

Americans and the 2017 Eclipse

An initial report on public viewing of the August total solar eclipse

Jon D. Miller
University of Michigan

September 21, 2017

Americans and the 2017 Eclipse:

An initial report on public viewing of the August total solar eclipse

On August 21, 2017, a total solar eclipse crossed the United States from the west coast to the east coast, providing millions of Americans with the first opportunity to see a total solar eclipse in their life time. This experience represents an important stimulus to interest in our solar system and in cosmology broadly. It is important to understand how many American adults viewed the eclipse – in totality or partially – and what impact this experience has had on them.

As a part of an ongoing national study of the development of scientific literacy at the University of Michigan, NASA asked Jon Miller and his team to assess the impact of the August total solar eclipse in terms of the number of adults who viewed the event directly or on some form of electronic media and to estimate the impact of that experience on subsequent interest in and understanding of the solar system and related cosmology.

The University of Michigan/NASA cooperative study¹ of the development of civic scientific literacy is a three-wave study. In February and March of 2017 a national probability sample of 2,915 adults was selected² and asked a set of baseline questions designed to estimate their level of civic scientific literacy and their interest in and engagement with science and space-related matters. To assess the preparation for and viewing of the total solar eclipse on August 21, the same sample of adults were asked to complete a short questionnaire – online or by phone – describing their actual viewing experience and their activities in the months prior to the eclipse. This report will describe the initial findings from the baseline and immediate post-eclipse surveys.

A third survey will be conducted with the same individuals in October and November of 2017 to measure the science and eclipse-related activities that eclipse viewers engaged in during the months following the eclipse. The full impact of engagement in an event like the total solar eclipse is a combination of (1) the actual viewing experience, the preparation for eclipse viewing, and short-term discussion and engagement activities directly related to the viewing experience, and (2) subsequent science information seeking activities and the increased learning that comes from additional information acquisition and discussion with friends, family, and colleagues. A final report will be issued in January, 2018, summarizing the full impact of the viewing of the 2017 total solar eclipse.

¹ The 2017 Michigan Scientific Literacy Study is supported by a collaborative agreement between the University of Michigan and the National Aeronautics and Space Administration (award NNX16AC66A). The author gratefully acknowledges this support, but any errors or omissions are the responsibility of the author and not of NASA or any of its staff or officers.

² The data collection for the Michigan Study is conducted by AmeriSpeak, an address-based national probability sample of U.S. households operated by the National Opinion Research Center at the University of Chicago. AmeriSpeak uses a combination of online questionnaires and telephone surveys, reflecting the preference of each respondent. A complete description of the AmeriSpeak Panel and its sample can be found at: http://d3qi0qp55mx5f5.cloudfront.net/amerispeak/i/research/AmeriSpeak_Technical_Overview_2017_05_09.pdf?mtime=1494625611.

How many American adults viewed the total solar eclipse?

To obtain an accurate estimate of the viewership of the total solar eclipse, all of the adults that were surveyed in February and March were asked to complete a short follow-up survey about their experiences on August 21st. The online survey and telephone interviewing began on the evening of August 21st hours after the eclipse and continued through the end of Labor Day. This short window was used to assure more accurate recall by respondents. Of the original 2,925 baseline respondents, a total of 2,175 participants were reached and persuaded to participate in the immediate follow up – a response rate of 74% of the baseline sample.

A total of 154 million American adults – 62.8% of all adults age 18 or older – viewed the eclipse directly (see Table 1). An additional 61 million adults who did not see the eclipse directly viewed the eclipse electronically on a television, computer, tablet, or smart phone screen. Twelve percent of American adults – about 29 million – reported that they did not see the eclipse in person or electronically. A total 215 million American adults viewed the eclipse directly or electronically, or 88% of American adults.³

Table 1: Viewing of the total solar eclipse, 2017.

