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Supplemental Material

Short-Term Exposure to Wildfire Smoke and PM_{2.5} and Cognitive Performance in a Brain-Training Game: A Longitudinal Study of U.S. Adults

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Figure S13. Sensitivity of the observed associations between attention score and (A) PM_{2.5} in the western U.S., (B) PM_{2.5} in the contiguous U.S., and (C) smoke density in the western U.S. to the number of plays required in the user inclusion criteria (i.e., users who completed less than 20 plays). To allow for comparison, users still must have completed each play across unique dates (e.g., a user with 18 plays must have completed the plays across 18 unique dates).

References

Table S1. Change in attention score associated with a 10 $\mu\text{g}/\text{m}^3$ increase in daily and subdaily $\text{PM}_{2.5}$ for western and contiguous U.S. users. A *P*-value of 0.05 was used to determine statistical significance. Exposure metrics include the maximum population-weighted hourly average $\text{PM}_{2.5}$ in the 3, 6, and 12 hours prior to gameplay (3, 6, and 12-Hour Max) and the population-weighted daily average $\text{PM}_{2.5}$ in the 7 days prior to gameplay (Lags 0-6 and 7-Day Cumulative).

Exposure Metric	Western U.S. (n= 1,809)		Contiguous U.S. (n=10,228)	
	Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>
3-Hour Max	-41.66 (-69.72, -13.60)	0.0036	-20.99 (-38.66, -3.32)	0.020
6-Hour Max	-38.36 (-65.56, -11.16)	0.0057	-22.59 (-39.68, -5.49)	0.0096
12-Hour Max	-40.70 (-66.38, -15.03)	0.0019	-24.52 (-40.74, -8.30)	0.0031
Lag 0	-44.28 (-84.27, -4.28)	0.030	-26.41 (-47.90, -4.91)	0.016
Lag 1	31.83 (-21.24, 84.89)	0.24	-1.54 (-27.06, 23.98)	0.91
Lag 2	-38.15 (-91.28, 14.98)	0.16	-9.97 (-35.56, 15.63)	0.45
Lag 3	15.28 (-38.90, 69.46)	0.58	7.69 (-18.31, 33.69)	0.56
Lag 4	-1.2 (-54.95, 52.55)	0.97	-4.23 (-29.97, 21.50)	0.75
Lag 5	-28.46 (-81.69, 24.77)	0.29	-23.41 (-48.89, 2.07)	0.072
Lag 6	17.37 (-22.13, 56.86)	0.39	24.89 (3.34, 46.45)	0.024
7-Day Cumulative	-47.62 (-88.08, -7.17)	0.021	-32.97 (-62.51, -3.43)	0.029

Table S2. Change in attention score associated with a 10 $\mu\text{g}/\text{m}^3$ increase in daily and subdaily PM_{2.5} for western and contiguous U.S. users, overall and by age group, gender, and habitual behavior. A *P*-value of 0.05 was used to determine statistical significance. Exposure metrics include the maximum population-weighted hourly average PM_{2.5} in the 3 and 12 hours prior to gameplay (3 and 12-Hour Max), the population-weighted daily average PM_{2.5} the day of gameplay (Lag 0), and the cumulative population-weighted daily average PM_{2.5} in the 7 days prior to gameplay (7-Day Cumulative).^a

	# Users	3-Hour Max		12-Hour Max		Lag 0		7-Day Cumulative	
		Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>
Western U.S.									
All	1,809	-41.66 (-69.72, -13.60)	0.0036	-40.70 (-66.38, -15.03)	0.0019	-44.28 (-84.27, -4.28)	0.030	-47.62 (-88.08, -7.17)	0.021
<i>Age Group</i>									
18-29	147	-64.54 (-206.47, 77.39)	0.37	-81.09 (-210.82, 48.64)	0.22	5.45 (-191.57, 202.46)	0.96	-107.42 (-314.35, 99.51)	0.31
30-39	254	-32.60 (-112.31, 47.12)	0.42	1.05 (-72.55, 74.66)	0.98	-46.66 (-166.29, 72.97)	0.44	-30.71 (-143.92, 82.50)	0.59
40-49	276	-21.31 (-92.76, 50.13)	0.56	-18.43 (-81.92, 45.05)	0.57	-24.45 (-128.52, 79.61)	0.65	-19.03 (-121.58, 83.51)	0.72
50-59	457	-49.28 (-104.80, 6.24)	0.082	-61.88 (-113.03, -10.73)	0.018	-68.72 (-146.77, 9.32)	0.084	-66.15 (-148.21, 15.91)	0.11
60-69	427	-42.32 (-96.44, 11.79)	0.13	-49.15 (-98.64, 0.33)	0.052	-29.39 (-105.23, 46.46)	0.45	-30.26 (-107.21, 46.69)	0.44
≥70	248	-63.58 (-124.80, -2.37)	0.042	-59.54 (-116.46, -2.61)	0.040	-89.67 (-178.38, -0.96)	0.048	-71.40 (-164.54, 21.74)	0.13
<i>Gender</i>									
Male	559	-38.76 (-92.41, 14.88)	0.16	-49.52 (-97.80, -1.24)	0.044	-50.95 (-126.86, 24.97)	0.19	-55.15 (-134.39, 24.09)	0.17
Female	1,250	-43.49	0.0096	-37.62	0.015	-44.10	0.066	-48.58	0.044

		(-76.40, -10.59)		(-67.91, -7.32)		(-91.17, 2.98)		(-95.74, -1.41)	
<i>Habitual Behavior</i>									
Habitual	146	-114.82 (-210.96, -18.69)	0.019	-122.51 (-207.01, -38.00)	0.0045	-139.78 (-266.35, -13.21)	0.030	-125.67 (-256.73, 5.40)	0.060
Nonhabitual	1,663	-36.22 (-65.55, -6.88)	0.016	-34.19 (-61.11, -7.27)	0.013	-36.49 (-78.64, 5.66)	0.090	-40.24 (-82.78, 2.30)	0.064
Contiguous U.S. # Users									
All	10,228	-20.99 (-38.66, -3.32)	0.020	-24.52 (-40.74, -8.30)	0.0031	-26.41 (-47.90, -4.91)	0.016	-32.97 (-62.51, -3.43)	0.029
<i>Age Group</i>									
18-29	859	-4.97 (-83.73, 73.80)	0.900	-15.71 (-87.84, 56.42)	0.67	-40.55 (-138.12, 57.01)	0.42	-87.71 (-226.94, 51.52)	0.22
30-39	1,238	-16.38 (-71.15, 38.39)	0.56	-20.08 (-70.57, 30.40)	0.44	-28.73 (-95.31, 37.85)	0.400	-26.17 (-114.91, 62.56)	0.56
40-49	1,530	7.22 (-38.18, 52.62)	0.76	1.01 (-39.43, 41.44)	0.96	11.61 (-46.39, 69.62)	0.69	23.78 (-51.31, 98.87)	0.53
50-59	2,752	-36.13 (-69.65, -2.62)	0.035	-31.82 (-62.75, -0.89)	0.044	-34.29 (-74.47, 5.88)	0.094	-71.43 (-128.70, -14.16)	0.015
60-69	2,614	-22.29 (-54.61, 10.03)	0.18	-31.45 (-61.38, -1.53)	0.039	-22.92 (-61.60, 15.75)	0.25	-18.52 (-72.78, 35.74)	0.500
≥70	1,235	-41.94 (-86.09, 2.21)	0.063	-48.58 (-89.65, -7.50)	0.020	-57.22 (-111.80, -2.65)	0.040	-49.47 (-122.19, 23.25)	0.18
<i>Gender</i>									
Male	3,014	-24.34 (-58.16, 9.48)	0.16	-28.15 (-58.96, 2.66)	0.073	-50.59 (-92.42, -8.76)	0.018	-22.31 (-79.93, 35.30)	0.45
Female	7,214	-19.64 (-40.34, 1.06)	0.063	-23.06 (-42.13, -4.00)	0.018	-17.58 (-42.60, 7.44)	0.17	-37.99 (-72.34, -3.64)	0.030

<i>Habitual Behavior</i>									
Habitual	873	-49.01 (-110.43, 12.40)	0.12	-50.71 (-107.22, 5.80)	0.079	-91.53 (-164.42, -18.63)	0.014	-8.29 (-108.41, 91.82)	0.87
Nonhabitual	9,355	-18.68 (-37.13, -0.23)	0.047	-22.44 (-39.38, -5.50)	0.0094	-21.44 (-43.94, 1.05)	0.062	-34.46 (-65.37, -3.55)	0.029

^a Results for all daily and subdaily PM_{2.5} exposure metrics by age, gender, and habitual behavior in the western and contiguous U.S. can be viewed on the Dashboard (ehs-bccdc.shinyapps.io/PMSmoke_Attention_Dashboard/).

Table S3. Change in attention score associated with light, medium, or heavy density smoke, relative to no smoke, for western U.S. users, overall and by age group, gender, and habitual behavior. A *P*-value of 0.05 was used to determine statistical significance. Exposure metrics include the daily maximum smoke density the day of and day prior to gameplay (Lag 0 and Lag 1) and in the 1 week prior to gameplay (1-Week).

Group	Smoke Density	Lag 0		Lag 1		1-Week	
		Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>
All (n=1,809)	Light	16.01 (-51.69, 83.71)	0.64	-47.84 (-115.74, 20.06)	0.17	-49.91 (-109.18, 9.36)	0.099
	Medium	-111.53 (-220.26, -2.79)	0.044	-33.06 (-140.68, 74.55)	0.55	-10.40 (-97.25, 76.44)	0.81
	Heavy	7.20 (-107.84, 122.25)	0.90	-117.00 (-232.34, -1.66)	0.047	-119.30 (-212.24, -26.36)	0.012
Ages 18-29 (n=147)	Light	185.34 (-134.00, 504.68)	0.26	182.50 (-128.25, 493.25)	0.25	-62.55 (-323.40, 198.30)	0.64
	Medium	-433.84 (-916.27, 48.59)	0.078	393.98 (-111.06, 899.01)	0.13	-279.55 (-659.51, 100.41)	0.15
	Heavy	-142.21 (-678.02, 393.60)	0.60	-481.05 (-1005.71, 43.60)	0.072	-276.14 (-688.80, 136.52)	0.19
Ages 30-39 (n=254)	Light	40.73 (-150.71, 232.16)	0.68	-123.77 (-314.69, 67.15)	0.20	-34.45 (-202.74, 133.85)	0.69
	Medium	1.50 (-326.39, 329.38)	0.99	179.64 (-140.37, 499.66)	0.27	61.82 (-192.54, 316.17)	0.63
	Heavy	149.06 (-203.10, 501.22)	0.41	-143.73 (-494.88, 207.43)	0.42	-94.96 (-359.60, 169.68)	0.48
Ages 40-49 (n=276)	Light	-37.06 (-221.35, 147.24)	0.69	-50.67 (-235.14, 133.80)	0.59	-22.80 (-181.45, 135.85)	0.78
	Medium	-143.91 (-460.77, 172.94)	0.37	-193.08 (-507.18, 121.01)	0.23	-18.30 (-258.41, 221.82)	0.88

