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Viewing the Viewers: How Adults With Attentional Deficits Watch Educational Videos

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Abstract

Objective: Knowing how adults with ADHD interact with prerecorded video lessons at home may provide a novel means of early screening and long-term monitoring for ADHD. **Method:** Viewing patterns of 484 students with known ADHD were compared with 484 age, gender, and academically matched controls chosen from 8,699 non-ADHD students. Transcripts generated by their video playback software were analyzed using *t* tests and regression analysis. **Results:** ADHD students displayed significant tendencies ($p \leq .05$) to watch videos with more pauses and more reviews of previously watched parts. Other parameters showed similar tendencies. Regression analysis indicated that attentional deficits remained constant for age and gender but varied for learning experience. **Conclusion:** There were measurable and significant differences between the video-viewing habits of the ADHD and non-ADHD students. This provides a new perspective on how adults cope with attention deficits and suggests a novel means of early screening for ADHD. *(J. of Att. Dis. 2014; 18(7) 585-593)*

Keywords

ADHD, attention, unobtrusive neuropsychological assessment

Long-term, objective observations on the effects of ADHD on the everyday activities of affected adults are sparse. Information has been collected mostly from clinical tests (DuPaul, Power, Anastopoulos, & Reid, 1998; Kuntsi, McLoughlin, & Asherson, 2006; Snyder & Hall, 2006), interviews (Epstein, Johnson, & Conners, 2002; Kooij et al., 2008), self-reports (Barkley & Murphy, 2010; Brown, 1996; Conners, Erhardt, & Sparrow, 1999; Kessler et al., 2005; Ward, Wender, & Reimherr, 1993), medical records (Barkley, 2002; Swensen et al., 2004), or performance markers, including academic (Barkley, 2006; Biederman et al., 2008), professional (Biederman et al., 2008; de Graaf et al., 2008), automobile driving (Barkley & Cox, 2007; Barkley, Guevremont, Anastopoulos, DuPaul, & Shelton, 1993), and criminal records (Mannuzza, Klein, & Moulton, 2008; Young et al., 2009). These demonstrate that adult ADHD is a prevailing problem, yet provide little insight into the daily activities of those afflicted.

We designed the current study to collect long-term, objective evidence on how ADHD affects the everyday activities of affected adults outside the clinic in an unobtrusive manner. We chose the parameter of their study habits that we monitored in the participants' natural environment, without their awareness of being monitored and therefore without influencing their behavior. Our goal was to provide new and much-needed understanding of how adult students cope with ADHD (Marije Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005; Wender, Wolf, & Wasserstein, 2001) and ultimately to use this information to devise novel early screening techniques. Online educational videos are well suited to facilitate such observations. Typically, servers provide access to educational videos for client computers located at students' homes. During playback, video software routinely reports any video playback–related action performed by the viewer to these servers (e.g., pressing Play or Stop). These reports are then recorded ("logged") by the servers. By analyzing these logs, we observed and recorded several characteristics of the students' viewing. We hypothesized that ADHD patients will utilize these features differently than will controls as a result of their inattentiveness. We also considered that these tendencies will

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be logged, and would therefore provide objective evidence of attention deficits measured outside the clinic.

Method

Study population. This study was performed at the The Open University of Israel (OUI) and approved by its Research Ethics committee. The results reported herein were obtained by analyzing viewing logs recorded between January 1, 2009, and September 10, 2009, by the OUI video servers. More than 30,000 individuals, most of them adults (i.e., aged 13-77 years), logged in to watch video lessons in undergraduate or graduate humanities, social, and exact science courses. These video lessons are available as part of the different academic study programs, but watching them was not mandatory. All OUI students agreed on registration to have their records at the OUI used for research purposes. This approval is signed on registration to each and every course. Students were otherwise unaware of any monitoring of their video-watching activities over the duration of the study.

