aggression and hyperactivity.[19,20,21,22] However, findings from individual studies sometimes convey differing conclusions about the impact of screen time on development, and should be interpreted with caution depending on the research design, sample size, research methodology, and the effect sizes of reported results.[23,24] However, meta-analyses of multiple combined studies of children suggest that higher levels of screen time are linked with future depression risk (drawing on findings from 16 studies)[25] and socio-emotional difficulties (drawing on findings from 45).[26]

While the findings from meta-analyses drawing on multiple studies can help offer clarity, interpreting these findings can also present challenges. For example, one meta-analysis examining the impact of video games on development suggested that young people who play video games, in comparison with other past times, had increased levels of aggression and displayed lower prosocial behaviour (drawing on findings from 33 studies).[21] In contrast, another meta-analysis, also examining the effect of video games, found that video games contributed to cognitive enhancements in the areas of visual and spatial processing and

hand-eye coordination (drawing on findings from 118 studies).[27] Therefore, depending on the aspect of psychological development being examined, screen use may be associated with positive effects or negative effects, and in some instances no effects.

Despite a lack of research directly examining the impact of daily screen use on the development of reasoning ability in early childhood, other studies with older children suggest it may have a role to play. For example, O'Connell[28] recently reported positive correlations between screen use and non-verbal reasoning in 13-year-olds. Yang[29] also found that playing digital games in school was effective in improving 14- and 15-year-olds' problem-solving skills in comparison to a control group using traditional classroom methods. Other research has examined the role of television in children's problem-solving ability.[30-33] These studies found that, for children aged 5-15 years, watching educational television programmes improved problem-solving and scientific reasoning ability, in comparison to those in a control group or those viewing less educational content.

Some researchers argue that digital games, compared to TV watching, can be seen as a tool for decision-making behaviour and understanding the link between cause and effect, creating a meaningful environment and framework for problem-solving.[29,34] In a study exploring 7- to 10-year-olds' reasoning ability, Mackey et al.,[11] monitored children's reasoning development as they played fluid reasoning training computer-games for 15 minutes twice a week, for 8 weeks. After the intervention, the overall performance IQ of the children improved substantially. Fessakis, Gouli, and Mavroudi[35] also found that the mathematical, problem-solving, and social skills of 5- and 6-year-old children improved after a classroom intervention involving a series of computer programming-based learning activities. While these targeted interventions show positive effects, it is unclear whether these positive effects might extend to a home setting with more naturalistic use of screen based games.

These studies suggest a link between screen use and reasoning and problem-solving abilities. However, little previous research has focused on children as young as 5 years of age, or compared the effect of different types of screen activity in the home on reasoning development in early childhood. The current study is exploratory in nature and aims to investigate what effect, if any, daily screen time and various screen activities have on young children's reasoning ability, drawing on data from the large nationally representative sample of children in the Growing Up in Ireland (GUI) study. Use of this data permits not only investigation of the role of screen use in reasoning ability in young children, but also to explore whether this is affected by other factors that are known to influence the development of reasoning ability (e.g., parent's education).

Method

The Growing Up in Ireland study is a government-funded longitudinal study of children in Ireland, which collects a wide range of information from families and children through face-to-face interviews with both mothers and fathers in each household of the study child. Data collection for the Infant Cohort started in 2008 with over 11,000 children and their families. The sample was initially drawn from the Child Benefit Registrar as it allowed for participant sampling from all socio-economic backgrounds, and encompassed all family types living in Ireland with children (see Murray, McNamara, Williams, & Smyth[36] for additional information on the Growing Up in Ireland study methodology). Wave 3 of the data from this cohort was used in the current study as it contains information on both screen time and screen activity (previous waves of data collection do not contain this information), alongside current family circumstances (e.g., income), which may also affect non-verbal reasoning scores. The data were respondent weighted, and no children were excluded from the analysis.

Participants

The data used in the current study was collected when the children were 5 years of age (N = 9,001; 4612 males and 4389 females). The majority of primary caregivers (81%) had additional educational qualifications after completing secondary (high) school (42% had a certificate, technical or vocational qualification; 39% had a degree level qualification or higher), and were either employed (57%) or looking after their family (33%). Informed consent was obtained from all adult participants, and informed assent from the study children. Ethical approval was granted by the Research Ethics Committee established by the Department of Health and Children.