	Heavy	-132.49 (-452.11, 187.12)	0.42	-265.92 (-588.70, 56.86)	0.11	-261.33 (-519.56, -3.10)	0.047
Ages 50-59 (n=457)	Light	-2.64 (-135.94, 130.66)	0.97	-34.63 (-170.93, 101.66)	0.62	-35.80 (-155.75, 84.16)	0.56
	Medium	-140.19 (-349.29, 68.90)	0.19	-135.65 (-338.61, 67.32)	0.19	-60.52 (-229.62, 108.59)	0.48
	Heavy	112.40 (-109.36, 334.16)	0.32	-142.63 (-368.34, 83.08)	0.22	-132.84 (-314.30, 48.61)	0.15
Ages 60-69 (n=427)	Light	61.91 (-62.61, 186.43)	0.33	-109.31 (-233.31, 14.70)	0.084	-71.05 (-179.84, 37.74)	0.20
	Medium	-125.58 (-327.22, 76.07)	0.22	-82.05 (-279.36, 115.27)	0.42	118.41 (-42.30, 279.12)	0.15
	Heavy	-55.64 (-264.99, 153.71)	0.60	-52.28 (-258.24, 153.67)	0.62	-61.01 (-234.07, 112.05)	0.49
Ages \geq 70 (n=248)	Light	-59.14 (-212.62, 94.33)	0.45	-28.64 (-183.11, 125.82)	0.72	-47.56 (-183.76, 88.64)	0.49
	Medium	0.62 (-231.13, 232.36)	1.00	-103.36 (-342.41, 135.69)	0.40	-75.57 (-272.95, 121.81)	0.45
	Heavy	-16.53 (-270.42, 237.35)	0.90	63.41 (-194.59, 321.42)	0.63	-67.64 (-282.75, 147.47)	0.54
Male (n=559)	Light	-26.44 (-152.01, 99.13)	0.68	-94.72 (-220.07, 30.63)	0.14	-107.46 (-218.02, 3.10)	0.057
	Medium	-87.58 (-290.63, 115.48)	0.40	-120.03 (-322.58, 82.53)	0.25	-52.84 (-212.73, 107.05)	0.52
	Heavy	-109.06 (-328.89, 110.78)	0.33	-258.64 (-474.29, -43.00)	0.019	-247.55 (-420.79, -74.31)	0.0051
Female (n=1,250)	Light	29.33 (-51.00, 109.66)	0.47	-31.20 (-111.93, 49.53)	0.45	-27.07 (-97.25, 43.11)	0.45

	Medium	-114.50 (-243.23, 14.23)	0.081	6.91 (-120.09, 133.91)	0.92	14.57 (-88.85, 117.98)	0.78
	Heavy	55.64 (-79.29, 190.57)	0.42	-52.24 (-188.75, 84.26)	0.45	-63.04 (-173.07, 47.00)	0.26
Habitual (n=146)	Light	-62.01 (-275.52, 151.49)	0.57	11.78 (-206.95, 230.51)	0.92	-85.94 (-281.14, 109.26)	0.39
	Medium	-269.69 (-609.15, 69.76)	0.12	-18.22 (-354.98, 318.54)	0.92	0.08 (-273.72, 273.88)	1.00
	Heavy	-53.43 (-417.30, 310.45)	0.77	-193.45 (-567.29, 180.39)	0.31	-255.83 (-571.94, 60.29)	0.11
Nonhabitual (n=1,663)	Light	21.88 (-49.36, 93.11)	0.55	-54.23 (-125.57, 17.11)	0.14	-50.01 (-112.15, 12.14)	0.11
	Medium	-98.83 (-213.32, 15.65)	0.091	-39.56 (-152.88, 73.77)	0.49	-20.14 (-111.57, 71.29)	0.67
	Heavy	8.84 (-112.15, 129.82)	0.89	-111.90 (-232.98, 9.18)	0.07	-111.78 (-209.00, -14.56)	0.024

Table S4. Results for all sensitivity analyses of the associations between daily and subdaily PM_{2.5} and attention score for western and contiguous U.S. users. A *P*-value of 0.05 was used to determine statistical significance. Exposure metrics include the maximum population-weighted hourly average PM_{2.5} in the 3 and 12 hours prior to gameplay (3 and 12-Hour Max), the population-weighted daily average PM_{2.5} the day of gameplay (Lag 0), and the cumulative population-weighted daily average PM_{2.5} in the 7 days prior to gameplay (7-Day Cumulative).

		3-Hour Max		12-Hour Max		Lag 0		7-Day Cumulative	
		Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>
Western U.S.	Users								
<i>Raw vs. Percentile Score</i>									
Raw Score*	All (n=1,809)	-41.66 (-69.72, -13.60)	0.0036	-40.70 (-66.38, -15.03)	0.0019	-44.28 (-84.27, -4.28)	0.030	-47.62 (-88.08, -7.17)	0.021
Percentile Score	All (n=1,809)	-0.22 (-0.42, -0.02)	0.028	-0.22 (-0.40, -0.04)	0.018	-0.20 (-0.48, 0.09)	0.18	-0.33 (-0.61, -0.04)	0.026
<i># of Lags</i>									
1 Lag	All (n=1,809)	-	-	-	-	-35.00 (-62.51, -7.50)	0.013	-35.00 (-62.51, -7.50)	0.013
2 Lags	All (n=1,809)	-	-	-	-	-37.17 (-76.27, 1.93)	0.062	-34.08 (-64.04, -4.11)	0.026
3 Lags	All (n=1,809)	-	-	-	-	-43.15 (-82.96, -3.34)	0.034	-44.74 (-77.55, -11.93)	0.0075
4 Lags	All (n=1,809)	-	-	-	-	-43.58 (-83.52, -3.65)	0.032	-42.88 (-78.36, -7.39)	0.018
5 Lags	All (n=1,809)	-	-	-	-	-43.63 (-83.56, -3.70)	0.032	-48.08 (-85.62, -10.54)	0.012
6 Lags	All (n=1,809)	-	-	-	-	-43.36 (-83.31, -3.42)	0.033	-51.86 (-91.15, -12.57)	0.0097
7 Lags*	All (n=1,809)	-	-	-	-	-44.28 (-84.27, -4.28)	0.030	-47.62 (-88.08, -7.17)	0.021
<i>Habitual User Definition</i>									

7 days, 2 hours*	Habitual (n = 146)	-114.82 (-210.96, -18.69)	0.019	-122.51 (-207.01, -38.00)	0.0045	-139.78 (-266.35, -13.21)	0.030	-125.67 (-256.73, 5.40)	0.060
	Nonhabitual (n = 1,663)	-36.22 (-65.55, -6.88)	0.016	-34.19 (-61.11, -7.27)	0.013	-36.49 (-78.64, 5.66)	0.090	-40.24 (-82.78, 2.30)	0.064
7 days, 3 hours	Habitual (n = 146)	-34.22 (-88.86, 20.41)	0.22	-36.19 (-85.84, 13.46)	0.15	-54.23 (-128.74, 20.29)	0.15	-76.13 (-153.43, 1.17)	0.054
	Nonhabitual (n = 1,663)	-42.33 (-74.78, -9.88)	0.011	-40.69 (-70.42, -10.95)	0.0073	-40.67 (-87.44, 6.09)	0.088	-38.05 (-85.15, 9.04)	0.11
7 days, 4 hours	Habitual (n = 146)	-58.08 (-98.02, -18.14)	0.0044	-55.85 (-92.43, -19.27)	0.0028	-62.82 (-120.24, -5.40)	0.032	-93.74 (-152.24, -35.23)	0.0017
	Nonhabitual (n = 1,663)	-26.48 (-65.13, 12.17)	0.18	-26.64 (-61.96, 8.68)	0.14	-29.77 (-84.40, 24.87)	0.29	-16.03 (-71.31, 39.25)	0.57
14 days, 2 hours	Habitual (n = 146)	-114.44 (-207.73, -21.14)	0.016	-115.18 (-196.82, -33.54)	0.0057	-254.57 (-371.46, -137.69)	0.0002	-135.09 (-260.87, -9.30)	0.035
	Nonhabitual (n = 1,663)	-35.26 (-64.70, -5.81)	0.019	-33.67 (-60.71, -6.63)	0.015	-22.18 (-64.72, 20.37)	0.31	-38.15 (-80.88, 4.59)	0.080
<i>User Inclusion Criteria (# Unique Dates)</i>									
≥5 dates	All (n=7,543)	-18.40 (-36.52, -0.28)	0.047	-18.48 (-35.01, -1.95)	0.028	-24.06 (-49.88, 1.76)	0.068	-25.25 (-51.43, 0.93)	0.059
≥10 dates	All (n=6,216)	-23.92 (-42.43, -5.41)	0.011	-24.32 (-41.23, -7.41)	0.0048	-29.93 (-56.26, -3.60)	0.026	-31.20 (-57.94, -4.46)	0.022
≥15 dates	All (n=4,604)	-13.88 (-33.91, 6.15)	0.17	-14.15 (-32.46, 4.15)	0.13	-19.02 (-47.30, 9.27)	0.19	-23.78 (-52.45, 4.89)	0.10
20 dates*	All (n=1,809)	-41.66 (-69.72, -13.60)	0.0036	-40.70 (-66.38, -15.03)	0.0019	-44.28 (-84.27, -4.28)	0.030	-47.62 (-88.08, -7.17)	0.021
<i>User Inclusion Criteria (# Unique Plays)</i>									
≥5 plays	All (n=11,966)	5.65 (-9.45, 20.74)	0.46	3.09 (-10.77, 16.95)	0.66	2.71 (-19.71, 25.13)	0.81	1.57 (-19.27, 22.41)	0.88