Students at the OUI may apply for alterations in academic requirements, such as modified tests and additional tutoring, based on attention deficits. As is standard procedure, in all public educational institutions in Israel, to apply, OUI students must present an up-to-date (within the last 4 years) diagnosis of ADHD by a qualified educational expert or a physician specializing in ADHD diagnostics. Precise diagnostic procedures, however, may vary from one student to the next, and there is no possibility of controlling for or identifying the method used to diagnose each student, existing comorbidities, or what, if any, treatment had been or was being administered. Students recognized by the OUI as having attention deficits comprised the current study group, and the matched-control group was selected from the remaining members of the student body. We are aware that there could have been students with undiagnosed or unreported ADHD among them.

For this study, we considered only those students whose video lessons were longer than 1,000 s (~16.6 min) because shorter clips often provide too little information. Students who viewed fewer than 10 video lessons over the course of the study were also excluded. These exclusions left 9,183 students, of them 484 adults (age range = 16-59 years) presented the OUI with a diagnosis for attention disorder, and they composed the study group. Each of these participants was matched for age, gender, and academic record (defined as the number of completed credits at the time of our study) with a randomly selected student from the remaining 8,699 students.

The demographics of the study group and the matched-control group are detailed in Table 1. Interestingly, the percentage of participants with attention deficits (Table 1) matched the estimated distribution of adult ADHD in the general public, that is, 1% to 6% (Wender et al., 2001). The male-to-female ratio of the study group was almost 1:1, a figure consistent with the observation that the prevalence of ADHD in females is the same and sometimes more than that of males in adult populations (Biederman et al., 2004; Keltner & Taylor, 2002; Kooij et al., 2005).

Table 1. Demographics of the Study Participants Who Had Been Diagnosed As having an Attention Disorder and Matched Allegedly Healthy Controls.

	Study participants	Matched controls[a]
	n = 484 (~5.2%)	*n* = 484 (~5.2%)
Male:female (%)	239:245 (49.3:50.6)	239:245 (49.3:50.6)
Age range (years)	16-59	16-59
Age, year, mean (*SEM*)	28.8 (0.2)	28.8 (0.3)
Age, year, median	28	28

Note: *SEM* = standard error of mean.
[a]Derived from 8,699 students without reported attention disorders.

Procedures and data analysis. OUI video lessons are hosted by Windows Media Services (WMS) servers (Koyun, 2007), which handle the streaming of video content to each client's computer (typically located in the student's home). Videos are viewed using standard video playback software, such as the Windows Media Player. These programs automatically relay reports to the central server on playback-related operations performed by the user (e.g., pressing the Play or Stop buttons). Each of these operations generates a separate report (a "log") that includes several values that describe the operation. These values include the identification of the specific video lesson, the type of actions that were taken, the time of day when the actions were performed and their duration, the position in the video clip where an action was performed, and so on. In addition, to access the video lessons, students must identify themselves to the media server by logging on with an internal OUI identification number (ID). This ID is encrypted and attached to a computerized file in which the student's cumulative data as well as his or her background information are readily accessible.

It should be noted that similar log data have been used in the past for such diverse tasks as effective storage of video data in computer networks (Acharya, Smith, & Parnes, 2000), analyzing the reaction that videos have on viewers (Mongy & Djeraba, 2007) and the design of novel video playback interfaces (Crockford & Agius, 2006). To the best of our knowledge, however, we are the first to examine how individual attention capabilities reflect in these data.

We examined the logs generated by each student for each video lesson and extracted various parameters, for example, the number of times the Play button was pressed, the number of times any part of the video was rewatched, and so forth. Each such value was averaged over the 10 or more videos watched by the student, and therefore, the students' viewing patterns were then characterized by a fixed list of the numeric values, which comprised the viewing profile. These values were chosen in an effort to capture different aspects of viewing behavior, but are not exhaustive.

Statistical analysis. We performed two different statistical assays. One was a series of two-tailed, paired *t* tests to study the differences between the study and matched-control groups, setting significance at alpha = .05. The results are given as sample means ± *SE, t* values, *p* values, and 95% confidence intervals (CI) on the difference of the population means. The other was a linear regression analysis to study the effects of age, gender, and prior academic experience on the observed video-watching behavior.

The term *sequence* will be used henceforth to refer to a part of a video that had been viewed without interruption. An *overlap* is the part of a video watched during separate sequences; that is, a part of the video watched more than once. *Pausing playback* refers to ceasing to watch a sequence, typically by pressing the Stop button (no distinction is made between Pause and Stop). Finally, unless otherwise noted, all durations are measured in seconds.