	Percent	Number*	N
Did not view the eclipse directly or electronically	12.0	29,425,000	261
Viewed the eclipse electronically, not directly	25.2	61,575,000	547
Viewed the eclipse directly in home town	54.7	134,025,000	1,191
Traveled to another city to view the eclipse	8.1	19,782,000	176
Total	100.0	244,807,000	2,175
* Population estimates are rounded to the nearest whole thousand.			

Although the total level of viewing directly and electronically is very high, it is important to ask whether some groups were significantly more likely to experience the eclipse than others. An analysis of some of the major demographic groups shows that there is no difference in the frequency of eclipse viewing by men and by women, but that there are small, but statistically significant, differences by age, education, and the degree of totality in an individual's home area (see Table 2).

Younger adults were slightly more likely to view the 2017 total solar eclipse directly than were older adults, but older adults were more likely to watch the event electronically than were young adults (see Table 2). When direct viewing and electronic viewing are combined, young adults were slightly more likely to have seen the eclipse than older adults. The gamma⁴ for this relationship is -0.17.

American adults with higher levels of formal education were more likely to have viewed the eclipse directly than were adults with less formal education. The differences were moderate – 11% of college graduates did not see the eclipse at all compared to 19% of adults who did not finish high school. Less well educated adults were more likely to have viewed the eclipse electronically than better educated

³ Comparatively, Nielsen reported that 111 million Americans watched the 2017 Super Bowl.

⁴ Gamma is an ordinal proportional reduction of error statistic and can be interpreted the same as a Pearson's r^2 . For a discussion of gamma and other PRE statistics, see Costner (1965).

adults (see Table 2). It is not clear whether this differential reflects a higher level of interest by better educated adults or a lack of job and time flexibility by less-well-educated adults. The gamma for this relationship is 0.19.

It is possible to compute the degree of totality for each respondent's city or area and the results indicate that adults who live closer to the path of totality were more likely to have viewed the eclipse directly (see Table 2). Slightly more than three-quarters of adults living in areas of 90% to 100% totality reported viewing the eclipse directly, compared to 54% of adults living in areas with less than 70% totality. Surprisingly, adults who live in areas of higher totality were more likely to reporting traveling to another

Table 2: Frequency of eclipse viewing, by selected demographic group, 2017.

	Did not view	Viewed electronically only	Viewed in-person in home area	Traveled to view in another area	N
All U.S. Adults	12%	25%	55%	8%	2,175
Gender					
Female	11	27	54	8	1,122
Male	13	23	55	9	1,052
Age					
18 to 29 years	10	22	58	10	464
30 to 39 years	12	18	62	8	371
40 to 49 years	10	20	60	10	358
50 to 59 years	14	26	52	8	388
60 to 69 years	13	32	49	6	350
70 or more years	15	39	41	5	242
Education					
Less than high school	19	28	40	13	155
High school graduate/GED	12	31	51	6	1,081
Associate degree	10	29	54	7	204
Baccalaureate	11	18	59	12	408
Graduate/professional degree	11	12	67	10	322
Degree of Totality					
Less than 70%	14	32	50	4	411
70% to 79%	16	30	46	8	562
80% to 89%	12	25	54	8	566
90% to 100%	7	16	67	10	634

area to improve their viewing experience. While this may seem counter intuitive, it suggests that individuals who live close to totality were willing to make the shorter trip than individuals living much farther away. In future analyses, we expect to use the available GIS information about each individual's address and the location from which they viewed the eclipse to quantify the travel distances involved.

The nature of the viewing experience

Seventy-five percent of the 154 million America adults who viewed the solar eclipse directly watched the event with other friends, family, or co-workers (see Table 3). Adults who viewed the eclipse in their home area were slightly more likely to have viewed it alone than those who traveled to another site. A third of Americans who viewed the eclipse directly reported that they watched along with co-workers, suggesting that the mid-day viewing occurred on a break from normal work activities. Thirty percent of viewers indicated that they viewed the eclipse with their spouse or partner, and 23% said that they watched the eclipse with their children or grandchildren. Only three percent of all viewers reported that they watched the eclipse as a part of group activity organized by a local astronomy group, planetarium, science center, or similar organization.