≥10 plays	All (n=4,744)	-9.18 (-28.30, 9.94)	0.35	-9.49 (-27.02, 8.05)	0.29	-18.45 (-46.69, 9.79)	0.20	-11.83 (-38.30, 14.63)	0.38
≥15 plays	All (n=2,729)	-17.31 (-40.81, 6.18)	0.15	-16.47 (-37.97, 5.04)	0.13	-22.71 (-56.59, 11.18)	0.19	-14.04 (-47.40, 19.32)	0.41
20 plays*	All (n=1,809)	-41.66 (-69.72, -13.60)	0.0036	-40.70 (-66.38, -15.03)	0.0019	-44.28 (-84.27, -4.28)	0.030	-47.62 (-88.08, -7.17)	0.021
Covariate Model Specification									
No covariates, no interaction	All (n=1,809)	-44.3 (-71.71, -16.89)	0.0015	-42.53 (-67.61, -17.45)	0.00089	-46.86 (-86.47, -7.24)	0.020	-46.82 (-85.01, -8.62)	0.016
Covariates, no interaction	All (n=1,809)	-41.23 (-69.3, -13.16)	0.004	-40.14 (-65.82, -14.46)	0.0022	-44.78 (-84.74, -4.81)	0.028	-46.42 (-86.91, -5.92)	0.025
Covariates, interaction*	All (n=1,809)	-41.66 (-69.72, -13.60)	0.0036	-40.70 (-66.38, -15.03)	0.0019	-44.28 (-84.27, -4.28)	0.030	-47.62 (-88.08, -7.17)	0.021
Contiguous U.S. Users									
<i>Raw vs. Percentile Score</i>									
Raw Score*	All (n=10,228)	-20.99 (-38.66, -3.32)	0.020	-24.52 (-40.74, -8.30)	0.0031	-26.41 (-47.90, -4.91)	0.016	-32.97 (-62.51, -3.43)	0.029
Percentile Score	All (n=10,228)	-0.08 (-0.20, 0.05)	0.23	-0.10 (-0.22, 0.01)	0.088	-0.12 (-0.27, 0.03)	0.12	-0.20 (-0.40, 0.01)	0.067
# of Lags									
1 Lag	All (n=10,228)	-	-	-	-	-29.32 (-47.16, -11.48)	0.0013	-29.32 (-47.16, -11.48)	0.0013
2 Lags	All (n=10,228)	-	-	-	-	-26.04 (-47.51, -4.56)	0.017	-32.07 (-52.52, -11.61)	0.0021
3 Lags	All (n=10,228)	-	-	-	-	-26.38 (-47.87, -4.89)	0.016	-35.76 (-58.52, -13.00)	0.0021
4 Lags	All (n=10,228)	-	-	-	-	-26.41 (-47.90, -4.91)	0.016	-34.76 (-59.71, -9.80)	0.0063

5 Lags	All (n=10,228)	-	-	-	-	-26.34 (-47.84, -4.85)	0.016	-39.23 (-66.04, -12.42)	0.0041
6 Lags	All (n=10,228)	-	-	-	-	-26.20 (-47.70, -4.70)	0.017	-42.69 (-71.00, -14.38)	0.0031
7 Lags*	All (n=10,228)	-	-	-	-	-26.41 (-47.90, -4.91)	0.016	-32.97 (-62.51, -3.43)	0.029
<i>Habitual User Definition</i>									
7 days, 2 hours*	Habitual (n=873)	-49.01 (-110.43, 12.40)	0.12	-50.71 (-107.22, 5.80)	0.079	-91.53 (-164.42, -18.63)	0.014	-8.29 (-108.41, 91.82)	0.87
	Nonhabitual (n=9,355)	-18.68 (-37.13, -0.23)	0.047	-22.44 (-39.38, -5.50)	0.0094	-21.44 (-43.94, 1.05)	0.062	-34.46 (-65.37, -3.55)	0.029
7 days, 3 hours	Habitual (n=873)	-20.24 (-57.22, 16.74)	0.28	-18.01 (-52.24, 16.23)	0.30	-45.38 (-90.07, -0.69)	0.047	-1.13 (-61.80, 59.54)	0.97
	Nonhabitual (n=9,355)	-20.77 (-40.86, -0.68)	0.043	-25.87 (-44.28, -7.46)	0.0059	-21.86 (-46.34, 2.62)	0.080	-40.16 (-73.93, -6.40)	0.02
7 days, 4 hours	Habitual (n=873)	-28.02 (-54.10, -1.93)	0.035	-33.58 (-57.41, -9.75)	0.0057	-45.11 (-77.05, -13.17)	0.0056	-36.84 (-81.01, 7.34)	0.10
	Nonhabitual (n=9,355)	-15.11 (-38.96, 8.74)	0.21	-17.42 (-39.40, 4.55)	0.12	-13.84 (-42.72, 15.03)	0.35	-28.69 (-68.24, 10.87)	0.16
14 days, 2 hours	Habitual (n=873)	-44.15 (-102.41, 14.10)	0.14	-43.61 (-97.28, 10.06)	0.11	-121.24 (-189.23, -53.26)	0.00047	-1.27 (-95.29, 92.74)	0.98
	Nonhabitual (n=9,355)	-18.83 (-37.38, -0.28)	0.047	-22.84 (-39.86, -5.81)	0.0086	-17.08 (-39.74, 5.59)	0.14	-35.69 (-66.80, -4.57)	0.025
<i>User Inclusion Criteria (# Unique Dates)</i>									
≥5 dates	All (n=38,994)	-8.05 (-19.47, 3.36)	0.17	-9.54 (-20.02, 0.94)	0.074	-11.81 (-25.79, 2.18)	0.098	-14.73 (-33.82, 4.37)	0.13
≥10 dates	All (n=32,610)	-9.64 (-21.32, 2.03)	0.11	-11.54 (-22.25, -0.82)	0.035	-13.81 (-28.08, 0.46)	0.058	-19.97 (-39.46, -0.47)	0.045

≥15 dates	All (n=24,408)	-8.62 (-21.21, 3.98)	0.18	-11.37 (-22.95, 0.20)	0.054	-9.64 (-25.01, 5.73)	0.22	-19.82 (-40.73, 1.10)	0.063
20 dates*	All (n=10,228)	-20.99 (-38.66, -3.32)	0.020	-24.52 (-40.74, -8.30)	0.0031	-26.41 (-47.90, -4.91)	0.016	-32.97 (-62.51, -3.43)	0.029
<i>User Inclusion Criteria (# Unique Plays)</i>									
≥6 plays	All (n=51,035)	-4.99 (-15.32, 5.34)	0.34	-6.82 (-16.36, 2.72)	0.16	-4.25 (-17.13, 8.63)	0.52	-8.45 (-24.96, 8.05)	0.32
≥10 plays	All (n=26,429)	-15.84 (-28.13, -3.54)	0.012	-16.53 (-27.85, -5.21)	0.0042	-18.92 (-34.19, -3.65)	0.015	-17.65 (-37.41, 2.12)	0.080
≥15 plays	All (n=15,305)	-22.65 (-37.51, -7.79)	0.0028	-23.50 (-37.17, -9.83)	0.00076	-20.91 (-39.13, -2.69)	0.024	-25.12 (-49.62, -0.62)	0.044
20 plays*	All (n=10,228)	-20.99 (-38.66, -3.32)	0.020	-24.52 (-40.74, -8.30)	0.0031	-26.41 (-47.90, -4.91)	0.016	-32.97 (-62.51, -3.43)	0.029
<i>Covariate Model Specification</i>									
No covariates, no interaction	All (n=10,228)	-28.4 (-45.78, - 11.03)	0.0014	-27.13 (-43.06, -11.19)	0.00085	-22.83 (-43.72, -1.94)	0.032	-30.27 (-58.39, -2.15)	0.035
Covariates, no interaction	All (n=10,228)	-20.84 (-38.52, - 3.17)	0.021	-24.37 (-40.6, -8.14)	0.0033	-26.22 (-47.71, -4.72)	0.017	-31.98 (-61.55, -2.4)	0.034
Covariates, interaction*	All (n=10,228)	-20.99 (-38.66, -3.32)	0.020	-24.52 (-40.74, -8.30)	0.0031	-26.41 (-47.90, -4.91)	0.016	-32.97 (-62.51, -3.43)	0.029

* Results from the primary analyses

Table S5. Results for all sensitivity analyses of the associations between smoke density and attention score for western U.S. users. A *P*-value of 0.05 was used to determine statistical significance. Exposure metrics include the daily maximum smoke density the day of and day prior to gameplay (Lag 0 and Lag 1) and in the 1 week prior to gameplay (1-Week).

	Users	Smoke Density	Lag 0		Lag 1		1-Week	
			Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>	Beta (95% CI)	<i>P</i>
<i>Raw vs. Percentile Score</i>								
Raw Score*	All (n=1,809)	Light	16.01 (-51.69, 83.71)	0.64	-47.84 (-115.74, 20.06)	0.17	-49.91 (-109.18, 9.36)	0.099
		Medium	-111.53 (-220.26, -2.79)	0.044	-33.06 (-140.68, 74.55)	0.55	-10.40 (-97.25, 76.44)	0.81
		Heavy	7.20 (-107.84, 122.25)	0.90	-117.00 (-232.34, -1.66)	0.047	-119.30 (-212.24, -26.36)	0.012
Percentile Score	All (n=1,809)	Light	0.09 (-0.40, 0.57)	0.73	-0.22 (-0.70, 0.26)	0.38	-0.25 (-0.67, 0.17)	0.24
		Medium	-0.82 (-1.59, -0.04)	0.038	-0.03 (-0.80, 0.73)	0.93	-0.17 (-0.79, 0.45)	0.59
		Heavy	0.05 (-0.77, 0.87)	0.91	-0.79 (-1.61, 0.03)	0.059	-0.83 (-1.48, -0.17)	0.014
<i>Habitual User Definition</i>								
7 days, 2 hours*	Habitual (n = 146)	Light	-62.01 (-275.52, 151.49)	0.57	11.78 (-206.95, 230.51)	0.92	-85.94 (-281.14, 109.26)	0.39
		Medium	-269.69 (-609.15, 69.76)	0.12	-18.22 (-354.98, 318.54)	0.92	0.08 (-273.72, 273.88)	1.00
		Heavy	-53.43 (-417.30, 310.45)	0.77	-193.45 (-567.29, 180.39)	0.31	-255.83 (-571.94, 60.29)	0.11
	Nonhabitual (n = 1,663)	Light	21.88 (-49.36, 93.11)	0.55	-54.23 (-125.57, 17.11)	0.14	-50.01 (-112.15, 12.14)	0.11
		Medium	-98.83 (-213.32, 15.65)	0.091	-39.56 (-152.88, 73.77)	0.49	-20.14 (-111.57, 71.29)	0.67
		Heavy	8.84	0.89	-111.90	0.07	-111.78	0.024

			(-112.15, 129.82)		(-232.98, 9.18)		(-209.00, -14.56)	
7 days, 3 hours	Habitual (n = 146)	Light	17.36 (-115.38, 150.10)	0.8	-87.33 (-218.47, 43.80)	0.19	-70.92 (-189.74, 47.90)	0.24
		Medium	-229.07 (-440.41, -17.73)	0.034	-43.68 (-244.59, 157.22)	0.67	-81.11 (-251.36, 89.14)	0.35
		Heavy	-158.87 (-379.37, 61.64)	0.16	-330.34 (-557.88, -102.79)	0.0044	-284.28 (-470.08, -98.48)	0.0027
	Nonhabitual (n = 1,663)	Light	12.97 (-65.08, 91.02)	0.74	-38.77 (-117.35, 39.81)	0.33	-47.85 (-115.84, 20.14)	0.17
		Medium	-79.13 (-204.76, 46.49)	0.22	-35.29 (-161.10, 90.53)	0.58	1.04 (-99.21, 101.29)	0.98
		Heavy	46.13 (-87.28, 179.53)	0.50	-68.89 (-201.72, 63.95)	0.31	-84.13 (-190.84, 22.58)	0.12
7 days, 4 hours	Habitual (n = 146)	Light	29.40 (-67.21, 126.01)	0.55	-20.52 (-115.35, 74.31)	0.67	-20.89 (-107.34, 65.56)	0.64
		Medium	-153.51 (-308.29, 1.28)	0.052	-20.33 (-170.39, 129.74)	0.79	-13.57 (-139.89, 112.74)	0.83
		Heavy	-55.95 (-216.02, 104.13)	0.49	-152.58 (-316.72, 11.57)	0.068	-156.11 (-290.85, -21.37)	0.023
	Nonhabitual (n = 1,663)	Light	3.48 (-89.36, 96.32)	0.94	-67.79 (-162.31, 26.72)	0.16	-70.11 (-150.37, 10.14)	0.087
		Medium	-83.24 (-232.58, 66.09)	0.27	-49.55 (-199.62, 100.52)	0.52	-14.06 (-131.82, 103.70)	0.81
		Heavy	51.32 (-109.34, 211.98)	0.53	-103.47 (-262.01, 55.08)	0.20	-102.59 (-228.94, 23.76)	0.11
14 days, 2 hours	Habitual (n = 146)	Light	-18.85 (-219.89, 182.19)	0.85	-46.62 (-252.69, 159.44)	0.66	-146.07 (-328.62, 36.48)	0.12
		Medium	-182.83 (-505.49, 139.84)	0.27	15.60 (-304.78, 335.97)	0.92	-43.85 (-301.01, 213.31)	0.74
		Heavy	-144.45	0.41	-355.80	0.049	-336.25	0.027