Results

Viewing profile measurements. The two-tailed, paired *t*-test analysis is presented in Table 2. The mean number of times they rewound the videos, returning to watch earlier content, was larger for the study group than for the controls (Feature 1: 15.2 vs. 12, $p < .01$). The mean duration of watching a part of the video more than once (the overlap between two separately watched sequences) was larger for the study group than the controls (Feature 2: 3.48 vs. 3.16, $p < .01$). The duration of the longest uninterrupted viewing was shorter for the study group than for the control group, with a mean duration of 973.4 s versus 1,055.0, respectively (Feature 4: $p = .05$). The number of sequences watched, as reflected by the number of times Play was pressed and the number of logs generated for a start-sequence event, was also significantly different for both groups: The study group watched more sequences than the controls (*M* 31.8 study vs. 27.3 controls for start-sequence events, Feature 6, and 31.5 vs. 27.2 for the times Play was pressed, Feature 7, $p < .01$ for both).

We assessed the durations of the intervals between views. This is the time that transpired without watching the videos. These intervals could range between a few seconds and several days. The shortest duration, measured in hours, was longer for the study group than the controls (Feature 8: 4.83 vs. 2.06, respectively, $p = .03$). This is true also for the mean duration that elapsed between different viewing sessions (Feature 10: 17.4 vs. 12.2, respectively, $p < .01$) and the median duration between views (Feature 12: 8 vs. 3.8, respectively, $p < .01$). The study group stopped watching the videos, without returning to watch them again, significantly earlier in the videos than did the controls, watching only an average of 59% of the videos compared with 62% for the controls (Feature 13: $p = .01$).

Although there was no significant difference in the mean time of the day that the videos were watched or the latest time of day, there was a significant group difference in how early in the day the videos were viewed, with the study group starting to watch the videos earlier than did the controls (Feature 17: $p = .02$). The former also watched videos over more parts of the day, as evident in the *SD* of the viewing hour of the day (Feature 15: $p = .01$). None of the other parameters tested were found significant.

Effect of gender. Regression analysis (Table 3A) was performed separately on the study group and the remaining student population (8,699 participants) to evaluate the effects of age on the viewing habits of the students. There were significant differences between male and female controls. Specifically, the females in the control group returned to previously viewed parts of the video more than did the males (Feature 1: $p < .01$), and had longer overlaps between sequences (Feature 2: $p = .04$). The longest sequence watched by males was longer than that watched by females (Feature 4: $p < .01$) and the same held true for the median sequence (Feature 5: $p < .01$). Females watched more sequences (Feature 6: $p < .01$) as well as pressed the Play button more than males did (Feature 7: $p < .01$). The median interval duration between watching the videos was longer for females (Feature 12: $p = .03$). Males viewed the videos significantly later than females (Feature 14: $p < .01$), over more of the day (Feature 15: $p < .01$) and to have their latest viewings later than females (Feature 17: $p < .01$). Other parameters were not significantly different.

Taken separately, the study group exhibited fewer significant differences between males and females. These were related to the times of day the videos were watched. The average starting hour for viewing a video was later for males than for females (Feature 14: $p = .02$); the males viewed the videos over more hours of the day (Feature 15: $p = .03$), and the latest they started to watch was later than the females (Feature 16: $p < .01$). Finally, the mean period of time between watching videos was longer for the females than for the males (Feature 10: $p = .05$). None of the other parameters were significantly different between the males and females of the study group.

Effect of age. We limited our analysis (Table 3B) to ages 22 to 35 years to prevent skewing the results by the small numbers of study participants in the extreme age groups. This left 450 students in the study group and 6,999 in the general student population. The controls exhibited many significant age-dependent changes. Specifically, older students had longer overlaps between sequences (Feature 2: $p = .01$); their shortest sequence viewed was longer than for the younger students (Feature 3: $p < .01$) as was their longest sequence viewed (Feature 4: $p < .01$) and their median sequence (Feature 5: $p < .01$). The number of

Table 2. Paired Two-Tailed *t*-test Comparison of Viewing Profile Features for the Study Participants and Controls Matched for Age, Gender, and Academic Record.

