The Complex Model of Television Viewing and Educational Achievement

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ABSTRACT **Six studies containing data obtained from over 1 million students in elementary, intermediate, and high school were meta-analyzed to examine the relationship between amount of television viewing and educational achievement. The findings led to the formulation of the complex viewing—achievement model. According to the model, the function relating achievement to viewing can be described as an inverted check mark. For small amounts of viewing, achievement increased with viewing, but as viewing increased beyond a certain point, achievement decreased. That function was found for each of the 3 ages studied, but optimal viewing time—the apex of the function—was different at each age and decreased with the age of the students.**

Key words: achievement, television viewing

The literature examining the relationship between amount of television viewing and educational achievement has not been consistent in providing an answer to the question of what this relationship is. Studies have shown contradictory findings (Beentjes & Van der Voort, 1988; Foertsch, 1992). Researchers have reported that (a) the relationship is negative—the more a student views television, the lower are his or her educational achievements (Williams, Haertel, Haertel, & Walberg, 1982); (b) the relationship is positive—the more the student views television, the higher are his or her educational achievements (Blosser, 1988); and (c) there is no relationship between television viewing and educational achievement (Scarborough, 1989). However, a close look at those studies suggests that their contradictory findings may be explained by the interaction of television viewing effects with age, by the nonlinear relationship of television viewing and achievement, and by the treatment of nonsignificant findings.

I analyzed the research by Williams et al. (1982) on the relationship between viewing and achievement for 13 different ages, ranging from 5 to 17 years, by clustering them into three groups and computing average correlations for each age group. My analysis suggests that whether the relationship between viewing and achievement is negative or positive depends on the age of the child. The finding indicated that at ages 5 and 6, the average correlation between television viewing and achievement is positive; for ages 7 through 9, the average correlation is negative; and at ages 10 through 17, the average correlation is even more negative. The results of this analysis are presented in Figure 1. Thus, the first reason that the literature has been inconsistent as to whether the average correlation is positive or negative may be that various studies report statistics for children of different ages.

A second reason that previous research reviews that have examined the linear correlation between viewing and achievement have led to inconsistent conclusions may be how they treated correlations that were not statistically significant. Those correlations were usually not reported and were considered as zero correlations instead of as statistically insignificant positive or statistically insignificant negative correlations (Beentjes & Van der Voort, 1988; Scarborough, 1989). However, as Glass (1978) noted, it is the very essence of research integration that several nonsignificant findings "can add up to a strong conclusion" (p. 356). In meta-analysis, an abundance of nonsignificant findings is not evidence for a lack of relationship. An abundance of nonsignificant negative correlations leads to a conclusion of negative correlation; an abundance of nonsignificant positive correlations leads to a conclusion of positive correlation. A lack of relationship is concluded when an equal number of positive and negative results are found.

A third reason for the contradictory results regarding the direction of the relationship between television viewing and academic achievement may be that the function relating the two variables may not be linear, as suggested by several investigators (Neuman, 1988, 1995; Williams et al., 1982). Williams et al. suggested that the overall negative correlation between viewing time and achievement consists of two opposing trends—up to 10 viewing hr per week (1.4 hr a day), the correlation is positive, whereas viewing beyond this amount is correlated negatively with achievement. The researchers did not find any significant effect of age or grade on the nonlinear relationship. Neuman (1988, 1995),

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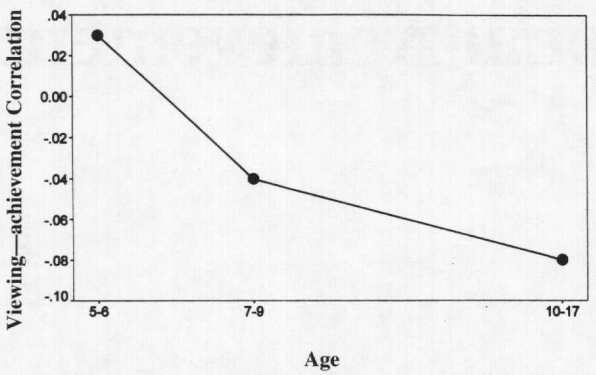
Figure 1. Correlation Between Viewing and Achievement as a Function of Age



Note. These correlations were calculated on data reported by Williams, Haertel, Haertel, and Walberg (1982).

on the other hand, in her study of the relationship between television viewing and reading comprehension achievement, suggested that for primary school-aged children and for intermediate school-aged children the function is positive for short viewing times and negative for longer times (as suggested by Williams et al.), but for high school-aged children, the function is negative for all viewing times.