Seventy-four percent of adult viewers indicated that they used special solar glasses to observe the eclipse. Eighty-three percent of adults who traveled to another location to get a better view indicated that they used solar glasses (see Table 3).

A third of adult viewers reported that they photographed the eclipse or made a video recording of the event. About one in five adults who viewed the eclipse indicated that they posted a picture or commentary on social media to share the experience. Twenty-seven percent of adults who traveled to another location to view the eclipse reported posting their pictures or experiences on social media (see Table 3).

Most adult viewers of the eclipse characterized it as enjoyable and educational. When asked to agree or disagree with the statement “watching the eclipse was an enjoyable experience,” American adult viewers of the eclipse gave the experience a mean rating of 7.6 using a zero-to-10 scale. When asked to agree or disagree with the statement that “watching the eclipse was an educational experience,” the same adults gave a mean rating of 7.0 using a zero-to-10 scale (see Table 4).

When asked more specifically about learning more about “the Sun and the solar system” from watching the eclipse, the mean level of agreement dropped to 4.9 – just below the mid-point on a zero-to-10 scale (see Table 4). For a statement that they planned to “learn more about the Sun and the solar system in the near future,” the mean level of agreement dropped to 4.5 on the same zero-to-10 scale. These results suggest that many adults found the eclipse viewing experience to be enjoyable, but only a smaller proportion were stimulated to plan additional solar learning activities in the coming months.

Table 3: The August solar eclipse viewing experience, 2017.

	Used solar glasses	Made photo or video recording	Posted on social media	Viewed *						N
				Alone	With spouse or partner	With children or grandchild	With co-workers	With friends	At organized event	
All direct viewers	74%	34%	18%	24%	30%	23%	33%	29%	3%	1,366
Viewers in home area	73	34	17	27	29	23	32	29	3	1,191
Viewers in other area	83	38	27	9	37	22	37	30	5	175
* Note: The percentages will exceed 100% because a respondent may have viewed the eclipse with various combinations of viewers (i.e., spouse, children, and friends).										

Table 4: Mean viewer assessment of the 2017 viewing experience.

	All viewers	Viewed in home area	Traveled to view in another area
Watching the eclipse was an enjoyable experience.	7.6 _(0.07)	7.5 _(0.08)	8.1 _(0.19)
Watching the eclipse was an educational experience.	7.0 _(0.08)	6.9 _(0.09)	7.5 _(0.21)
I learned about the Sun and the solar system by watching the eclipse.	4.9 _(0.09)	4.9 _(0.10)	5.0 _(0.23)
I plan to learn more about the Sun and the solar system in the near future.	4.5 _(0.09)	4.5 _(0.10)	4.6 _(0.24)
Note: Cell entries are the mean score on a zero-to-10 scale, with zero representing complete disagreement with the statement and 10 meaning complete agreement with the statement. The standard error of the mean is shown in the subscript parentheses.			

What was the impact of prior understanding of an eclipse on actual viewing?

Half of American adults understood the meaning of a total solar eclipse six months prior to the August event. In the February-March baseline survey, each respondent was asked to provide an explanation of a total solar eclipse in an open-ended question and 49% of American adults were able to provide a scientifically correct answer. Were those adults who understood the idea of a total solar eclipse prior to the event more likely to view the eclipse than adults who did not have a prior understanding of an eclipse? The results of the 2017 Michigan study indicate that American adults who had a prior understanding of a total solar eclipse were slightly more likely to view the eclipse directly than were adults who did not have this understanding six months prior to the event (see Table 5).