No.	Feature description	Study mean ± *SE*	Control mean ± *SE*	95% mean difference CI	*t*	*p*[a]
1	Number of times a sequence starts earlier than end of a previously watched sequence	15.23 ± 0.70	11.59 ± 0.46	2.00-5.28	4.35	<.01
2	Longest overlap between sequences	3.48 ± 0.05	3.16 ± 0.04	0.20-0.45	4.95	<.01
3	Shortest sequence watched	59.14 ± 5.70	50.15 ± 4.29	−4.91-22.88	1.27	.20
4	Longest sequence watched	973.42 ± 27.13	1,055.03 ± 29.94	−161.74 to −1.47	−2.00	.05
5	Median sequence watched	134.25 ± 9.68	123.77 ± 7.39	−13.02-33.96	0.88	.38
6	Number of sequences watched per video	31.83 ± 1.22	27.34 ± 0.89	1.51-7.48	2.96	<.01
7	Number of times Play was pressed per video	31.54 ± 1.21	27.21 ± 0.89	1.37-7.30	2.87	<.01
8	Shortest break from watching (hr)	4.83 ± 1.18	2.06 ± 0.46	0.28-5.25	2.18	.03
9	Longest break from watching (hr)	155.47 ± 8.37	140.98 ± 8.08	−8.30-37.26	1.25	.21
10	Mean break from watching (hr)	17.39 ± 1.64	12.21 ± 0.88	1.57-8.80	2.82	<.01
11	*SD* of the duration of breaks from watching (hr)	35.20 ± 2.03	31.26 ± 1.83	−1.43-9.32	1.44	.15
12	Median duration of break (hr)	7.97 ± 1.32	3.80 ± 0.57	1.33-7.02	2.88	<.01
13	% Viewed of entire video	0.59 ± 0.01	0.62 ± 0.01	−0.05 to −0.01	−2.81	.01
14	Mean hour of the day when the videos were watched (% of day)	0.57 ± 0.00	0.58 ± 0.00	−0.02-0.00	−1.12	.26
15	*SD* of the hours when the videos were watched	0.063 ± 0.00	0.057 ± 0.00	0.00-0.01	2.71	.01
16	Latest hour of watching the videos	0.66 ± 0.00	0.66 ± 0.00	−0.01-0.01	0.23	.82
17	Earliest hour of watching the videos	0.48 ± 0.00	0.50 ± 0.00	−0.03 to −0.00	−2.38	.02

Note: CI = confidence interval; *SE* = standard error. Shaded rows indicate significant findings. Time is measured in seconds unless noted otherwise by (hr) for hours.
[a]Statistical significance is set to alpha = .05.

sequences watched was less (Feature 6: $p = .02$) as was the number of times the Play button was pressed (Feature 7: $p = .01$). The longest break in viewing increased with age (Feature 9: $p = .01$), as did the *SD* of break duration (Feature 11: $p < .01$), the mean break duration (Feature 10: $p < .01$), and the median break duration (Feature 12: $p = .03$). Two watching parameters increased with age: the total amount of the videos that were watched (Feature 13: $p = .02$) and the various times of day used for watching (Feature 15: $p < .01$). The time of day students started to watch the video decreased with age (Feature 17: $p < .01$). There were no significant age-related differences for other parameters. Generally speaking, the study group showed no significant age-related changes with the exception of taking the longest break from studying (longer for the older study participants: Feature 9: $p = .04$).

Effect of academic credits prior to this survey. Finally, we evaluated the effect of previous academic experience; academic experience was measured by the number of credit points obtained by successfully completed OUI courses prior to our survey (Table 3C). Here, both groups were significantly affected.

