



Television viewing duration during childhood and long- association with adolescent neuropsychological outcomes

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ABSTRACT

This study is aiming to evaluate the association between television viewing during childhood and long-term adolescent neuropsychological outcomes and the potential explanatory pathways. This is a longitudinal study based on 278 children participating in the INMA birth cohort (1998) in Menorca Island, Spain. The exposure is parent-reported duration of child television viewing (hours per week) at 6 and 9 years of age. Neuropsychological outcomes were assessed at 14 years of age using the N-back test. Behavioral outcomes at 14 years of age were assessed using the Strengths and Difficulties Questionnaire (SDQ) and school performance was assessed by the global school score. Regression models were developed to quantify the associations between duration of television viewing and neuropsychological outcomes adjusted for child and parents' characteristics. The average of weekly TV viewing from 6 to 9 years was 9.2 h (SD: 4.1). Only N-back test outcomes exhibited statistically significant differences in crude models. Children viewing > 14 h per week tended to show larger latencies in working memory reaction time (HRT in ms), beta (CI) = 53 (0–107). After adjusting for potential social confounders, the association weakened and became non-significant but adverse trends were slightly preserved. Early life TV viewing was not associated with adolescent neuropsychological outcomes after adjustment for potential confounders. Further research including larger and exhaustive population-based cohort studies is required in order to verify our conclusions.

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1. Introduction

In the past years, there has been a dramatic increase in the use of television and digital media. Nowadays media plays a central and ever increasing role in the lives of children and adolescents [1]. This has raised a question on whether media affects neuropsychological development in children and adolescent. Some studies have aimed to address the potential health effects of media exposure over the years but the

effects remain unclear due to the complexity of the exposure and the possible confounders such as socio-economic status, family structure and mother's mental health [2–5].

The American Academy of Pediatrics (AAP) in 2011 reaffirmed its original 1999 statement on children and media, leaving it essentially unchanged [6]. AAP discourages television viewing in the first two years of life and recommends a daily limit of 1 to 2 h of quality programming for older children. Despite these recommendations, many studies in the last ten years have shown most of children surpass this recommended exposure time [7–8].

Available evidence on the impact of television watching and media use on neuropsychological development is inconsistent. While a few cross-sectional studies and fewer longitudinal studies suggest adverse effects, others suggest media has a beneficial effect on neuropsychological development [9,10]. Such inconsistency can be partly attributed to

Abbreviations: AAP, American Academy of Pediatrics; d', Accuracy; HTR, Hit Reaction Time; INMA, Infancia y Medio Ambiente Project; SDQ, Strengths and Difficulties Questionnaire; SD, Standard Deviation; TV, Television.

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different methodologies applied by these studies. The majority of studies available are cross-sectional by design and have a limited capability to establish a causal link. To establish such a link an experimental study would be ideal although it would require an unlikely long term modification of lifestyle factors to study of the possible cognitive effects of television viewing on children. A longitudinal design is warranted in order to attribute certain degree of causality in the association, particularly in population-based cohort studies followed consistently for long-term periods.

The aim of this study was to evaluate the association between television viewing time during childhood and long-term adolescent neuropsychological outcomes including cognitive performance, mental health, and school performance, as well as to explore and the potential explanatory pathways.

2. Methods

2.1. Population and study design

This study was conducted in an established population-based birth cohort in Menorca, Spain, which is a member of the INMA (Infancia y Medio Ambiente) network of birth cohorts [11]. In INMA cohorts, mothers were recruited at the first prenatal check-up if they met the inclusion criteria [1] to be resident in the cohort area, [2] to be at least 16 years old, [3] to have singleton pregnancy, [4] to not have followed any program of assisted reproduction, [5] to wish to deliver in the reference hospital and [6] to have no communication problems. Further description of INMA cohorts have been detailed elsewhere [11]. In the Menorca cohort, recruitment of pregnant woman began in 1997–1998 ($n = 482$, 94% eligible). Written consent was obtained from all participants at recruitment and before each follow-up. At the final follow up (year 2012) there was a 58% of participation rate ($n = 278$). The study was approved by the appropriate ethical committees, and written informed consent was obtained from the parents of all children before enrollment in the study.