Thus, despite the prevalence of television viewing in the lives of most children and young persons, and despite public agreement as to the importance of this issue, the details of the relationship between television viewing and academic achievement have yet to be described. This study is an attempt to characterize the relationship in detail, including identifying and providing quantitative estimates of the parameters of the relationship.

Method

I examined the relationship between television viewing and educational achievement in a meta-analysis of data reported in six international and national studies of educational achievement. My search included large studies that were published after 1985 and that specified achievement as a function of viewing time. Each study contained data regarding educational achievement of various age cohorts, geographical entities, and school subjects; each one also contained data regarding the amount of television viewed by the students whose achievements were tested. The studies were the following:

1. High School and Beyond (HSB; Keith, Reimers, Fehrmann, Pottebaum, & Aubey, 1986), a study that includes about 28,000 American 17-year-olds who were tested in reading and mathematics
2. International Assessment of Educational Progress (IAEP-1988; Lapointe, Mead, & Phillips, 1989), a study that consists of about 24,000 13-year-olds from 12 countries who were tested in mathematics and science
3. IAEP-1991 (Lapointe, Askew, & Mead, 1992), a study that includes about 175,000 9-year-olds and 13-year-olds from 34 countries who were tested in mathematics and science
4. National Assessment of Educational Progress–Trends in Academic Progress (NAEP–Trend; trends in achievement of different cohorts in exactly the same tests administered yearly; Campbell, Voelkl, & Donahue, 1997), a study consisting of 227,000 American 9-, 13-, and 17-year-olds who were tested in reading and mathematics
5. NAEP–Nation Assessment–Assessment of Nation and States (through different tests that were adapted to the needs of each year) of the National Assessment of Educational Progress (e.g., National Center for Education Statistics, 1994), a study that includes about 300,000 American 9-, 13-, and 17-year-olds who were tested in reading, mathematics, and science
6. The Third International Mathematics and Science Study (TIMSS) of the International Association for Evaluation (IEA; Mullis et al., 1998), a study that includes about 268,000 9-, 13-, and 17-year-olds from 39 countries who were tested in mathematics and science

For all those studies, I computed correlations between amount of television viewing and educational achievement on average achievement reported for different categories of viewing time separately for each age, country, subject, and year of testing. Finally, I performed sign tests on the distribution of positive and negative correlations in each study separately and in all the studies combined. I used the sign test to determine whether the distribution of positive and negative correlations was significantly different from 50%–50%. A 50%–50% distribution was predicted by the null hypothesis, which was that the viewing–achievement correlation was zero.

Findings

The results of the computations on data presented in the six studies are given in Table 1. The bottom line of Table 1 shows an overwhelming majority of negative correlations between viewing time and achievement in data gathered from more than 1 million students. Of the 305 correlations that were computed on the data presented in the six studies, 273 (90%) were negative in sign, a statistically significant result. Also, sign tests that I performed on the correlations from each study (only five of the studies were included in this analysis because only one correlation could be computed in one of the studies) yielded a statistically significant finding in each study. Those results leave little room for doubt concerning the negative nature of the overall linear relationship between television viewing and educational achievement.

Although my results from the six studies indicate that the overall linear relationship between viewing time and achievement is negative, I examined the exact form of this relationship in more depth, particularly in light of the sug-

gestion of Neuman (1995) and Williams et al. (1982) that the overall negative correlation may consist, at least in some cases, of two opposing trends—a positive correlation for a small amount of viewing and a negative correlation for larger amounts. I therefore computed the average achievements in the different viewing-time categories separately for each study listed in Table 1 and for each of the three ages studied. I based my analysis on the midpoints of the time ranges of the viewing categories. To compare findings from various studies and ages, I transformed each average achievement into a standard score. In those studies in which findings were reported for more than one school subject or for more than 1 year, I computed an average of the standard scores over school subjects and over years. The findings from those computations are given in Table 2.

To discover the shape of the overall viewing–achievement function, I assembled the data in Table 2 into groups of viewing times while disregarding age; the average achievement in each group was plotted in Figure 2. The overall viewing–achievement function has an inverted check mark shape (see Figure 2). The function has a short positive viewing range, that is, a time range in which viewing is positively related to achievement—between 0 and 2 viewing hr—and a long negative viewing range, that is, a time range in which viewing is negatively related to achievement—between 2 and 7 hr. That curve is similar in shape to that drawn by Williams et al. (1982, p. 35, Figure 2) except that they concluded that "achievement diminishes with increased viewing up to 35 or 40 hr per week [5 or 6 hr per day] and beyond that level, additional viewing apparently has little further impact" (p. 35). The findings of the present study indicate that there is no leveling off of the slope beyond 5 or 6 viewing hr daily. Also, Williams and colleagues' (1982) curve is a theoretical one, for which the general shape was "estimated from the mean correlations at different viewing levels" (p. 34), whereas the curve in Figure 2 is an empirical one, resulting from averaging *Z* scores.