A second measure of prior understanding uses a question about the relative position of the Earth and the Sun. This question has been asked of national probability samples of Americans since 1988 and is a component of Miller's Index of Civic Scientific Literacy (Miller, 1983, 1987, 1995, 1998, 2000, 2004, 2010a, 2010b, 2012; Miller, Pardo, & Niwa, 1997), but it is a useful stand-alone question because it demonstrates an understanding of the rotation of the Earth and the Sun. The first part of this question asks whether the Earth rotates⁵ around the Sun or the Sun rotates around the Earth. Those respondents who indicated that the Earth rotates around the Sun were then asked if the Earth rotates around the Sun once a day, once of month, or once a year. Individuals who were able to report that the Earth rotates around the Sun once a year are classified as having provided a correct response and all other responses are coded as incorrect. In early 2017, 62% of American adults were able to describe the relationship of the Earth and the Sun correctly.

American adults who understand the relationship of the Earth and the Sun were slightly more likely to view the August total solar eclipse directly than adults who did not understand this relationship. Sixty-

⁵ Some astrophysicists have observed that this statement implies that the Sun is stationary and that the Earth rotates around it. The authors of this question understand that our heliosphere is rotating around the center of a large spiral galaxy at a substantial speed and that none of these objects are stationary. Given the limits inherent in questionnaire wording, nearly 30 years of experience with this question leads us to conclude that most respondents do not think that it implies a stationary Sun and that those that might be confused often have a more fundamental misunderstanding of the solar system and the universe.

nine percent of adults who understand this relationship viewed the eclipse directly (at home or elsewhere) compared to 53% of adults who did understand this relationship. The gamma for this relationship is 0.25, meaning that 25% of the variance in viewing can be attributed to this form of prior understanding.

Table 5: The impact of prior understanding on the likelihood of viewing the 2017 eclipse.

	Did not view	Viewed electronically only	Viewed in-person in home area	Traveled to view in another area	N
All U.S. Adults	12%	25%	55%	8%	2,175
Understanding of total solar eclipse [G = 0.18]					
Incorrect	14	27	52	7	1,113
Correct	10	23	58	10	1,063
Understanding of Earth and Sun [G = 0.25]					
Incorrect	16	31	45	8	822
Correct	10	22	61	8	1,354
Civic Scientific Literacy [G = 0.29]					
Not scientifically literate	12	30	51	6	1,501
Scientifically literate	11	14	63	12	673

A third – and more comprehensive measure – of prior understanding is Miller’s Index of Civic Scientific Literacy (Miller, 1983, 1987, 1995, 1998, 2000, 2004, 2010a, 2010b, 2012; Miller, Pardo, & Niwa, 1997). The CSL Index is a measure of an individual’s understanding of a core set of scientific constructs – the nature of matter, energy, and life – and should be thought of as an indicator of an individual’s cognitive toolbox for reading and understanding quality science journalism. Approximately 30% of American adults age 18 and older qualify as civic scientific literate. American adults who are scientifically literate were more likely to view the eclipse directly (at home or elsewhere) than adults who are not scientifically literate (see Table 5). The gamma for this relationship is 0.29.

The strength of association between these three measures of prior understanding and subsequent viewing behavior was consistently positive and ranged from 0.18 to 0.29, indicating that some level of prior understanding serves as a foundation for thinking about a forthcoming event and enables an individual to know where and how to obtain additional information about an event – the total solar eclipse in this case – prior to the event or experience. This relationship has been documented in the informal science learning literature for several decades, but it has been observed more often in regard to an exhibit or staged event rather than a major natural event like the 2017 eclipse.

How did individuals prepare for viewing the 2017 solar eclipse?

The preceding analyses have outlined the magnitude of the public viewing experience on August 21 but it is useful to inquire about the level of information seeking and preparation in the months prior to the event. For several months prior to the August eclipse, NASA and a national coalition of informal science learning organizations worked to raise public awareness about the August eclipse and to improve public understanding of some of the safety issues involved in direct observation of the Sun. For future

programming efforts for similar natural and planned events, it is important to examine the kinds and frequency of information acquisition activities that interested adults used to improve their understanding of the forthcoming eclipse and related solar system questions.