Materials

Non-Verbal Reasoning ability was measured by the Pictures Similarities task from the Early Years Battery of the British Ability Scales II (BAS II; Elliott, Smith & McCullough[37]). It is a 32-item test which involves showing a row of four pictures and asks the child to identify and place down a further congruent picture that best matches the set. It allows the child to solve non-verbal problems by identifying key features in pictures, and attaching meaning to pictures.

Children's screen use was measured through two questions. The question relating to screen time asked parents: "How many hours does [study child] spend on screen time on an average weekday". These data were collapsed into four groups by the Growing Up in Ireland study: '*No screen time', 'One to less than two hours', 'Two to less than three hours',* and *'More than three hours*'. For screen activity the question asked of parents was "What does [study child] mostly engage in during screen time? Is s/he usually engaged in '*Educational games', 'Video games', 'Watching TV/Videos',* or a *'Mix of all activities*'.

Information about other factors relating to the family was obtained from self-report questionnaires and interviews of the primary caregiver. The questions of interest for this study were the primary caregivers' highest educational achievement, income and employment status, and the quality of their relationship with the study child, as measured by the closeness and conflict subscales of the Child-Parent Relationship Scale (CPRS, Pianta[38]).

Procedure

Interviews were conducted with parents during visits to the household by trained interviewers. The interviewers also administered the cognitive test to the children, in their home.

Data Analysis

The study used a cross-sectional design to explore the effect of screen activity and screen time on non-verbal reasoning ability in 5-year-old children. The two screen use variables (time and activity) were dummy-coded so as each category within the variables could be entered into a hierarchical regression model independently. The screen activities (*Educational games, Video games,* and *TV/Videos*) were entered into the regression in Step 1 with '*Mix of all Activities*' used as the reference category, for comparison with the other categories. Similarly, the screen time categories (*No screen time, two to less than three hours,* and *more than three hours*) were entered into the regression at Step 2 with '*One to less than two hours*' used as a reference category. These variables were used as reference categories as over half of the study sample was contained in these categories, with 56% mostly engaged in a *Mix of activities* and 55% engaged in *one to less than two hours* of screen time per day (their combined presence in the sample was 29%).

The control factors related to the family (the primary caregivers' education level, employment status, household income, and the parent-child relationship) were then entered into the regression in the final step. The variables were entered in this order to assess whether the impact of the screen use on non-verbal reasoning scores was moderated after the family factors were accounted for.

Results

Preliminary analysis showed that there was no significant difference in non-verbal reasoning scores between children who had no daily screen use (M = 87.91, SD = 12.56, N = 232) and those who had any screen use (M = 86.59, SD = 11.74, N = 8691; $t(8920)=1.69$, p = .091). However, the number of children not engaged in any screen use represents a very small portion of the sample (2.6%). An examination of Figure 1 below suggests that there may be variation in the reasoning scores of those children who engage in different amounts of screen time and different types of screen activities. A hierarchical multiple regression was conducted to further investigate the role of screen use in non-verbal reasoning.