In light of some findings (Neuman, 1988, 1995; Williams et al., 1982) indicating that the viewing-achievement function was different for different-aged children, I further examined the shape of the function separately for different age groups. In Figure 3, representative findings from three studies concerning average achievement as a function of viewing time are plotted separately for each age. The vertical axis shows the average educational achievement of the 17-year-olds. To avoid overlapping of the graphs of the different age groups and to make clear the age-specific distinguishing features, I plotted the data of the 13-year-olds so that the zero point, that is, the average score, was placed at the .5 point on the ordinate. I plotted the data of the 9-year-olds so that the zero point was placed at the 1.0 point on the ordinate. The curves in Figure 3 are similar to those reported by Neuman (1988, 1995, p. 125, Figure 6.3), although her lack of finer viewing-time categories at the lower end of the viewing-time scale for 17-year-olds is probably what prevented her from obtaining a reversed check mark function for this age.

The following conclusions have been drawn from Figures 2 and 3 and Table 2:

1. For each age, an optimal viewing time exists, that is, a viewing time for which a larger or a smaller amount are both related to lower achievement. For example, at age 9, the optimal viewing time seems to be 2 hr, as indicated by the findings of the NAEP–Nation Assessment. The TIMSS findings indicate that at age 13, optimal viewing time is 1.5

Table 1.—Testing the Direction (Positive or Negative) of TV Viewing–Achievement Relationships in Six Large Studies

Study	*N*	Age	No. of countries	Subjects	Years of testing	Total no. *rs*	No. of negative *rs*	Z of sign test
HSB[a]	28,000	17	1	Reading, mathematics	1	1	1	—
IAEP–1988[b]	24,000	13	12	Mathematics, science	1	24	24	4.69*
IAEP–1991[c]	175,000	9, 13	34	Mathematics, science	1	105	89	7.03*
NAEP–Trends[d]	227,000	9, 13, 17	1	Reading, mathematics	3	18	18	4.01*
NAEP–Nation Assessment[e]	300,000	9, 13, 17	1	Reading, mathematics, science	1	9	9	2.67*
TIMSS[f]	268,000	9, 13, 17	39	Mathematics, science	1	148	132	9.45*
Total	1,022,000					305	273	13.74*

Note. HSB = High School and Beyond; IAEP = International Assessment of Educational Progress; NAEP = National Assessment of Educational Progress; TIMSS = Third International Mathematics and Science Study of the International Association for Evaluation.
[a]Keith, Reimers, Fehrmann, Pottebaum, & Aubey (1986); [b]Lapointe, Mead, & Phillips (1989, p. 56, Figure 7.1, pp. 90–91, Data Appendix). [c]Lapointe, Askew, & Mead (1992, pp. 18–19, Figure 1.1, pp. 146, 152, Data Appendix); Lapointe, Mead, & Askew (1992, pp. 18–19, Figure 1.1, pp. 148, 152, Data Appendix); Chu, Morganstein, & Wallace (1992). [d]Mullis & Jenkins (1990, pp. 54–62, Data Appendix); Campbell, Voelkl, & Donahue (1997, p. 93, Table 4, 7, pp. B42–B46, Tables B16–B18, pp. C66–C70, Tables C16–C18); Campbell, Reese, O'Sullivan, & Dossey (1996, p. 93, Table 6.6). [e]National Center for Education Statistics (1994, p. 401, Table 11.16, pp. 530–534, Data Appendix); National Center for Education Statistics (1993, p. 114, Table 33); Jones, Mullis, Raizen, Weiss, & Weston (1992, p. 17, Table 1.7, pp. 145–147, Data Appendix). [f]Mullis, Martin, Beaton, Gonzalez, Kelly, & Smith (1997, p. 130, Table 4.11, p. A14, Table A5 p. C4, Table C3); Martin, Mullis, Beaton, Gonzales, Smith, & Kelly (1997, p. 116, Table 4.11, p. A14, Table A5, p. C4, Table C3); Beaton, Martin, Mullis, Gonzalez, Smith, & Kelly (1996, p. 110, Table 4.10, p. A14, Table A5, p. E4, Table E.3); Mullis, Martin, Beaton, Gonzalez, Kelly, & Smith (1998, p. 122, Table 4.20, p. B23, Table B9, p. E7, Table E6).
*$p < .05$.