Fewer returns to early video content (fewer rewind operations) were required by study participants with more academic experience (Feature 1: $p = .02$); this parameter was not significant for the controls. The longest overlap between sequences decreased in both groups (Feature 2: $p = .02$ for the study group and $p < .01$ for the controls). The shortest sequence was shorter for the controls with more academic credits (Feature 3: $p = .01$), but there was no difference among students of the study group with more academic credits. The number of watched sequences dropped for both groups with more academic credits (Feature 6: $p = .02$ study and $p = .01$ controls), and similarly for the number of times the Play button was pressed (Feature 7: $p = .02$ study and $p = .01$ controls). The longest break in viewing was shorter for the more experienced controls than those with fewer credits (Feature 9: $p = .03$), and they got further into the videos than did the controls with fewer credits (Feature 13: $p < .01$). For study and control groups, the more accumulated credits the earlier in the day they started to watch the videos. Particularly, the mean hour of the day drops for both groups (Feature 14: $p = .01$ study and $p < .01$ controls), the *SD* of the time the videos were watched drops for the controls only (Feature 15: $p < .01$), the latest hour students start to watch drops for both groups (Feature 16: $p < .01$ study and $p < .01$ controls), and the earliest time both groups begin watching drops (Feature 17: $p = .04$ study and $p < .01$ controls).

Table 3. Linear Regression Analysis Comparing Gender, Age, and Credits Completed in Studies at the OUI to Viewing Profile Features.

		Study patients			Controls		
No.	Feature description	β	*t*	*p*[a]	β	*t*	*p*[a]
A. Effects of gender							
1	Number of times a sequence starts earlier than end of a previously watched sequence	0.55	0.79	.43	–0.65	–4.69	.00
2	Longest overlap between sequences	0.02	0.38	.70	–0.02	–2.06	.04
3	Shortest sequence watched	–5.33	–0.94	.35	0.75	0.57	.57
4	Longest sequence watched	32.71	1.21	.23	46.90	6.74	.00
5	Median sequence watched	0.47	0.05	.96	6.74	2.84	.00
6	Number of sequences watched per video	0.64	0.53	.60	–0.83	–3.11	.00
7	Number of times Play was pressed per video	0.58	0.48	.63	–0.79	–3.00	.00
8	Shortest break from watching (hr)	–2.07	–1.77	.08	–0.31	–1.56	.12
9	Longest break from watching (hr)	–5.62	–0.67	.50	2.63	1.36	.17
10	Mean break from watching (hr)	–3.20	–1.97	.05	–0.39	–1.27	.20
11	*SD* of the duration of breaks from watching (hr)	–2.19	–1.07	.28	0.30	0.67	.50
12	Median duration of break (hr)	–2.33	–1.77	.08	–0.53	–2.18	.03
13	% Viewed of entire video	–0.00	–0.03	.98	0.00	1.25	.21
14	Mean hour of the day when the videos were watched (% of day)	0.01	2.39	.02	0.00	4.16	.00
15	*SD* of the hours when the videos were watched	0.00	2.14	.03	0.00	7.27	.00
16	Latest hour of watching the videos	0.01	3.19	.00	0.01	6.29	.00
17	Earliest hour of watching the videos	0.00	0.75	.45	0.00	0.10	.92
B. Effects of age							
1	Number of times a sequence starts earlier than end of a previously watched sequence	–0.10	–0.44	.66	0.02	0.56	.58
2	Longest overlap between sequences	0.01	0.49	.63	0.01	3.34	.00
3	Shortest sequence watched	–0.66	–0.32	.75	1.30	2.97	.00
4	Longest sequence watched	10.25	1.05	.29	19.14	8.39	.00
5	Median sequence watched	1.73	0.49	.62	3.17	4.12	.00
6	Number of sequences watched per video	–0.35	–0.88	.38	–0.18	–2.29	.02
7	Number of times Play was pressed per video	–0.36	–0.93	.36	–0.19	–2.46	.01
8	Shortest break from watching (hr)	0.09	0.48	.63	0.00	0.75	.45
9	Longest break from watching (hr)	6.05	2.05	.04	1.76	2.72	.01
10	Mean break from watching (hr)	0.77	1.30	.19	0.35	3.81	.00
11	*SD* of the duration of breaks from watching (hr)	0.94	1.31	.19	0.61	4.17	.00
12	Median duration of break (hr)	0.62	1.30	.20	0.16	2.17	.03
13	% Viewed of entire video	–0.00	–1.26	.21	0.00	2.42	.02
14	Mean hour of the day when the videos were watched (% of day)	0.00	0.46	.65	–0.00	–1.34	.18
15	*SD* of the hours when the videos were watched	0.00	0.47	.64	0.00	6.63	.00
16	Latest hour of watching the videos	0.00	0.69	.49	0.00	1.54	.12
17	Earliest hour of watching the videos	0.00	0.09	.93	–0.00	–4.02	.00
C. Effects of accumulated credits at previous OUI studies							
1	Number of times a sequence starts earlier than end of a previously watched sequence	–0.05	–2.42	.02	–0.00	–0.60	.55
2	Longest overlap between sequences	–0.00	–2.25	.02	–0.00	–4.20	.00
3	Shortest sequence watched	–0.27	–1.65	.10	–0.10	–2.64	.01
4	Longest sequence watched	–0.48	–0.60	.55	–0.02	–0.08	.94
5	Median sequence watched	–0.46	–1.62	.10	–0.11	–1.70	.09
6	Number of sequences watched per video	–0.08	–2.36	.02	–0.02	–2.48	.01
7	Number of times Play was pressed per video	–0.08	–2.30	.02	–0.02	–2.61	.01
8	Shortest break from watching (hr)	–0.06	–1.60	.11	–0.00	–0.60	.55
9	Longest break from watching (hr)	–0.17	–0.70	.48	–0.12	–2.16	.03
10	Mean break from watching (hr)	–0.07	–1.46	.15	–0.01	–1.02	.31