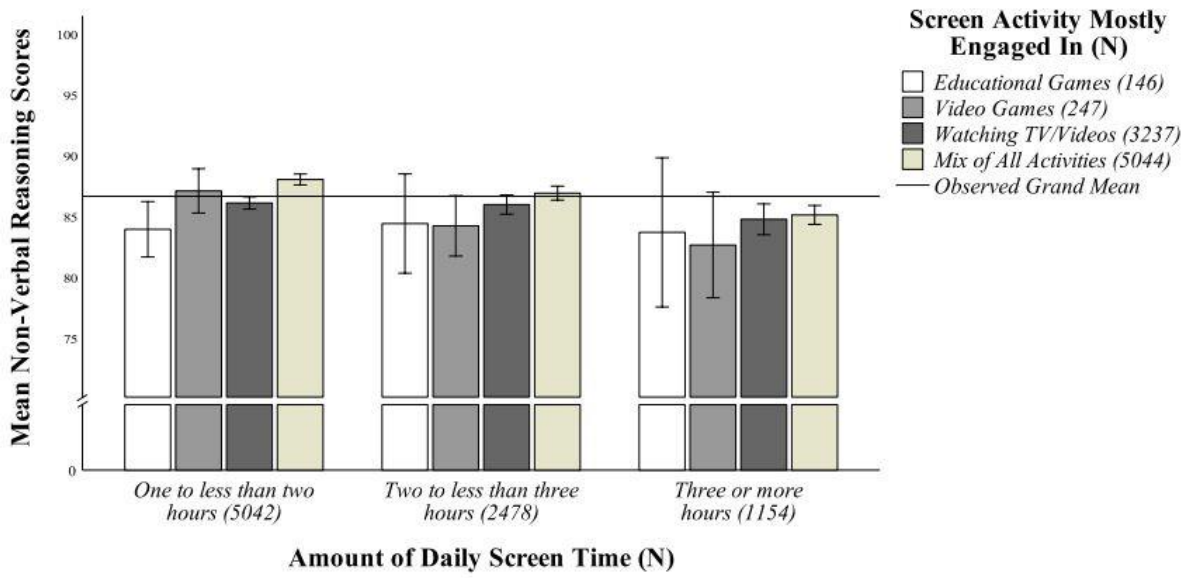

Figure 1. The 5-year-olds' mean non-verbal reasoning scores for screen time and screen activity (Error bars represent 95% CI)

The regression model indicated that at Step 1, screen activity accounted for 0.4% of the variation in the children's non-verbal reasoning scores, $R^2_{adj} = .004$, $F(4,8475) = 9.42$, $p < .001$. An examination of the unstandardized B coefficients indicated that *Educational games*, *Video games* and *Watching TV/videos* all made significant unique contributions to the model (all *p*'s < .05). Compared to engaging in a *Mix of screen activities*, each of these individual activities were associated with lower non-verbal reasoning scores ranging between -1.36 and -2.91 points (see Table 1, Step 1).

The amount of screen time the child engaged in was added in Step 2 and explained an additional 0.5% of variation in reasoning scores, $R^2_{adj} = .009$, $F(6,8475) = 13.62$, $p < .001$. Not engaging in any screen time did not make a significant contribution to the model. Children who engaged in *three or more hours* of screen time per day had lower reasoning scores, as did the children in the *two to less than three hours* time bracket, although to a lesser extent (see Table 1, Step 2).

Table 1. Hierarchical Multiple Regression Analysis on the 5-year-olds' Non-Verbal Reasoning Ability, by Children's Screen Activity, Screen Time, and Family Factors.

Blocks of Predictors	Models								
	Model 1			Model 2			Model 3		
	B	β	p	B	β	p	B	β	p
Step 1: Screen Activity (Mix of All Activities as constant)									
Educational Games	-2.91	-.03	.004	-3.17	-.03	.002	-2.88	-.03	.004
Video Games	-1.86	-.03	.013	-2.03	-.03	.007	-1.67	-.02	.024
Watching TV/Videos	-1.36	-.06	.000	-1.58	-.07	.000	-1.47	-.06	.000
Step 2: Screen Time (1 to less than 2 hours as constant)									
No Screen Time				.35	.01	n.s	.46	.01	n.s
2 to less than 3 hours				-.71	-.03	.016	-.26	-.01	n.s
More than 3 hours				-2.55	-.07	.000	-1.59	-.05	.000
Step 3: Family Factors									
Education Level							.25	.05	.000
Household Income							.28	.07	.000
Employment Status							-.12	-.03	.005
Level of Closeness							.31	.05	.000
Level of Conflict							-.12	-.06	.000
ΔR^2	0.4%, p < .0001			0.5%, p < .0001			2.3%, p < .0001		
Total R^2 Adjusted							3.1%, p < .0001		

Note. **n.s = not significant**

The family factors were then added to the regression model in the final step and explained an additional 2.3% of the variation in non-verbal reasoning scores. The final model with all variables entered accounted for 3.1% of the variance in reasoning scores, $R^2_{adj} = .031$, $F(12,8630) = 20.13$, $p < .001$. An examination of the standardised beta values (β) indicated that the family factors did not moderate the impact of the various screen activities on non-verbal reasoning scores (see Table 1). For example, β values for the screen activities remained the same in Step 1, when no other factors were included in the model, as in Step 3, when both screen time and family factors were included (e.g., *Education Games*: β = -.03 in both steps; *Watching TV/Videos*: β = -.06 in both steps; *Video Games*: β changed from -.03 to -.02 from Step 1 to 3, but remained a significant unique contributor in the final model).