Table 2.—Average Achievement and Frequencies, as a Function of TV Viewing Time

Study	Type of data[a]	9-year-olds					13-year-olds				
HSB	Viewing category	—	—	—	—	—	—	—	—	—	—
	Midpoint	—	—	—	—	—	—	—	—	—	—
	Achievement Z score	—	—	—	—	—	—	—	—	—	—
	% of students	—	—	—	—	—	—	—	—	—	—
IAEP–88	Viewing category	—	—	—	—	—	–2[c]	3–4	5+[b]	—	—
	Midpoint	—	—	—	—	—	1	3.5	6	—	—
	Achievement Z score	—	—	—	—	—	.27	.11	–.15	—	—
	% of students	—	—	—	—	—	37.5	43.8	18.8	—	—
IAEP–91	Viewing category	0–1	2–4	5+[b]	—	—	0–1	2–4	5+[b]	—	—
	Midpoint	0.5	3	6	—	—	0.5	3	6	—	—
	Achievement Z score	–.01	.06	–.11	—	—	.09	.05	–.16	—	—
	% of students	28.8	52.5	18.6	—	—	23.1	63.2	14.1	—	—
NAEP–Trend	Viewing category	0–2	3–5	6+[d]	—	—	0–2	3–5	6+[d]	—	—
	Midpoint	1	4	7	—	—	1	4	7	—	—
	Achievement Z score	.09	.16	–.24	—	—	.20	.01	–.43	—	—
	% of students	44.6	34.3	21.0	—	—	40.7	45.3	14.0	—	—
NAEP–Nation Assessment	Viewing category	–1[e]	2	3	4–5	6+[d]	–1[e]	2	3	4–5	6+d
	Midpoint	0.5	2	3	4.5	7	0.5	2	3	4.5	7
	Achievement Z score	.10	.23	.18	.05	–.46	.27	.23	.10	–.09	–.59
	% of students	19.3	19.7	17.3	21.7	22.7	13.5	22.0	22.5	27.3	14.3
TIMSS	Viewing category	< 1[a]	1–2	3–4	> 4[f]	—	< 1[a]	1–2	3–5	> 5[g]	—
	Midpoint	0.5	1.5	3.5	6	—	0.5	1.5	4	7	—
	Achievement Z score	–.03	.13	.10	–.20	—	–.01	.08	.01	–.28	—
	% of students	39.2	36.2	13.7	10.9	—	23.4	44.5	23.8	8.3	—

Note. The full names of the studies are given in the Note at the bottom of Table 1.
[a]Less than 1 hr; [b]5 hr or more; [c]2 hr or less; [d]6 or more hr; [e]1 hr or less; [f]more than 4 hr; [g]more than 5 hr.

Figure 2. Achievement as a Function of Viewing Time Averaged Over Age

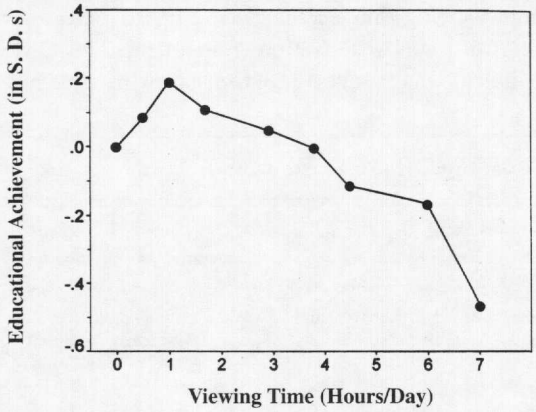
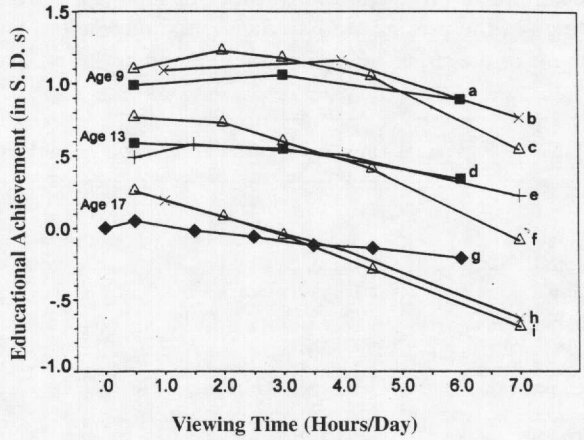


Figure 3. Achievement as a Function of Viewing Time at Different Ages



Note. a, b, c give data for age 9; d, e, f—for age 13; and g, h, i—for age 17. Sources of data include the following: a—IAEP-1991; b—NAEP-Trends; c—NAEP–Nation Assessment; d—IAEP-1991; e—TIMSS; f—NAEP-Nation Assessment; g—HSB; h—NAEP-Trends; i—NAEP-Nation Assessment.

hr. From the HSB findings, it appears that at age 17, optimal viewing time is .5 hr.