Respondents to the post-eclipse survey were asked to identify the kinds of eclipse relevant information acquisition activities they engaged in and report how many times they engaged in each activity in the two months prior to the eclipse (see Table 6). The two most common activities – talking to one’s co-workers and family – involved interpersonal communication rather than broadcast or electronic media. Using

Table 6: Information acquisition activities in the months prior to the 2017 eclipse.

Information Acquisition Activity	All Viewers	Did not View	Viewed electronically only	Viewed in-person in home area	Traveled to view in another area
Talked to your friends or co-workers about the solar eclipse?	4.0	2.0	3.0	4.6	5.6
Talked to other members of my family about the solar eclipse?	2.7	1.2	2.1	3.1	3.9
Read a story about the solar eclipse in a newspaper or magazine (printed or online)?	2.3	0.9	1.8	2.6	3.5
Looked for information about solar eclipses on the Internet?	1.9	0.4	1.2	2.3	4.0
Talked to my children about solar eclipses?	1.4	0.5	0.8	1.7	2.2
Look for information about the solar eclipse at a public library (in person or online)	1.0	0.3	0.7	1.3	1.5
Watched a television show about solar eclipses?	0.7	0.2	0.7	0.8	0.7
Listened to a podcast about solar eclipses?	0.3	0.1	0.2	0.3	0.5
Printed or saved an Internet article or report about the solar eclipse?	0.2	0.1	0.1	0.3	0.6
Read a book (print or electronic) about solar eclipses?	0.1	0.1	0.1	0.2	0.2
Attended or streamed a lecture about solar eclipses?	0.1	0.0	0.1	0.1	0.2
Visited a planetarium or science center/museum to learn about solar eclipses?	0.1	0.0	0.0	0.1	0.1
Read or contributed to a blog about solar eclipses?	0.0	0.0	0.1	0.2	0.1
Mean number of eclipse information acquisition activities	15.0 _(0.38)	5.9 _(0.59)	10.9 _(0.58)	17.6 _(0.54)	23.6 _(1.77)
Note: Cell entries are the mean number of times survey respondents reported doing an eclipse-related information acquisition activity during the two months prior to the eclipse. The number of reported information acquisition activities ranged from zero to 132 for the two-month reporting period. The standard error of the mean is reported for only the total number of information acquisition activities and is shown in subscript parentheses.					

this two-month window, American adults reported an average of four conversations with friends and co-workers during the two months prior to the eclipse. More than 60 years ago, Katz and Lazarsfeld (1955) outlined the power of personal influence in a landmark study and these data confirm the continuing importance of interpersonal conversation in the development of interest and the sharing of information. The same adults reported an average of 2.7 conversations with other family members during the two months prior to the eclipse and 1.4 conversations or discussions with their children or grandchildren.

Newspaper and magazine stories (printed or online) were the third most frequent source of information about the forthcoming solar eclipse, with adults reporting that they read an average of 2.3 stories relevant to the eclipse during the two months prior to the event. During the same period, adults reported an average of 1.9 internet searches about the solar eclipse (see Table 6). These adults also reported using a public library (in-person or online) at least once during the two months prior to the eclipse. It is possible that some newspapers or magazines were consulted during library visits, but the granularity of the survey does not allow us to discern what kinds of materials were consulted or used.

In contrast, the adults in the 2017 eclipse follow-up study reported watching a television show about the solar eclipse slightly less than one time during the two months prior to the event. The use of podcasts, books (printed or electronic), lectures (attended or streamed), and reading or contributing to a blog was cited less often than once every two months (see Table 6). Few adults reported visiting a planetarium, science center/museum, or similar facility as a means to obtain information about the forthcoming solar eclipse.

When these information acquisition activities are combined, American adults engaged in an average of 15 information seeking activities in the two months prior to the eclipse. Those adults who eventually viewed the solar eclipse directly were more likely to have engaged in a larger number of information seeking activities than adults who saw the eclipse only on television or a computer or phone screen or who did not see it at all (see Table 6). Adults who traveled to see the eclipse in an area of higher totality reported an average of 23.6 information seeking activities prior to the eclipse, and individuals who watched the eclipse in their home city or area reported an average of 17.6 information seeking activities in the two months before the eclipse. In contrast, adults who did not see the eclipse at all reported only 5.9 information acquisition activities in the months prior to the event.