In contrast, the family factors had a moderating effect on the impact of screen time on non-verbal reasoning scores. The β values for screen time reduced from Step 2 to Step 3, when family factors were included in the model. The β value for *more than 3 hours* screen use per day changed from -.07 to -.05 from Step 2 to 3. The β values *for 2 to less than 3 hours* screen use also changed from -.03 to -.01 from Step 2 to 3, and although it was significant in Step 2, it was no longer a significant contributor in the final model with family factors added (see Table 1 also for changes in unstandardized Beta values).

Comparing across the β values in the final model indicated that household income made the largest unique contribution to the final model (β = .07), followed by watching tv/videos (β = -.06), the level of conflict with the parent (β = .06), the level of closeness with the parent (β = .05) and having more than 3 hours of daily screen time (β = -.05). The β values suggest a similar statistical contribution to the model for each of the individual screen use variables and individual family factors, with each making a small but significant contribution to the regression model (See Table 1 for exact *p*-values and other significant variables).

Discussion

This study aimed to assess the role of early screen use, both the amount of screen time and the type screen activity, on non-verbal reasoning ability in a nationally representative sample of 5-year-old children. The findings show that children who engaged in more than three hours of daily screen time scored significantly lower in non-verbal reasoning in comparison with those who had less than three hours of screen time a day. Those who mostly played educational or video games during that time scored the lowest of all the groups. These findings remained even after family factors were controlled for in the regression model.

Interestingly, not engaging in any screen use was not a significant predictor of non-verbal reasoning scores in the regression model. This suggests that a lack of screen use is not associated with significantly higher or lower non-verbal reasoning scores when compared to the scores of children who engaged daily in a mix of screen activities. A possible limitation of these findings relates to the relatively small number of children in the large sample who did not engage in any screen use. However, inclusion of this group in the sample is beneficial for comparison purposes, as not all studies include a control group with no screen time. The small percentage of 5-year-olds not engaged in any screen use (2.6%) also highlights the ubiquitous nature of screen use in early childhood.

It is important to note that while the findings show effects of screen use on non-verbal reasoning scores, that the effects are very small. While the screen use variables remained significant in the final regression model, the combined family factors played a larger role in predicting non-verbal reasoning scores overall, accounting for more than twice the amount of variance as the screen use variables. While the family factors have more of an impact on reasoning scores when combined, they may also be less amenable to change in comparison to screen use, as parents may be in a position to limit screen time or encourage their child towards particular screen activities.

The smaller sample sizes within the educational and video games categories (N = 146 and 247, respectively), compared to the television/videos or mix of activity categories, also warrant caution in interpreting the findings. These small participant numbers resulted in larger confidence intervals for these categories, highlighting the large variance within the groups' non-verbal reasoning scores (see Figure 1). However, the small samples also highlight the types of activities that 5-year-old children typically engage in at home on a daily basis, with most children watching television/videos or engaging in a mix of screen activities, rather than focusing on digital games.

A limitation of the current study is that the Growing Up in Ireland data did not account for the screen content that the children were engaging in. Separating screen activities into educational games, video games, and watching TV/Videos, may be a crude measure of children's media use. Future research should consider the types of content these programmes, videos, and games contain (e.g., whether the content serves entertainment or educational purposes, is age-appropriate material, interactive, and whether a parent is present). Additionally, the use of non-parent report measures of screen use, such as passive sensing,[39] would also be beneficial, as would including screen use outside of the home (e.g., in school). However, given the young age of the children in this sample, the multiple types of screen activities they engage in and for multiple hours per day, more direct measures or observations of naturalistic daily screen use in the home and other early childhood settings may be costly and challenging to implement.