The existence of an optimal viewing time that is related to higher achievement more than is a shorter viewing time is not an artifact of computing the averages presented in Figures 2 and 3 and in Table 2, but is apparently a real phenomenon that is replicated in almost all the data on which these averages were computed. For example, for age 9, in the IAEP-1991 study, in 29 of the 31 comparisons that could be made, achievements in 2–4 viewing hr were superior to those in 0–1 viewing hr. In the NAEP-Trend study, in 5 of 6 comparisons, achievements were higher in the 3–5-hr category than in the 0–2-hr category. In the NAEP-Nation Assessment study, in all three comparisons, 2 viewing hr were superior to 0–1 hr. In the TIMSS study, in all 49 comparisons that could be made, the 1–2-hr category was superior to the less-than-1-hr

17-year-olds						
0	< 1[a]	1–2	2–3	3–4	4–5	5+[b]
0	0.5	1.5	2.5	3.5	4.5	6
0	.05	−.02	−.06	−.12	−.14	−.21
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
0–2	3–5	6+[d]	—	—	—	—
1	4	7	—	—	—	—
.19	−.15	−.63	—	—	—	—
58.7	34.7	6.7	—	—	—	—
−1[e]	2	3	4–5	6+[d]	—	—
0.5	2	3	4.5	7	—	—
.26	.08	−.04	−.29	−.69	—	—
30.5	27.0	20.0	17.5	5.5	—	—
< 1[a]	1–2	3–5	> 5[g]	—	—	—
0.5	1.5	4	7	—	—	—
.14	.03	−.15	−.40	—	—	—
34.9	45.1	16.5	3.6	—	—	—

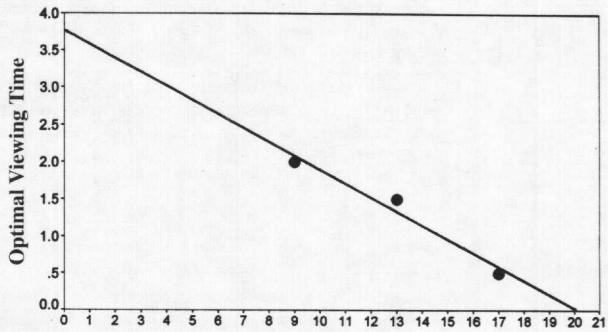
category. Over those four studies, in 86 of 89 comparisons, I found an optimal viewing time that was superior to a shorter viewing time ($Z = 8.69$, $p < .05$). Also with regard to age 13, I found that in 57 of 76 comparisons that could be made in the TIMSS data, the achievements in the 1–2 hr category were superior to those in the less-than-1-hr category, a statistically significant finding ($Z = 4.24$, $p < .05$). Those findings leave little room to doubt that optimal viewing time is a real phenomenon in television viewing.

The optimal viewing time for each age cannot be read directly from Figure 3 or calculated directly from the data because each study used different categories of viewing time. The exact optimal time for each age had to be derived from a synthesis of the data from all the studies. For students who were age 9, all studies show an optimal viewing time, but this time is different from one study to the next. Nevertheless, a synthesis of the data suggests that at age 9, the optimal viewing time is 2 hr.[1] A similar synthesis of the data for 13-year-olds suggests that at age 13, optimal viewing time is 1.5 hr.[2] Similarly, an estimate of the optimal viewing time of .5 hr for age 17 is based on the findings of the HSB study.[3]

2. A second conclusion drawn from the findings is that optimal viewing time decreases with age. Whereas at age 9 optimal viewing time was estimated at 2 hr per day, at age 13 it was 1.5 hr a day, and at 17 it was .5 hr a day.

Optimal viewing time is plotted as a function of age in Figure 4. The figure also presents the linear regression line

Figure 4. Optimal Viewing Time as a Function of Age



that best fits the three points. There are several reasons for relating cautiously to the linear regression line; these include (a) there are not enough data points to determine whether the decrease with age in optimal viewing time is linear; (b) the estimated optimal viewing times are based on crude viewing time categories, and it is therefore possible that the true optimal times are somewhat shorter or longer than the estimates. Still, the regression line that was computed on the three optimal viewing time estimates is based on more information than any of the estimates separately. Practically, the regression line allows one to obtain first estimates of optimal viewing times for ages for which there is no data. According to the regression line, optimal viewing time at the age of 1 year is 3.5 hr; the time decreases by about 11 min every year up to age 20 when no viewing is beneficial. The predictions for ages 1 and 20 are proposed with caution and should be considered as tentative because they are based on an extrapolation of the line beyond the domain for which there are data and, as extreme points, are particularly dependent on the assumption of linearity. There is, however, evidence that optimal viewing time does disappear with age. The findings of the HSB study (Keith et al., 1986) indicate that the upper achieving third of 12th graders do not derive any benefit from even half an hour of viewing. Therefore, the upper third of the population may not have any optimal viewing time at age 17; additional segments of the population may reach this state by age 20.