(continued)

Table 3. (continued)

No.	Feature description	Study patients β	Study patients t	Study patients p[a]	Controls β	Controls t	Controls p[a]
11	*SD* of the duration of breaks from watching (hr)	–0.03	–0.49	.63	–0.01	−1.01	.31
12	Median duration of break (hr)	–0.06	−1.48	.14	–0.01	–0.93	.35
13	% Viewed of entire video	0.00	0.56	.57	0.00	3.71	.00
14	Mean hour of the day when the videos were watched (% of day)	–0.00	–2.76	.01	–0.00	−10.41	.00
15	*SD* of the hours when the videos were watched	–0.00	–0.53	.60	–0.00	–5.03	.00
16	Latest hour of watching the videos	–0.00	–3.07	.00	–0.00	−11.65	.00
17	Earliest hour of watching the videos	–0.00	–2.11	.04	–0.00	–6.30	.00

Note: OUI = The Open University of Israel. Shaded cells indicate significant findings. Time is measured in seconds unless noted by (hr) for hours.
[a]Statistical significance is set to alpha = .05.

Discussion

We analyzed computer generated, unobtrusive observations of how students with and without reported attentional deficits view academic level, educational videos in an unsupervised setting, outside the clinic. As far as we know, this is the first such attempt to collect objective, long-term observations on the daily activities of large adult populations, "in the wild," and use them to gain insights into their attention skills.

The tendencies we observed match the requirements for attention deficit diagnosis in adults, as described by criteria such as the Utah scheme (Wender et al., 2001). Our study group showed significant tendencies to divide the videos into more segments, to review more sequences, to pause playback after less time had elapsed, and require more time to recuperate and return to watching the videos compared with the control group (Table 2). All of these behaviors suggest a difficulty with sustained attention, one of the most significant markers of ADHD (Barkley, 1997)—in our case, sustaining focus while viewing academic material. A follow-up, prospective study is required to gain more accurate insights into the particular neuropsychological capabilities being reflected in the viewing patterns, as well as to provide clear links between these profiles and particular executive function skills and impairments.

We note that for large populations such as those considered here, a more severe significance value, alpha = .01, is sometimes applied. As evident from Table 2, most of the tested parameters remain significant even with alpha = .01.

Our age-dependant analysis suggests that at different age groups, adults without attention deficits view videos in different ways (Table 3B). Specifically, older students from the control group watched significantly longer sequences and perform fewer re-viewing of sequences. There were no similarly significant age-related differences in our study group. This may suggest that inattentiveness is pervasive, as part of the symptoms of ADHD, and remains a debilitating condition throughout adult life, as observed also by Biederman et al. (Biederman, Mick, & Faraone, 2000).