			(-489.94, 201.05)		(-710.58, -1.02)		(-634.42, -38.09)	
	Nonhabitual (n = 1,663)	Light	19.07 (-52.71, 90.85)	0.60	-49.49 (-121.33, 22.36)	0.18	-44.91 (-107.54, 17.72)	0.16
		Medium	-104.55 (-219.84, 10.73)	0.075	-45.70 (-159.79, 68.38)	0.43	-17.80 (-109.95, 74.35)	0.70
		Heavy	20.85 (-100.95, 142.65)	0.74	-94.77 (-216.64, 27.09)	0.13	-104.44 (-202.28, -6.60)	0.036
<i>User Inclusion Criteria (# Unique Dates)</i>								
≥5 dates	All (n=7,543)	Light	39.83 (-3.75, 83.42)	0.073	13.96 (-29.40, 57.32)	0.53	10.07 (-27.78, 47.93)	0.60
		Medium	-19.41 (-90.32, 51.50)	0.59	49.49 (-21.11, 120.10)	0.17	23.63 (-32.48, 79.74)	0.41
		Heavy	31.95 (-44.62, 108.52)	0.41	-68.17 (-144.50, 8.15)	0.08	-33.96 (-94.72, 26.80)	0.27
≥10 dates	All (n=6,21,6)	Light	26.06 (-18.39, 70.51)	0.25	8.94 (-35.38, 53.26)	0.69	14.82 (-23.80, 53.44)	0.45
		Medium	-36.73 (-109.34, 35.88)	0.32	38.58 (-33.70, 110.87)	0.30	15.24 (-42.06, 72.54)	0.60
		Heavy	18.39 (-59.48, 96.26)	0.64	-73.46 (-150.99, 4.08)	0.063	-46.60 (-108.44, 15.24)	0.14
≥15 dates	All (n=4,604)	Light	26.19 (-21.09, 73.48)	0.28	-0.80 (-48.06, 46.46)	0.97	-7.92 (-49.04, 33.20)	0.71
		Medium	-62.55 (-139.65, 14.56)	0.11	36.30 (-40.84, 113.43)	0.36	-1.97 (-63.02, 59.08)	0.95
		Heavy	88.91 (6.43, 171.38)	0.035	-46.45 (-128.31, 35.41)	0.27	-47.41 (-112.88, 18.05)	0.16
20 dates*	All (n=1,809)	Light	16.01 (-51.69, 83.71)	0.64	-47.84 (-115.74, 20.06)	0.17	-49.91 (-109.18, 9.36)	0.099
		Medium	-111.53	0.044	-33.06	0.55	-10.40	0.81

			(-220.26, -2.79)		(-140.68, 74.55)		(-97.25, 76.44)	
		Heavy	7.20 (-107.84, 122.25)	0.90	-117.00 (-232.34, -1.66)	0.047	-119.30 (-212.24, -26.36)	0.012
<i>User Inclusion Criteria</i> (# Unique Plays)								
≥5 plays	All (n=11,966)	Light	16.12 (-23.86, 56.09)	0.43	-15.23 (-55.14, 24.69)	0.45	0.37 (-33.49, 34.22)	0.98
		Medium	-21.20 (-84.77, 42.38)	0.51	-11.87 (-75.48, 51.73)	0.71	-11.17 (-61.41, 39.06)	0.66
		Heavy	38.39 (-29.76, 106.53)	0.27	21.72 (-46.13, 89.57)	0.53	-46.34 (-99.70, 7.02)	0.089
≥10 plays	All (n=4,744)	Light	6.21 (-42.93, 55.35)	0.80	8.92 (-40.35, 58.20)	0.72	-14.63 (-56.66, 27.39)	0.49
		Medium	-60.56 (-138.17, 17.04)	0.13	-39.07 (-117.26, 39.12)	0.33	-33.17 (-94.89, 28.54)	0.29
		Heavy	11.23 (-71.74, 94.19)	0.79	-0.11 (-82.97, 82.75)	1.00	-77.48 (-143.32, -11.65)	0.021
≥15 plays	All (n=2,729)	Light	18.72 (-40.05, 77.50)	0.53	8.57 (-50.41, 67.55)	0.78	-34.39 (-84.92, 16.14)	0.18
		Medium	-62.30 (-155.49, 30.89)	0.19	-37.40 (-130.65, 55.85)	0.43	-5.99 (-80.13, 68.15)	0.87
		Heavy	73.88 (-25.02, 172.78)	0.14	-4.74 (-103.39, 93.91)	0.92	-73.08 (-151.88, 5.73)	0.069
20 plays*	All (n=1,809)	Light	16.01 (-51.69, 83.71)	0.64	-47.84 (-115.74, 20.06)	0.17	-49.91 (-109.18, 9.36)	0.099
		Medium	-111.53 (-220.26, -2.79)	0.044	-33.06 (-140.68, 74.55)	0.55	-10.40 (-97.25, 76.44)	0.81
		Heavy	7.20 (-107.84, 122.25)	0.90	-117.00 (-232.34, -1.66)	0.047	-119.30 (-212.24, -26.36)	0.012

<i>Covariate Model Specification</i>								
No covariates, no interaction	All (n=1,809)	Light	16.68 (-49.03, 82.38)	0.62	-42.86 (-108.88, 23.17)	0.20	-36.7 (-93.01, 19.6)	0.20
		Medium	-120.89 (-227.02, -14.76)	0.026	-29.87 (-135.13, 75.4)	0.58	-6.84 (-90, 76.32)	0.87
		Heavy	-5.03 (-115.06, 105.01)	0.93	-106.26 (-217.11, 4.6)	0.060	-107.21 (-192.59, -21.82)	0.014
Covariates, no interaction	All (n=1,809)	Light	15.08 (-52.6, 82.76)	0.66	-46.94 (-114.83, 20.95)	0.18	-50.49 (-109.78, 8.79)	0.095
		Medium	-108.75 (-217.46, -0.04)	0.050	-31.02 (-138.61, 76.58)	0.57	-9.64 (-96.54, 77.25)	0.83
		Heavy	8.91 (-106.2, 124.03)	0.88	-114.07 (-229.49, 1.35)	0.053	-117.36 (-210.44, -24.29)	0.013
Covariates, interaction*	All (n=1,809)	Light	16.01 (-51.69, 83.71)	0.64	-47.84 (-115.74, 20.06)	0.17	-49.91 (-109.18, 9.36)	0.099
		Medium	-111.53 (-220.26, -2.79)	0.044	-33.06 (-140.68, 74.55)	0.55	-10.40 (-97.25, 76.44)	0.81
		Heavy	7.20 (-107.84, 122.25)	0.90	-117.00 (-232.34, -1.66)	0.047	-119.30 (-212.24, -26.36)	0.012

* Results from the primary analyses

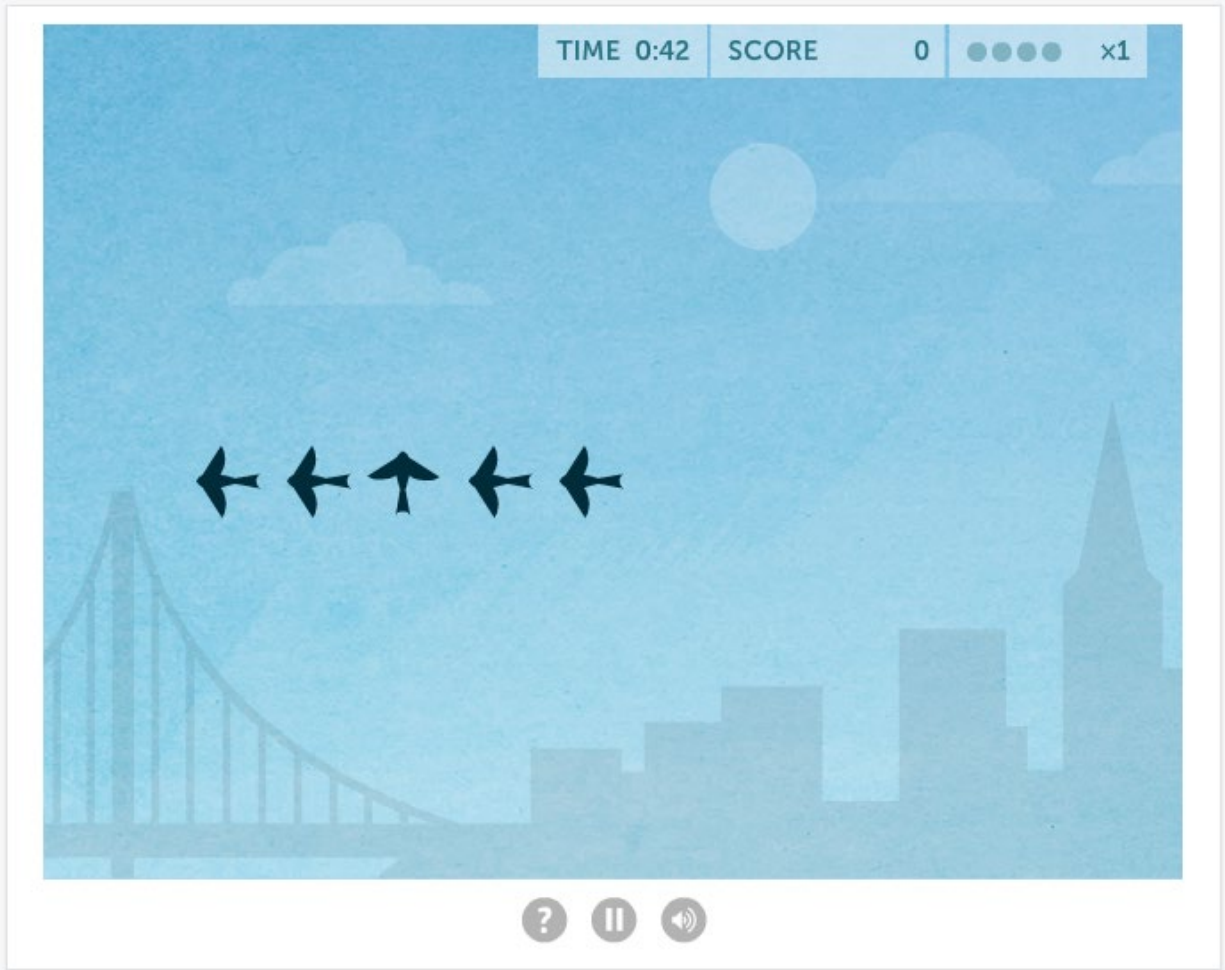


Figure S1. Screenshot showing the appearance of the *Lost in Migration* game.¹ In this example, the center bird is flanked by four other birds oriented in a different direction.