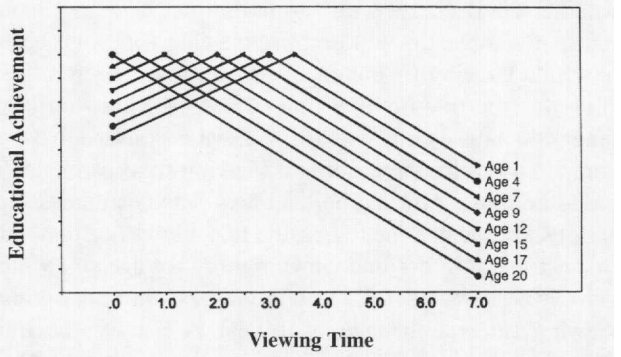
3. A third conclusion drawn from the findings is that the benefit of optimal viewing for educational achievement decreases with age. At age 9, the benefit of 1.5 hr of viewing (2 hr compared with .5 hr in the NAEP–Nation Assessment study) is .13 standard deviation. At 13, the benefit of 1 hr of viewing (1.5 hr compared with .5 hr in the TIMSS data) is .09 standard deviation. At age 17, the benefit of .5 hr of viewing relative to nonviewing (in the HSB study) is .05 standard deviation. Thus, in the positive viewing range, the slopes at the different ages are very similar, and, on average, 1 hr of viewing is related to an increase of .09 standard deviation in achievement.

Table 3.—Percentage of Students Viewing More TV Than Optimal Time, and Their Achievement

Age	Optimal viewing time (in hours)	Percentage viewing more than optimum[a]	Average[b] viewing time of those viewing more than optimum (in hours)	Difference between achievement in optimal category and average achievement of those viewing more than optimum (in Z score)[b]
9	2	43	5.0	0.25
13	1.5	55	4.6	0.26
17	0.5	68	2.8	0.28
Average	1.3	55	4.1	0.26

[a]Not all data given in Table 2 could be used, including those from the High School and Beyond study because no data on percentage of students were provided, those from the International Assessment of Educational Progress (1991) and the National Assessment of Educational Progress–Trend for ages 9 and 17 because viewing time categories were inappropriate. [b]Average weighted by percentage of students in the different viewing categories.

Figure 5. The Complex Model of Viewing and Achievement



4. A fourth conclusion drawn from the findings refers to the slope in the negative viewing range. The slopes at the different ages were similar (see Figure 3). Also, the average slope of the lines between the last two viewing-time categories (i.e., in the viewing range of 3 to 7 hr) was −.12 standard deviation per viewing hour and was larger by one third (in absolute value) than the slope of .09 in the positive viewing range.

It is possible to use the data collected in Table 2 to calculate the percentage of students aged 9, 13, and 17 who view more television than the optimal viewing time for their ages (see Figure 4), their average viewing times, and their achievement. The findings are presented in Table 3. Averaged over the three ages, the data indicate that 55% of students view television about 3 hr more a day than the optimal viewing time for their age, and their average achievement is .26 standard deviation lower than that for those who limit their viewing to the optimal viewing time.

Discussion

I have labeled the generalizations of the Findings section as the complex model of viewing and achievement, which is shown schematically in Figure 5. According to the model, the relationship between viewing time and achievement is different for each age, although for every age up to 20 years, it is curvilinear. The main difference between the curves for different ages is the magnitude of the optimal viewing time, which decreases with age. Also, the drawing of the complex model expresses the finding that the slope in the positive viewing range is smaller than the slope in the negative viewing range and that the slopes are the same for different ages.

The complex model could account for the findings presented in Figure 1—that is, a positive viewing–achievement correlation in early age that becomes negative at age 7 and even more negative as age increases. In early age, the positive viewing range is relatively large and the negative viewing range is relatively small. Therefore, in early age, a large part of viewing is done in the positive viewing range, and only a small part of viewing is done in the negative viewing range. That finding might explain why the viewing–achievement linear correlation is positive in early age. However, optimal viewing time decreases with age. Beginning with age 7, Grade 2, the viewing optimum decreases to such a degree that a relatively large part of viewing falls in the negative viewing range. In addition, viewing in the negative viewing range has a greater impact on the viewing—achievement linear correlation than does viewing done in the positive range because of the steeper slope in the negative range. The two factors lead to a negative viewing–achievement linear correlation beginning with age 7. With a further age increase, the viewing optimum keeps decreasing so that an increasing proportion of viewing is done in the negative range, resulting in an increasingly negative linear correlation. Fuligni and Stevenson (1995) reported that the average correlation is −.19 for Grade 11 students in the United States, China, and Japan. Keith et al. (1986) reported a correlation of −.20 in the large representative sample of American Grade 12 students in the HSB study.