2.2. Main exposure: television viewing time

Data were obtained prospectively by interviewing the children and their parents using standardized questionnaires completed by trained evaluators. Children were assessed with repeated measures on time spent watching television at 6, 9 and 14 years old. The child's television viewing duration was assessed according to parental report at 6 and 9 years of age by asking the following open-ended question "How many hours per week does your child watch television?" We constructed a four part categorical variable with the mean of weekly television viewing duration at 6 years and at 9 years. The groups were: reference group (children viewing <7 h/w), short duration (from 7 to 9 h/w), medium duration (from 10 to 13 h/w) and long duration (> 14 h/w). Since the American Academy of Pediatrics recommends watching <2 h per day [6] (14 h per week), children surpassing the recommended time are found in the last group.

2.3. Main outcomes: neuropsychological outcomes

Neuropsychological assessments were conducted at the 14 year old follow-up using the N-Back test by trained examiners. This test has been employed to investigate the neural basis of working memory processes and for the purpose of this study consists of a series of 2 different stimuli (numbers and words) presented in the center of the screen. All participants are required to press a specific button whenever a given stimulus is the same as the one presented n trials previously (1-, 2- and 3-back) [12]. Hit Reaction Times (HRTs) are obtained for each of the n trails (e.g. HRT2). An average HRT is computed from the hits of each load separately. As a measure of response accuracy, the d' prime (d') was calculated as a measure of detection, for each block separately. Higher d' indicates

better signal detection whereas higher HRT indicates more time for reaction.

2.4. Other outcomes

The Strengths and Difficulties Questionnaire (SDQ) was used to evaluate children's behavioral functioning at 14 years old. The SDQ questionnaire consists of four difficulties subscales including emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationship problems, and a strengths subscale for pro-social behavior. Each subscale comprises five items that can be scored zero, one, or two, with each total subscale score can range from zero to 10. An SDQ total difficulties score (range 0–40) was calculated by summing the scores of the four difficulties subscales (i.e. all subscales except for pro-social) [13]. Higher scores for total difficulties and individual difficulties subscales indicate more behavioral problems. For this study, the total SDQ score was used as a continuous variable in our analyses.

School performance at 14 years of age was obtained through the question "Which was the global mark in your last course?" The marks were classified into the following categories: fail (1–4.9), pass (5–6.9), good (7–8.4) and excellent (8.5–10).

2.5. Confounding and mediating variables

Data was obtained through standardized questionnaires administered to the parents in each follow-up visit by a trained examiner. These questionnaires included socio-demographical characteristics of the parents and information about child lifestyles (physical activity, sleeping duration, cultural activities). The children's cognitive background was obtained by a trained psychologist using different tests (Bayley's and McCarthy Scales). Other variables such as anthropometric measures were obtained through review of clinical reports and parental mental health (SCL90-R) and maternal IQ (Factor G Catell) were obtained by self-completed rating scales and a trained psychologist, respectively.

A priori, we took into consideration an extended list of confounders (Appendix 1) including: age in years at test, sex, body mass index at 14 years, parental education level and parental social class (both indicators of socio-economical status), having babysitter at 4 years and mother alcohol and tobacco consumption during pregnancy.

Mediating variables (i.e. variables in the causal pathway between TV viewing time and neuropsychological outcomes) were obtained from the questionnaires and tests administered at the 6 and 9 year follow-up. The child physical activity and sleep duration were assessed according to parental report at 6 and 9 years of age. For each mediating factor, a new variable was created using the mean of hours per week at 6 and 9 years of age. Cultural activities (theatre, languages) only were asked at 9 years of age and a new variable was constructed with hours per week practicing these kinds of activities. Television viewing time at 14 years was obtained through the same question as at ages 6 and 9 years and a continuous variable was constructed.

2.6. Statistical analysis

Of all 14 year old participants, 80% had complete data on neuropsychological development and the main covariates and were included in the final analysis ($n = 278$). Linear regression models were used to estimate the effects of television exposure on neuropsychological test outcomes. School marks were not shown in Section 3 as no crude association was found. Minimally-adjusted models included age at test as a mandatory child variable.

Correlations between the three measures of TV viewing times (6, 9 and 14 years of age) were analyzed. To address confounding, bivariate analyses were conducted. Predefined variables were selected a priori based on available literature (Appendix I). However, covariates were included in the final model only when they showed a crude association

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