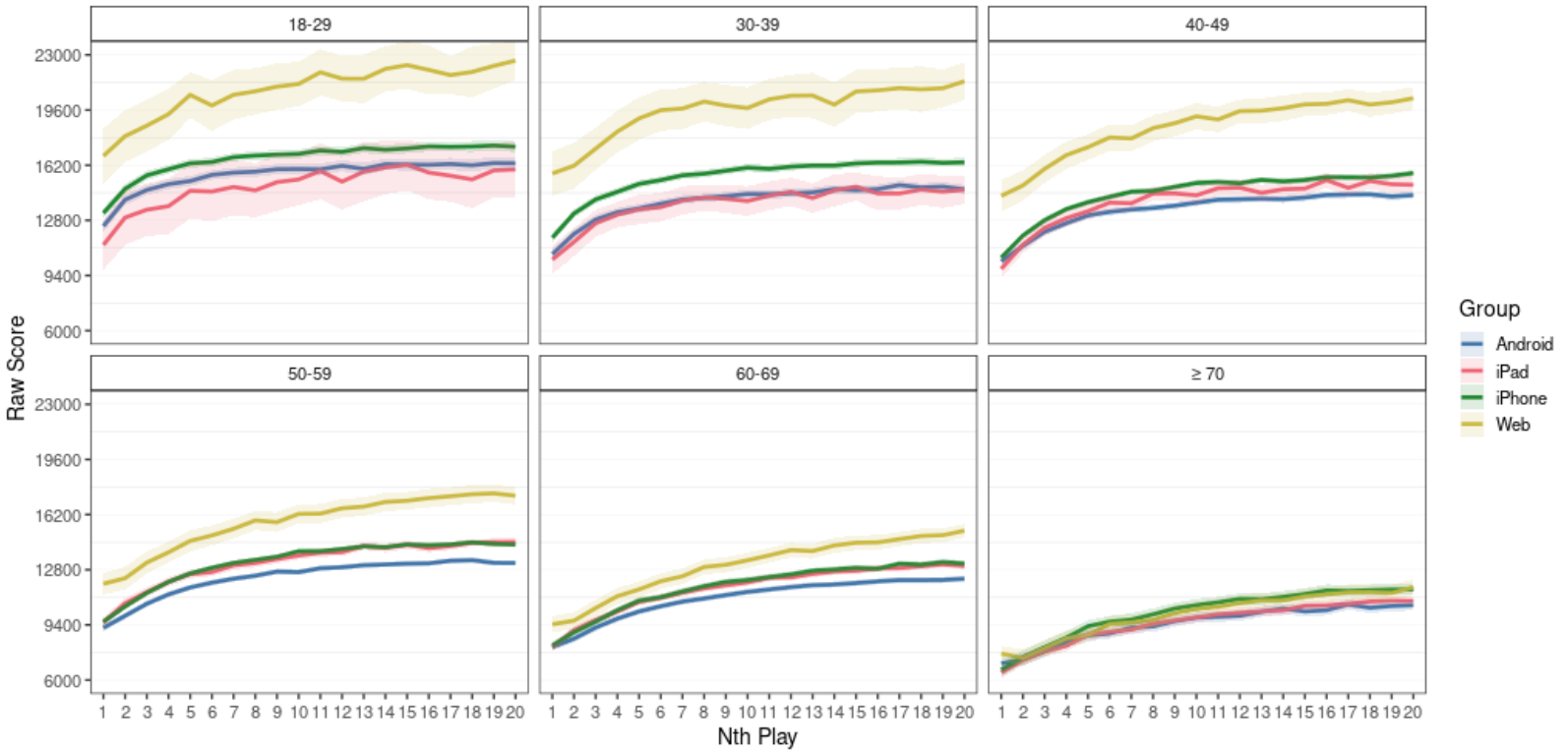


Figure S2. Average learning curves (95% CI) across 20 plays of *Lost in Migration* for contiguous U.S. users by age group and device. Learning curves for other subgroup combinations in the western and contiguous U.S. can be viewed on the Dashboard (ehs-bccdc.shinyapps.io/PMSmoke_Attention_Dashboard/).

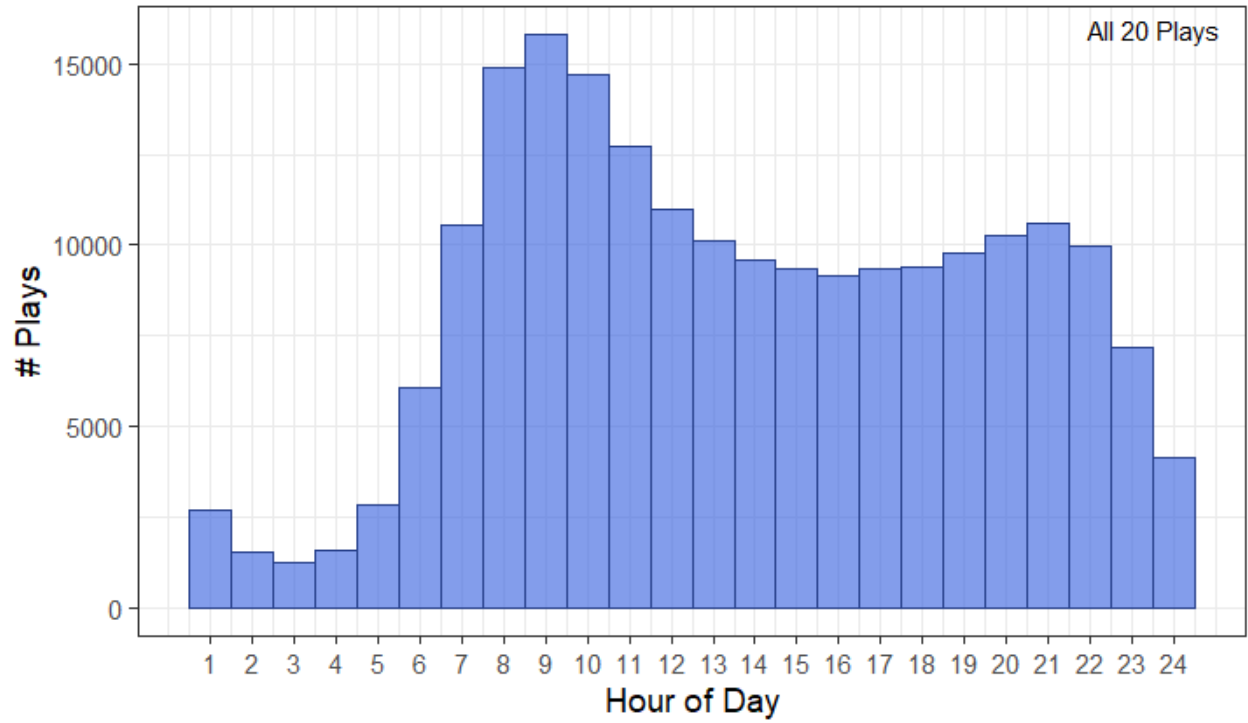


Figure S3. Distribution of the time of day played for all 20 plays of the contiguous U.S. study population.

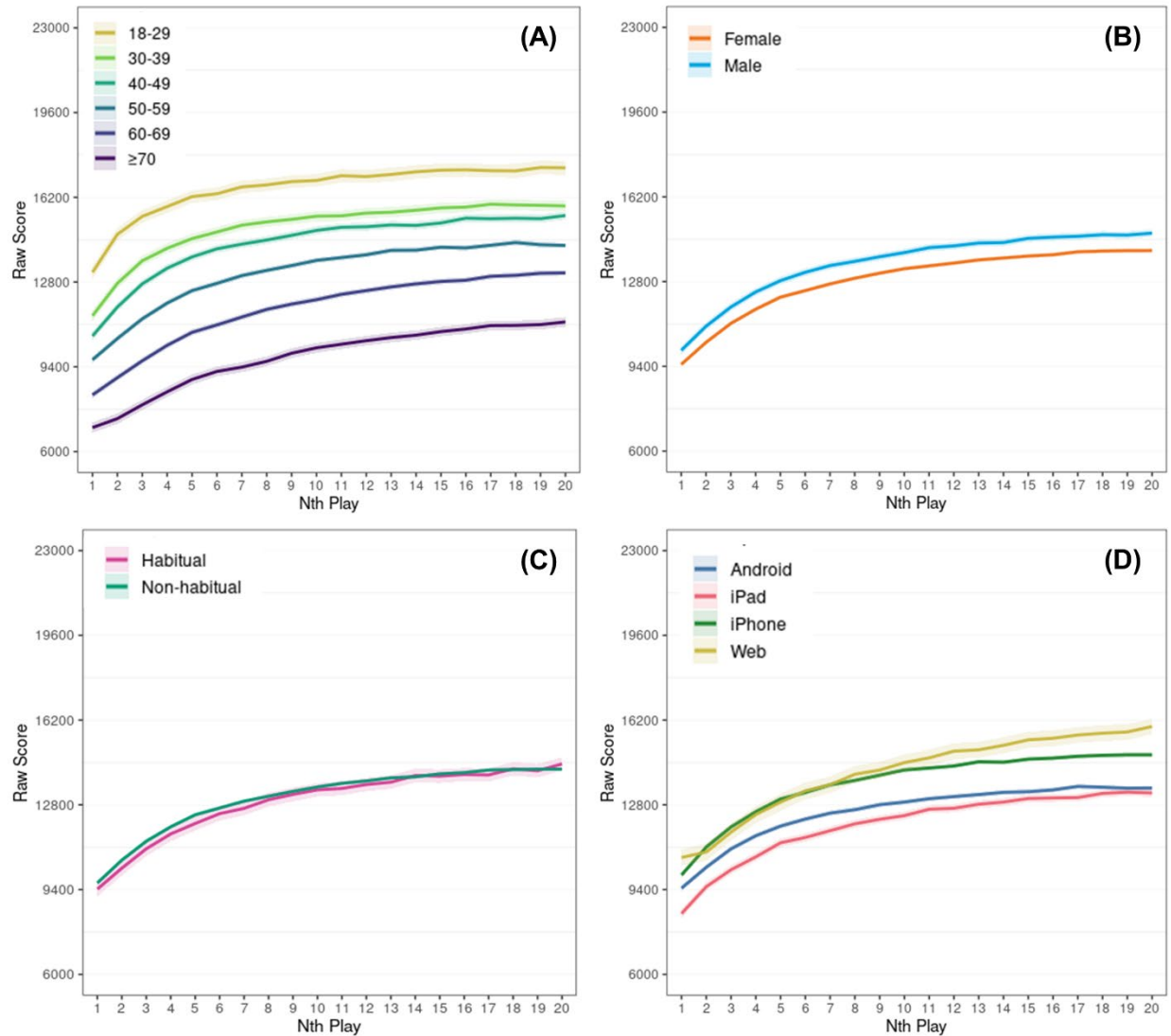


Figure S4. Average learning curves (95% CI) across 20 plays of *Lost in Migration* for contiguous U.S. users by (A) age group, (B) gender, (C) habitual behavior, and (D) device. Learning curves for western U.S. user subgroups can be viewed on the Dashboard (ehs-bccdc.shinyapps.io/PMSmoke_Attention_Dashboard/).