The finding that the overall linear viewing–achievement relationship was negative is explained according to the model by the following two factors: (a) The positive viewing range is usually smaller than the negative viewing range

and (b) the slope in the negative range is larger than that in the positive range.

The complex model of the viewing–achievement relationship presented here has not yet been proposed in the literature. The reason is probably that the findings are so complex that it is difficult to see any lawfulness in them (Foertsch, 1992, pp. 24–25). For example, Lewy (1994) concluded that "in spite of the multitude of studies on the relationship between television viewing and reading, it is difficult to reach clear summaries and unequivocal conclusions" (p. 73). Beentjes and Van der Voort (1988) concluded similarly that "Clearly the research findings are not quite consistent" (p. 406). In light of the complex model, studies that indicate a lack of viewing–achievement relationship (Scarborough, 1989), or even those that point to a positive viewing–achievement relationship (Blosser, 1988), receive a completely different meaning. Those studies do not contradict the conclusion concerning the overall negative viewing–achievement relation. Nor do they contradict the complex model. Rather, they point to certain contexts, such as short viewing times and viewing in young-aged children where the viewing–achievement relationship is positive, or contexts in which the positive viewing range is equal to the negative viewing range so that, on average, no relationship seems to exist between viewing time and achievement.

Obtaining a negative linear correlation between viewing and achievement does not prove that viewing is the cause of low achievement. According to elementary methodology, a linear correlation between variables X and Y could result from three causal possibilities: (a) X causes Y, (b) Y causes X, or (c) Z causes both X and Y (Welkowitz, Ewen, & Cohen, 1971, p. 155).

Thus, it is possible that television viewing is responsible for lowered achievement. However, NAEP researchers (National Assessment of Educational Progress, 1994) suggested that poor achievers watch more television. Neuman (1986, 1988, 1995) stated that socioeconomic status (SES) is responsible for the negative linear viewing–achievement correlation, and Hornik (1981) cited IQ as the cause.

However, my finding that the overall negative linear correlation is actually an inverse U function (see Figure 2) suggests a direction toward the nature of the causal relationship between the two variables. To explain the inverse U function by considering that achievement causes television watching, one would have to say that having a given test score causes one to watch a mean of x hr of television a day, and it also causes him or her to watch a mean of y hr a day (where x is different from y) because in the U function, two different values of viewing time are related to the same achievement score. That explanation appears to be a logical contradiction. The same point may be made for the possibility that a third variable, like IQ or SES, is the cause of the amount of television watching. If that possibility were true, then a given IQ or SES would cause a person to watch x hr of television a day, and the same given IQ or SES also would cause him or her to watch y hr a day—an apparent logical contradiction. Thus, if the inverse U-shaped function is the correct operation describing the relationship between viewing time and achievement, then it appears that the correct interpretation of this function is that viewing time is the cause of achievement.

The data presented in Table 3 indicate that, averaged over all ages, 55% of students view television about 3 hr a day more than the optimal viewing time for their age group, and that the educational achievements of these students were .26 standard deviation lower than that of students who restricted their viewing time to the optimal time. Because my interpretation of the inverse U function relating achievement and viewing time suggests that viewing time causes achievement, these findings imply that the viewing habits of more than half of the student population damage these students' achievement by .26 standard deviation.

To put the size of this damage into perspective, I used the NAEP–Trend data (Campbell et al., 1997, Data Appendixes A, B, C, and D), in which achievement scores for ages 9, 13, and 17 were reported on a single scale, to calculate the average achievement gap in standard deviations between two consecutive grade levels. Dividing the achievement gap by number of years, separating the ages of the students, and dividing the per-year achievement difference by the average standard deviation in the compared groups, then averaging over all testing years (about seven per subject) and all subjects (reading, mathematics, science, and writing), I found that the average achievement difference between two consecutive grade levels was .28 standard deviation.