Similar conclusions can be drawn from our gender-based analysis. Gender had little effect on the ADHD group, but interestingly, it did for the control group; males from the control group viewed the videos differently than females (Table 3a). This is somewhat surprising: Past studies have shown that children and teens with ADHD of both sexes have equally poor attention skills (O'Brien, Dowell, Mostofsky, Denckla, & Mahone, 2010; Seidman et al., 2005). However, we know of no conclusive evidence of gender-based differences in the executive functions of non-ADHD adults. We believe that the differences recorded in the present study may be explained by lifestyle differences between adult men and women (e.g., women in the age groups monitored here may have more child caring responsibilities). These differences may be less noticeable in the presence of the stronger influence of ADHD in the study group. The features that we would expect to be most influenced by such differing lifestyles are the ones relating to the times of day that the videos were watched. These indeed show significant differences in study and control groups. Further study is required to better understand these findings.

Finally, it seems that both groups benefit from more academic experience. This is evident from the reduced number of times they viewed sequences, the shorter overlaps between sequences and more (Table 3C). This finding may be linked to past studies demonstrating that performance of executive function skills in ADHD patients may be improved with training (e.g., Klingberg et al., 2005).

Regarding the limitations of this study, being as it is a retrospective analysis, it involves several uncontrolled variables which may potentially influence our measurements and conclusions. These include the variety of diagnostic protocols used to assign participants to the ADHD study group and the community nature of the controls. The existence of comorbid conditions, unknown to us in this study, may also affect results. Finally, physiological and environmental influences may have also influenced the way the students viewed the videos (while tired or in a noisy room): Although those parameters were probably distributed equally between the study and control groups, they may have affected the study group to a greater extent.

In conclusion, this study presents a novel means for monitoring participants with attention deficits. It demonstrates that poor attention skills have a measurable effect on the daily activities, particularly the study habits, of those affected. Beyond providing important insights into their daily performance, this type of analysis can potentially give rise to early screening tools with several attractive features:

1. Screening for ADHD based on viewing logs is unobtrusive, requires no interruption in the daily activities of the participants being analyzed, and is objective and provides information gathered over long periods of time, as opposed to short, incidental tests that may be unreliable (Erdodi, Lajiness-O'Neill, & Saules, 2010). Students identified by such screening must, however, be referred for further diagnosis and guidance; the information collected by such monitoring provides, by its nature, an incomplete picture that must be completed by a trained specialist.
2. Screening based on video lessons can be applied to adults, thereby overcoming many challenges related to adult ADHD screening, such as reliance on self-reports (Barkley, Murphy, & Fischer, 2007). It remains to be seen whether the same screening can be applied to children by modifying the academic content.
3. Such monitoring is less expensive than existing systems for ADHD screening (Gordon et al., 2007; Leark, Greenberg, Kindschi, Dupuy, & Hughes, 2007; Luciana, 2003) because it requires no specialized hardware (Sumner, 2010; Teicher, Ito, Glod, & Barber, 1996) or trained, individual supervision.
4. The long-term nature of this monitoring makes it a potential tool for observing the effects of treatment regimens and educational interventions over time.
5. The monitoring described here may be applied to large populations to evaluate the age, gender, comorbid, and other effects of attention capabilities and deficits.

The video logs described herein provide a wealth of information, which is by no means exhausted by the present research. We plan to examine additional viewing parameters to evaluate how they are influenced by the presence of ADHD. Differences between student populations, courses, or study tracks also warrant further study. Because students have the option of using alternative sources of information other than the video lessons (e.g., written textbook material), the motivation for choosing to watch videos is also of interest and may in itself provide valuable insights into the students and their attention skills.

Prospective experiments can provide more accurate statistical models by controlling for the exact ADHD diagnosis applied to each student, ongoing treatments, and existing comorbid conditions. It may further yield a more accurate picture of the exact neuropsychological capabilities reflected in the viewing patters. Finally, we believe that this approach can potentially provide means for obtaining objective information on other neuropsychological disorders in nonclinical settings.

Declaration of Conflicting Interests

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