Some researchers have also noted the prevalence of Type I error reporting in screen time research due to large sample sizes resulting in significant small effect sizes.[40] It is therefore important to interpret these findings with caution. Future research should focus on replicating past studies on screen use, with a critical approach towards the sample sizes, and exploring if similar results are found across various developmental domains, such as children's attentional ability or socio-emotional development. Conducting meta-analyses and longitudinal research may also provide greater clarity regarding the impact of screen use on development, particularly as research in this field progresses and takes account of the latest technology and screen based activities.

Despite these limitations, this study provides an insight to an area that has received little attention to date. Using a nationally representative sample the findings indicate that screen use plays a role in non-verbal reasoning in early childhood, albeit a very minor one, and highlights the importance of considering the impact of both screen time and screen activity. The findings of this study may have implications for current debates about the effect of screen use on early psychological development and for future research.[41-43] While this study explored an area of screen use and early childhood that is under researched, more work is needed to better understand the role of screen use in cognitive development in young children.

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References

1. Horn JL, Cattell RB. Age differences in fluid and crystallized intelligence. Acta Psychologica 1967; 26:107-29.

2. Johnson-Laird P. (2006) *How We Reason.* New York: Oxford University Press.

3. Fry AF, Hale S. Processing speed, working memory, and fluid intelligence: Evidence for a developmental cascade. Psychological Science 1996; 7:237-41.

4. Kail RV. Longitudinal evidence that increases in processing speed and working memory enhance children's reasoning. Psychological Science 2007; 18:312.

5. Cattell RB. (1987*) Intelligence: Its structure, growth and action.* Amsterdam: North Holland.

6. Floyd RG, Evans JJ, McGrew KS. Relations between measures of Cattell-Horn-Carroll (CHC) cognitive abilities and mathematics achievement across the school-age years. Psychology in the Schools 2003; 40:155-71.

7. Ferrer E, McArdle JJ. An experimental analysis of dynamic hypotheses about cognitive abilities and achievement from childhood to early adulthood. Developmental Psychology 2004; 40:935.

8. Ferrer E, McArdle JJ, Shaywitz BA, Holahan JM, Marchione K, Shaywitz SE. Longitudinal models of developmental dynamics between reading and cognition from childhood to adolescence. Developmental Psychology 2007; 43:1460-73.

9. Veena SR, Krishnaveni GV, Srinivasan K, et al. Childhood cognitive ability: relationship to gestational diabetes mellitus in India. Diabetologia 2010; 53:2134-8.

10. Carr A, Pike A. Maternal scaffolding behavior: links with parenting style and maternal education. Developmental Psychology 2012; 48:543.

11. Mackey AP, Hill SS, Stone SI, Bunge SA. Differential effects of reasoning and speed training in children. Developmental Science 2011; 14:582-90.

12. Neitzel C, Dopkins Stright A. Parenting behaviours during child problem solving: The roles of child temperament, mother education and personality, and the problem-solving context. International Journal of Behavioral Development 2004; 28:166-79.

13. Bernier A, Carlson SM, Deschênes M, Matte-Gagné C. Social factors in the development of early executive functioning: A closer look at the caregiving environment. Developmental Science 2012; 15:12-24.

14. Glaser D. Child abuse and neglect and the brain—a review. The Journal of Child Psychology and Psychiatry and Allied Disciplines 2000; 41:97-116.

15. Murray A, Egan SM. Does reading to infants benefit their cognitive development at 9-months-old? An investigation using a large birth cohort survey. Child Language Teaching and Therapy 2014; 30:303-15.

16. Evans MD, Kelley J, Sikora J, Treiman DJ. Family scholarly culture and educational success: Books and schooling in 27 nations. Research in Social Stratification and Mobility 2010; 28:171-97.

17. Hoyne C, Egan SM. Shared Book Reading in Early Childhood: A Review of Influential Factors and Developmental Benefits. An Leanbh Og: The OMEP Ireland Journal of Early Childhood Studies 2019; 12:77-92.

18. Rideout VJ. (2011) *Zero to eight: Children's media use in America.* San Francisco: Common Sense Media.

19. Christakis DA, Zimmerman FJ, DiGiuseppe DL, McCarty CA. Early television exposure and subsequent attentional problems in children. Pediatrics 2004; 4:708-13.

20. Linebarger DL, Walker D. Infants' and toddlers' television viewing and language outcomes. American behavioral scientist 2005; 48:624-45.