Thus, the average damage of .26 standard deviation caused by the typical viewing habits of the majority of 9-, 13-, and 17-year-olds is equivalent to lowering achievement by about one grade level. The average slope of –.12 standard deviation per 1 hr of viewing in the negative viewing range calculated above on the data given in Table 2 can also be couched in more meaningful terms: Every hour of additional viewing beyond the optimal viewing time could lower the students' achievement by 40% of a grade level. Similarly, the slope of .09 in the positive viewing range means that every hour of viewing up to the optimal viewing time raises achievement by 30% of a grade level. Those analyses suggest that television viewing has a major detrimental effect on achievement for the majority of students and a smaller positive effect for a minority of them. It seems, therefore, that a serious educational effort is needed to reduce television viewing to the optimal viewing time at each age.

My conclusion differs from Williams and colleagues' (1982) statement that "given that the overall average televiewing–achievement correlation is only –.05, it appears that the actual size of effect is small" (p. 34). Williams and colleagues' conclusion has been quoted by various researchers (Neuman, 1995, p. 42). However, "the overall average correlation" averages the positive effect of viewing in the early ages and of limited viewing on one hand, with the negative effect of viewing in later years and of extensive viewing on the other hand. The two opposing effects partial-

ly cancel each other in the overall average correlation that yields parameters of situations that, in reality, do not exist.

The complex model presented in the preceding paragraphs depicts the relationship between television viewing and achievement, but it does not explain it. Neuman (1995) discussed three theories that researchers proposed to account for the negative effects of television viewing on achievement. According to the displacement theory, television viewing keeps children from being engaged in more academically oriented activities, such as homework and reading. According to the information-processing theory, "television may be training students to process information in a way that is far different from what traditional school-based learning requires" (p. 15). According to the short-term gratification theory, the excitement, action, drama, and "inevitable satisfactory resolution of all problems raised" (p. 18) during a program influences children who also expect to be gratified immediately and who have shortened attention spans—two behavior patterns nonconducive to producing high achievement in school.

The findings of this study, along with findings of other research (Lemish & Rice, 1986), suggest that young children benefit from television viewing. Nevertheless, even for young children, viewing should probably be limited to the existing estimates of optimal viewing time, such as 3 hr a day at age 4 (see Figure 3).

In recent years, the literature relating to television viewing and educational achievement has often emphasized the need to consider the quality of the television material that is being viewed (St. Peters, Fitch, Huston, Wright, & Eakins, 1991). I did not address that issue in this research primarily because none of the studies that were analyzed presented any relevant data. Thus, my findings relate to the relationship that exists when natural everyday patterns of television viewing occur, averaging over all the qualities presented. However, the positive correlation between viewing time and achievement in small amounts of viewing may be related to higher quality viewing in small amounts of viewing. It is plausible that smaller amounts of viewing are instances of parentally controlled viewing, and where quantity is controlled, quality also may be controlled. Similarly, the larger optimal times for younger aged children are consistent with the possibility that a larger proportion of programs for young children, as compared with the proportion for older children, is designed to promote educational development. Thus, the finding of a larger optimal viewing time for younger children may be related to their higher quality viewing. It is clear that for a fuller understanding of the relationship between viewing time and achievement, researchers will have to consider the quality of the material being viewed.

NOTES

1. The details of the argument that justify this conclusion are as follows. The fact that in the NAEP–Trend study the average achievement for the 0–2 hr of viewing range was lower than that for the 3–5-hr range does not contradict the conclusion that the optimal viewing time is 2 hr, because in the 0–2 range the achievements related to 2 hr were mixed with the lower achievements related to 1 and 0 viewing hr. Likewise, the fact that in the IAEP-1991 and TIMSS studies achievements in the 2–4- and 1–2-hr ranges, respectively, were associated with the highest achievement is consistent with the conclusion that the optimal viewing time is 2 hr, because this time is included in these ranges. On the other hand, one cannot conclude from the NAEP–Trend study that the midpoint of the 3–5-hr range or even the minimal end of this range (3 hr) is related to higher achievements than those related to shorter viewing times, because the findings of the NAEP–Nation Assessment study show explicitly that the achievements related to 3 viewing hr are lower than the achievements related to 2 hr. Similarly, it cannot be concluded from the IAEP-1991 study that the advantage of the 2-4-hr range stems from the fact that the optimal viewing time is 3 hr, the midpoint of this range, because the NAEP–Nation Assessment study showed that 2 hr of viewing are superior to 3 hr of viewing.

2. From the TIMSS findings, one can conclude that at age 13, optimal viewing time is 1.5 hr. The fact that no optimal viewing time was found for this age in four other studies does not contradict this conclusion, because the ranges of the viewing-time categories in these studies were too broad.

3. From the HSB findings, one can conclude that at age 17, optimal viewing time is .5 hr. The fact that no optimal viewing time was found in three studies that contain data for this age does not contradict this conclusion, because only the HSB study used a viewing-time category with a viewing time shorter than .5 hr.

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