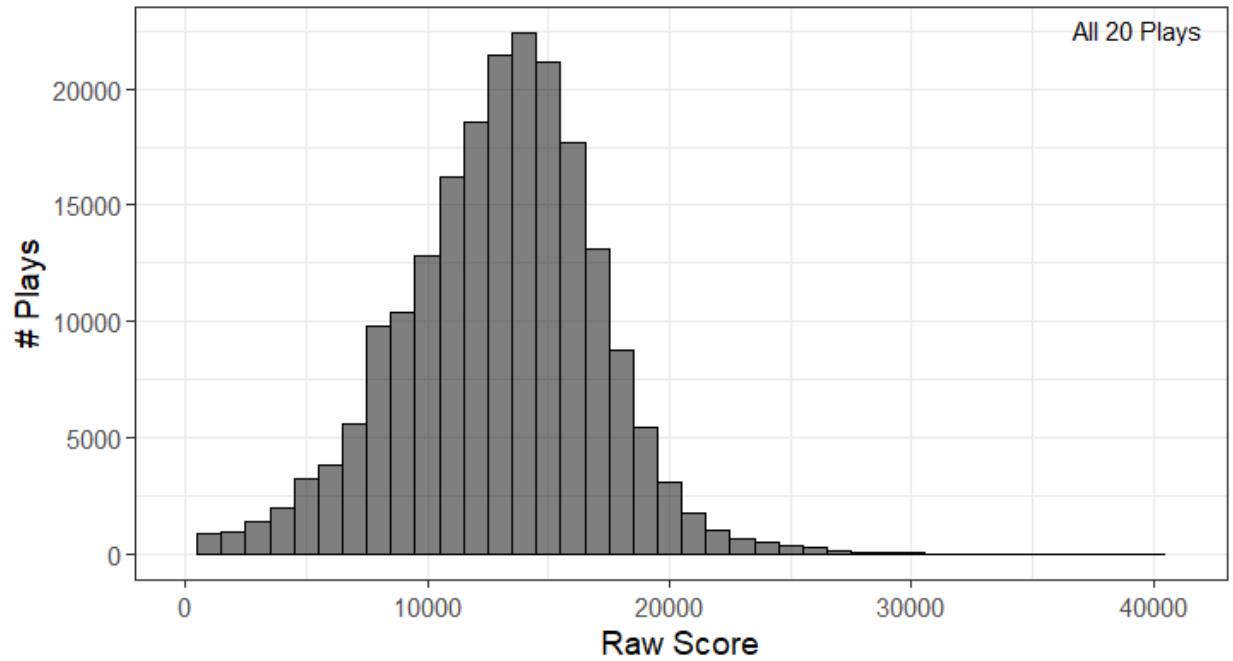


Figure S5. Distribution of the attention scores for all 20 plays of the contiguous U.S. study population. Score distributions for the western U.S. study population, different user subgroups, and specific plays can be viewed on the Dashboard (ehs-bccdc.shinyapps.io/PMSmoke_Attention_Dashboard/).

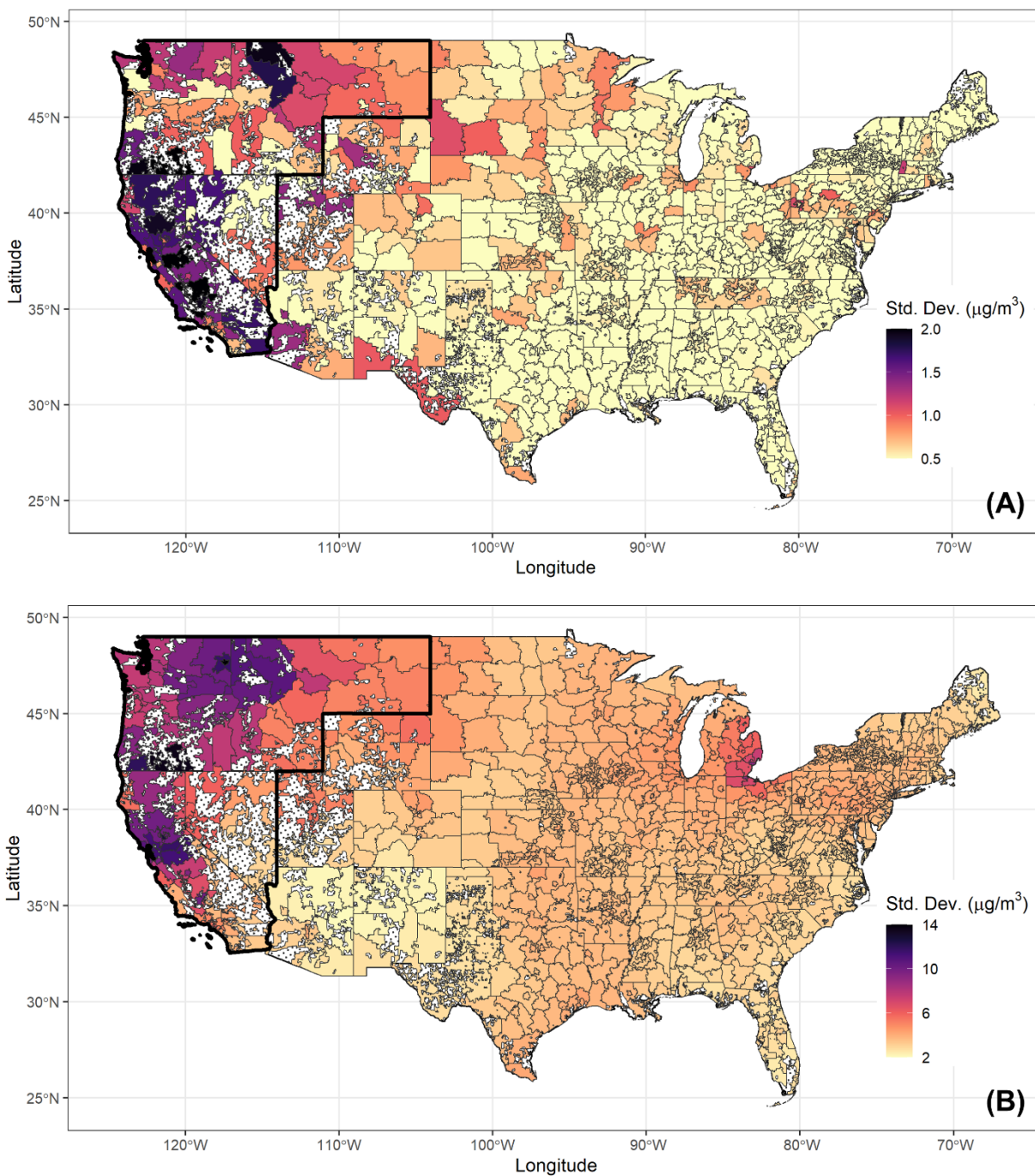


Figure S6. Maps of the (A) spatial and (B) temporal variability of daily $\text{PM}_{2.5}$ across the contiguous U.S. Spatial variability was calculated as the average of the standard deviation of census tract-level daily average $\text{PM}_{2.5}$ concentrations across each ZIP3 between 2017-2018. Temporal variability was calculated as the standard deviation of the ZIP3-level population-weighted daily average $\text{PM}_{2.5}$ concentrations between 2017-2018.

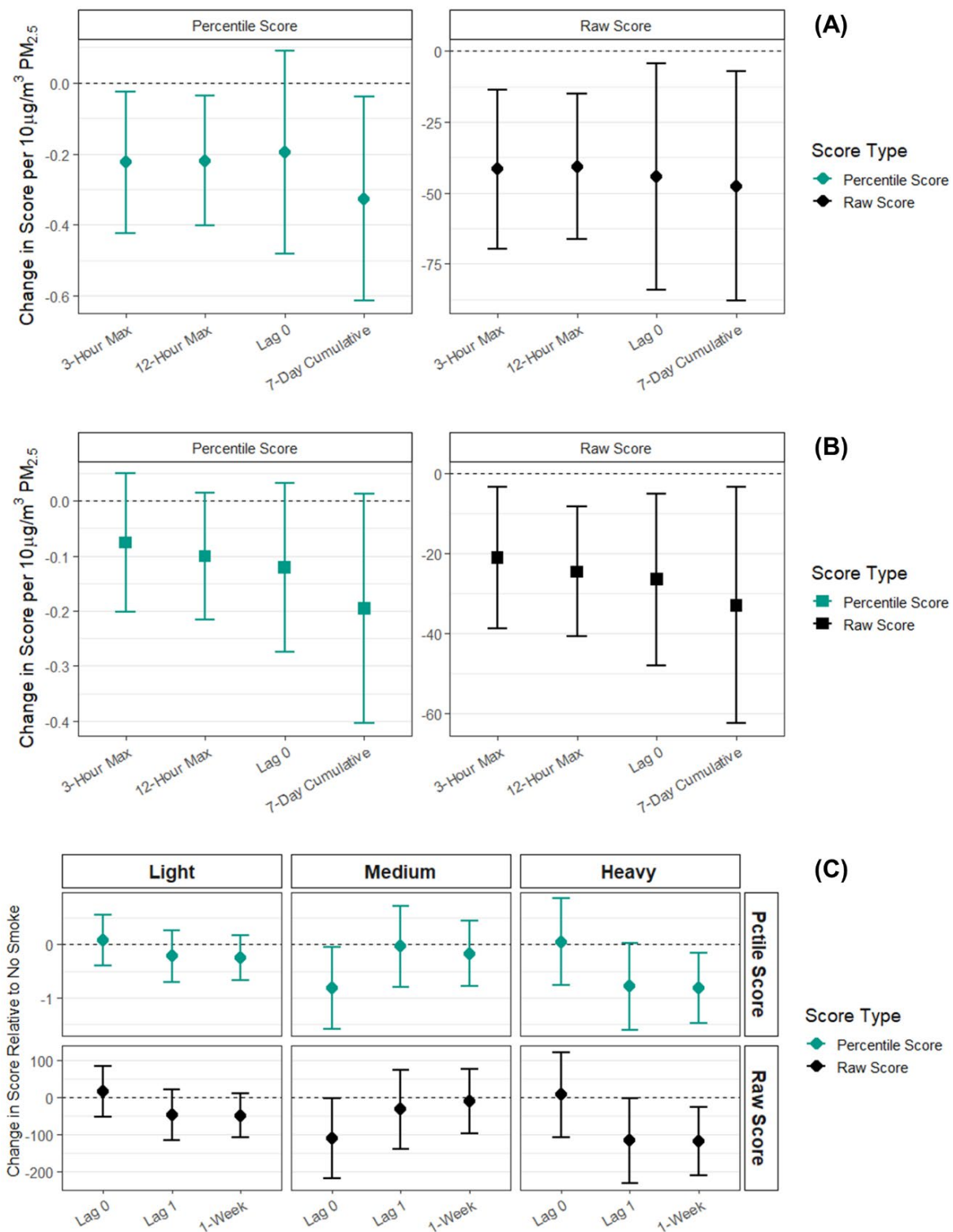


Figure S7. Sensitivity of the observed associations between attention score and (A) PM_{2.5} in the western U.S., (B) PM_{2.5} in the contiguous U.S., and (C) smoke density in the western U.S. to the type of score used (raw vs. percentile score).