21. Anderson CA, Bushman BJ. Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. Psychological science 2001; 12:353-9.

22. Ebenegger V, Marques-Vidal PM, Munsch S, Quartier V, Nydegger A, Barral J, Hartmann T, Dubnov-Raz G, Kriemler S, Puder JJ. Relationship of hyperactivity/inattention with adiposity and lifestyle characteristics in preschool children. Journal of child neurology 2012; 27:852-8.

23. Bell V, Bishop DV, Przybylski AK. The debate over digital technology and young people. British Medical Journal 2015; 351:h3064.

24. Ferguson CJ, Colwell J. Understanding why scholars hold different views on the influences of video games on public health. Journal of Communication 2017; 67:305-27.

25. Liu M, Wu L, Yao S. Dose–response association of screen time-based sedentary behaviour in children and adolescents and depression: a meta-analysis of observational studies. British Journal of Sports Medicine 2016; 50:1252-8.

26. Nikkelen SW, Valkenburg PM, Huizinga M, Bushman BJ. Media use and ADHD-related behaviors in children and adolescents: a meta-analysis. Developmental Psychology 2014; 50:2228.

27. Powers KL, Brooks PJ, Aldrich NJ, Palladino MA, Alfieri L. Effects of video-game play on information processing: a meta-analytic investigation. Psychonomic bulletin & review 2013; 20:1055-79.

28. O'Connell M. The Power of Cognitive Ability in Explaining Educational Test Performance, Relative to Other Ostensible Contenders. Intelligence 2018; 66:122 - 127.

29. Yang YT. Building virtual cities, inspiring intelligent citizens: Digital games for developing students' problem solving and learning motivation. Computers & Education 2012; 59:365-77.

30. Hodapp TV. Children's ability to learn problem-solving strategies from television. Alberta Journal of Educational Research 1977; 23:171-77.

31. Hall ER, Esty ET, Fisch SM. Television and children's problem-solving behavior: A synopsis of an evaluation of the effects of Square One TV. The Journal of Mathematical Behavior 1990; 9:161-74.

32. Gerber BL, Cavallo AM, Marek EA. Relationships among informal learning environments, teaching procedures and scientific reasoning ability. International Journal of Science Education 2001; 23:535-49.

33. Lavigne HJ, Hanson KG, Anderson DR. The influence of television co-viewing on parent language directed at toddlers. Journal of Applied Developmental Psychology 2015; 36:1-10.

34. Annetta LA. Video games in education: Why they should be used and how they are being used. Theory into Practice 2008; 47:229-39.

35. Fessakis G, Gouli E, Mavroudi E. Problem solving by 5–6 years old kindergarten children in a computer programming environment: A case study. Computers & Education 2013; 63:87-97.

36. Murray A, McNamara E, Williams J, Smyth E. (2019*) Growing Up in Ireland: The Lives of Five-Year Olds.* Dublin: The Stationery Office.

37. Elliott C, Smith P, McCulloch K. (1997) *British ability scales.* London: NferNelson.

38. Pianta RC. (1992) *Child–parent relationship scale.* Charlottesville, VA: University of Virginia

39. Yuan N, Weeks HM, Ball R, Newman MW, Chang YJ, Radesky JS. How much do parents actually use their smartphones? Pilot study comparing self-report to passive sensing. Pediatric Research 2019; 1-3.

40. Ferguson CJ. Pay no attention to that data behind the curtain: On angry birds, happy children, scholarly squabbles, publication bias, and why betas rule metas. Perspectives on Psychological Science 2015; 10:683-91.

41. Ferguson CJ. Do angry birds make for angry children? A meta-analysis of video game influences on children's and adolescents' aggression, mental health, prosocial behavior, and academic performance. Perspectives on Psychological Science 2015; 10:646-66.

42. Etchells PJ, Gage SH, Rutherford AD, Munafò MR. Prospective investigation of video game use in children and subsequent conduct disorder and depression using data from the Avon longitudinal study of parents and children. PloS one 2016; 11:e0147732.

43. Przybylski AK, Weinstein N. A large-scale test of the Goldilocks Hypothesis: Quantifying the relations between digital-screen use and the mental well-being of adolescents. Psychological Science 2017; 28:204-15.