Conclusions and Implications

The first two waves of the 2017 Michigan Scientific Literacy Study finds that approximately 154 million American adults watched the total solar eclipse on August 21, 2017. An additional 61 million adults viewed the total solar eclipse on a television, computer, tablet, or smartphone screen (but not directly). This is a level of exposure that dwarfs the viewership of Super Bowl games and ranks among the most viewed events in American history.

Most of the adults who viewed the eclipse found it to be enjoyable and educational. Three-quarters of eclipse viewers obtained and used special solar viewing glasses. Most adults viewed the eclipse with friends, family, children, or co-workers. Nearly 20 million American adults traveled to a place other than their home city to improve their view of the eclipse and to increase the level of totality observed.

During the two months prior to the eclipse, millions of American adults engaged in a wide array of information seeking and acquisition activities to improve their understanding of the forthcoming event. The average American adult reported 15 information seeking activities in the months prior to the eclipse, and those adults who viewed it directly or who traveled to another location to improve their view reported even higher levels of eclipse-related information seeking prior to the event itself. In the October-November follow-up survey of these same individuals, we will explore in greater depth their post-eclipse

information seeking activities and any longer-term changes in their interest in science or space. We expect that the largest amount of information seeking activity will occur subsequent to the viewing of the eclipse, but it is important to examine and understand both pre-eclipse and post-eclipse information acquisition activities.

We hope that this baseline work and future measurements and analysis will be helpful to NASA and the informal science learning community in advancing our understanding of the development and maintenance of civic scientific literacy in the United States.

References

- Costner, Herbert L. 1965. Criteria for measures of association. *American Sociological Review* 30(3):341-53.
- Katz, Elihu, and Lazarsfeld, Paul. 1955. *Personal Influence*. Glencoe, Ill.: Free Press.
- Miller, Jon D. 1983. Scientific Literacy: A Conceptual and Empirical Review. *Daedalus*, 112(2):29-48.
- Miller, Jon D. 1987. Scientific Literacy in the United States. In, *Communicating Science to the Public*, David Evered and Maeve O'Connor (Eds.). London: Wiley. Pp. 19-40.
- Miller, Jon D. 1995. Scientific Literacy for Effective Citizenship. In, *Science/Technology/Society as Reform in Science Education*, Robert E. Yager (Ed.). New York: State University Press of New York. Pp. 185-204.
- Miller, Jon D. 1998. The Measurement of Civic Scientific Literacy. *Public Understanding of Science*, 7:1-21.
- Miller, Jon D. 2000. The Development of Civic Scientific Literacy in the United States. In, *Science, Technology, and Society: A Sourcebook on Research and Practice*, David D. Kumar and Daryl E. Chubin (Eds.). New York: Plenum Press. Pp. 21-47.
- Miller, Jon D. 2004. Public understanding of and attitudes toward scientific research: what we know and what we need to know. *Public Understanding of Science*, 13:273-294.
- Miller, Jon D. 2010a. The conceptualization and measurement of civic scientific literacy for the 21st century. In *Science and the Educated American: A core component of liberal education*, John G. Hildebrand and Jerrold Meinwald (Eds.). Cambridge, MA: American Academy of Arts and Sciences. Pp. 241-255.
- Miller, Jon D. 2010b. Adult science learning in the Internet era. *Curator*, 53(2):191-208.
- Miller, Jon D. 2012. The Sources and Impact of Civic Scientific Literacy. In, Bauer, M. W., Shukla, R. & Allum, N. (Eds.), *The Culture of Science: How the Public Relates to Science Across the Globe*. New York: Routledge. Pp. 217-240.
- Miller, Jon D., Rafael Pardo, and Fujio Niwa. 1997. *Public Perceptions of Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada*. Madrid: BBV Foundation Press.