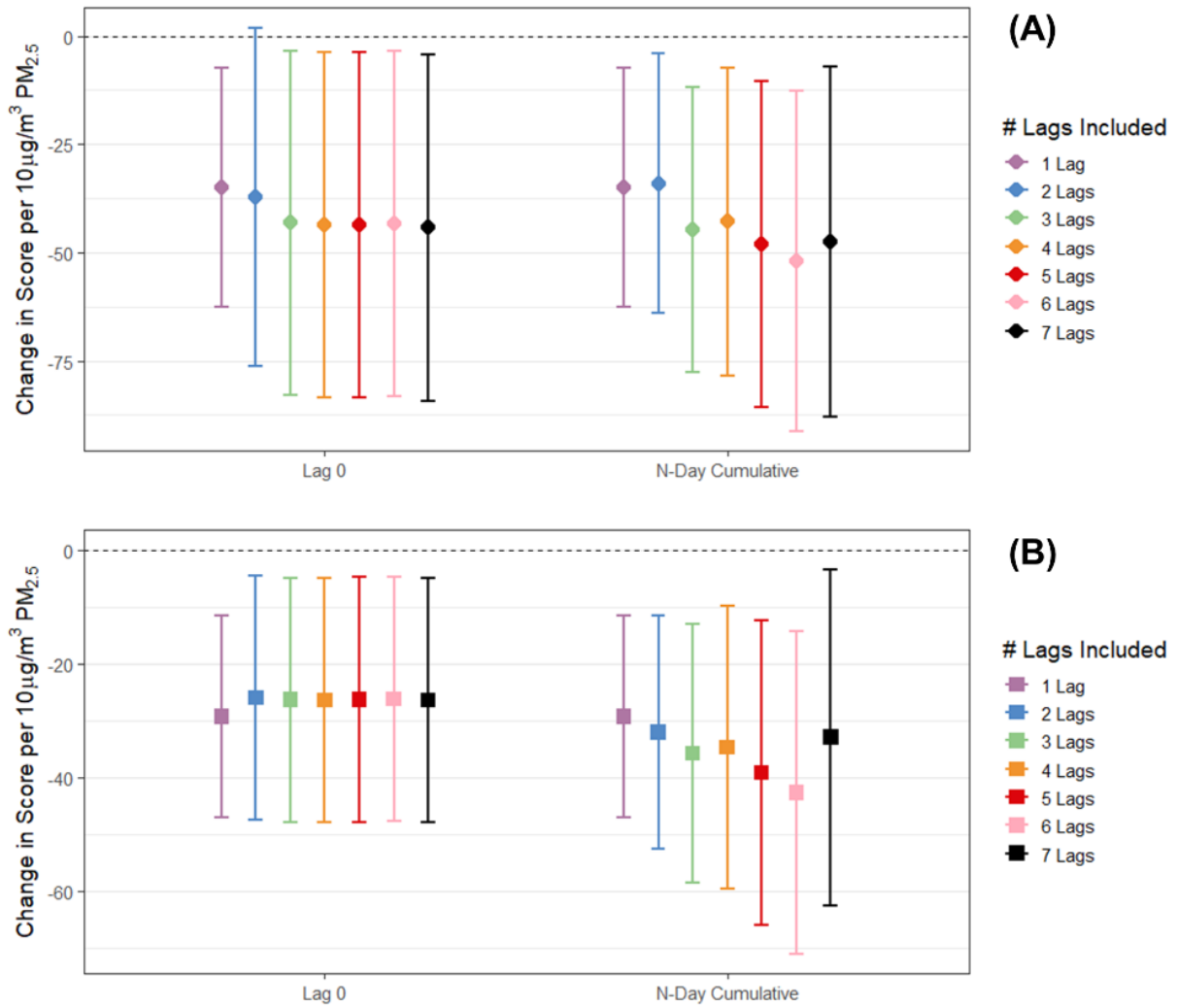


Figure S8. Sensitivity of the observed associations between attention score and $PM_{2.5}$ in the (A) western U.S. and (B) contiguous U.S. to the number of lags included in the distributed lag model (e.g., 1-6 lags instead of 7). The n-day cumulative association was calculated from all lags included in the model (e.g., if 5 lags were included, the value shown is the 5-day cumulative association).

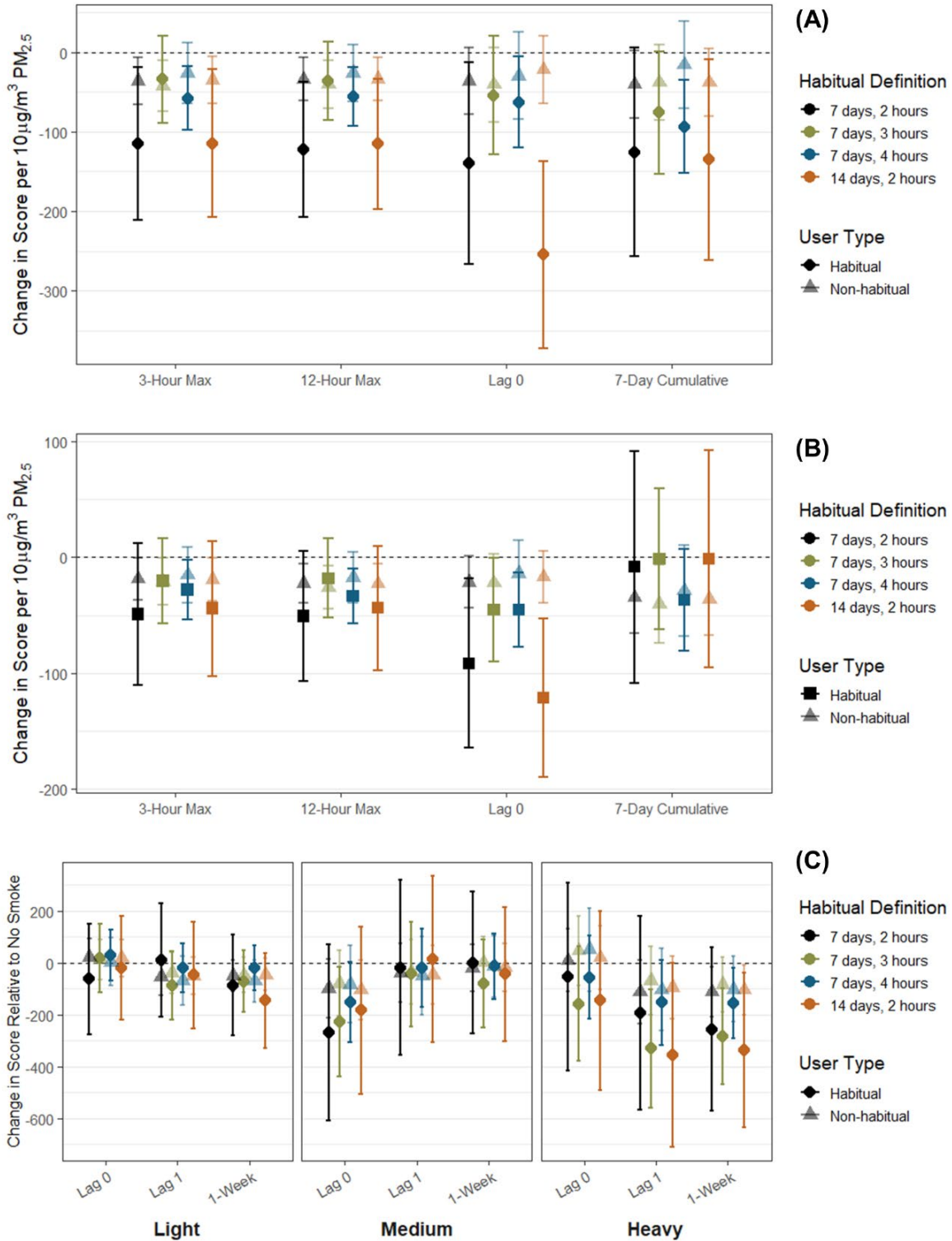


Figure S9. Sensitivity of the observed associations between attention score and (A) $\text{PM}_{2.5}$ in the western U.S., (B) $\text{PM}_{2.5}$ in the contiguous U.S., and (C) smoke density in the western U.S. to the definition of habitual users. The alternative definitions of habitual users considered a different cutoff for the median time between plays (14 days instead of 7) or for the standard deviation for time-of-day played (3 or 4 hours instead of 2).

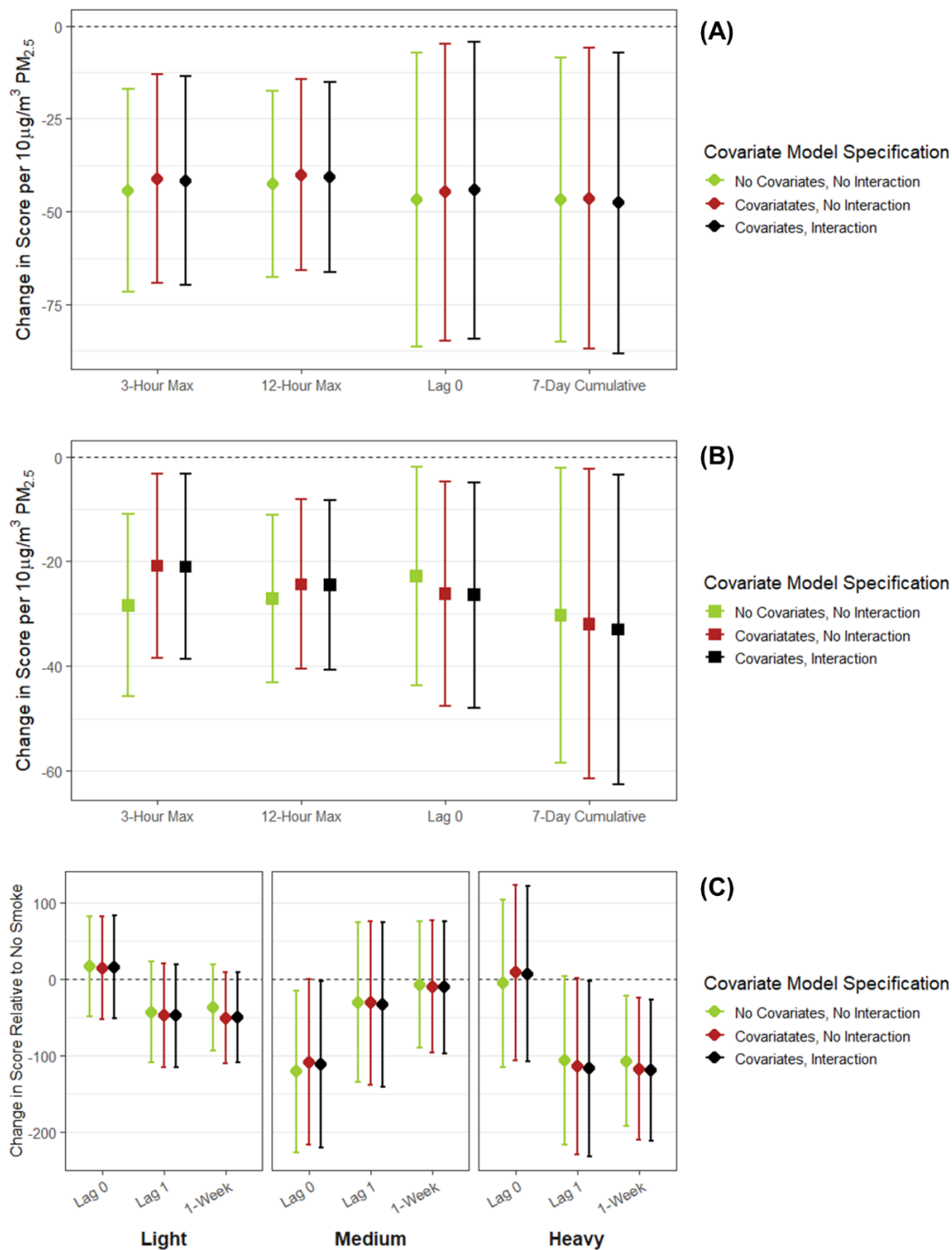


Figure S10. Sensitivity of the observed associations between attention score and (A) $\text{PM}_{2.5}$ in the western U.S., (B) $\text{PM}_{2.5}$ in the contiguous U.S., and (C) smoke density in the western U.S. to the covariate model specification. The 'No Covariates, No Interactions' model only included the exposure variable(s), the $\log(n)$ variable, and the third order autoregression. The 'Covariates, No Interactions' model included all covariates but no interactions between the $\log(n)$, age group, and device variables. The 'Covariates, Interactions' model is the model used in the primary analyses and included all covariate and interaction terms.

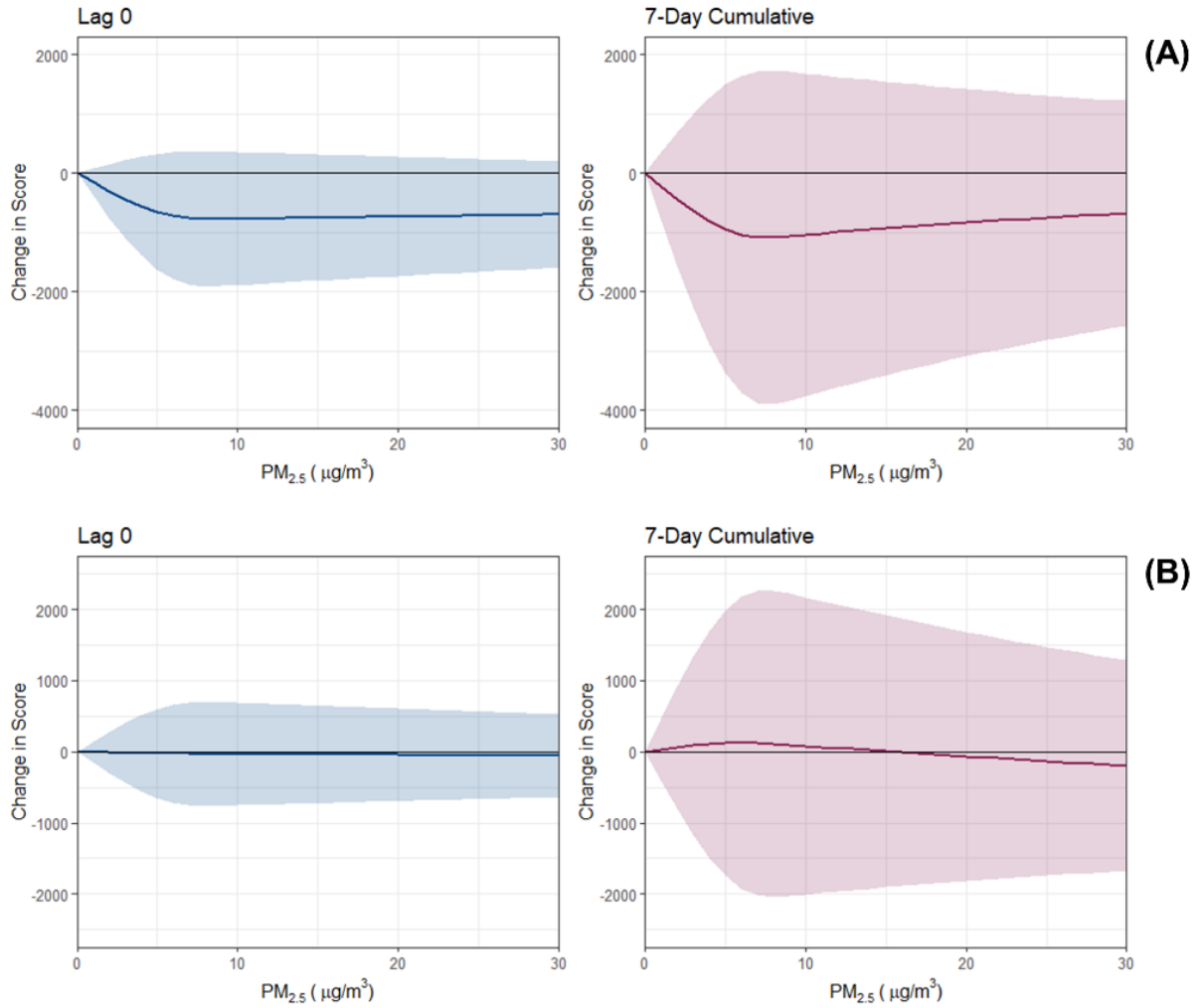


Figure S11. Nonlinear associations between daily $PM_{2.5}$ and attention score in the (A) western U.S. and (B) contiguous U.S.

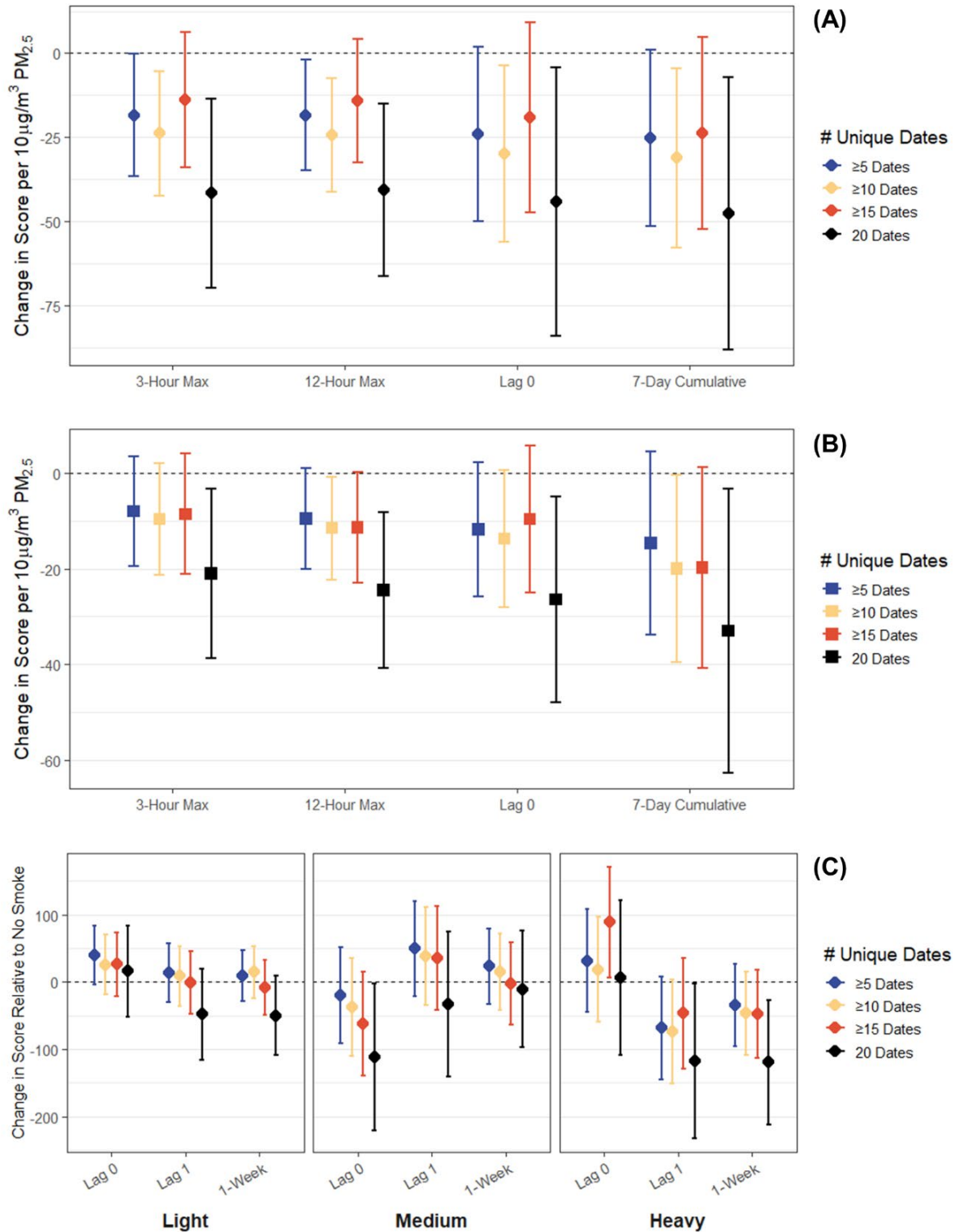


Figure S12. Sensitivity of the observed associations between attention score and (A) $\text{PM}_{2.5}$ in the western U.S., (B) $\text{PM}_{2.5}$ in the contiguous U.S., and (C) smoke density in the western U.S. to the number of unique dates required in the user inclusion criteria (i.e., users who completed 20 plays across less than 20 unique dates). To allow for comparison, only a user's first play on any given date was included (e.g., if plays 4-6 occurred on one date, only play 4 is included).

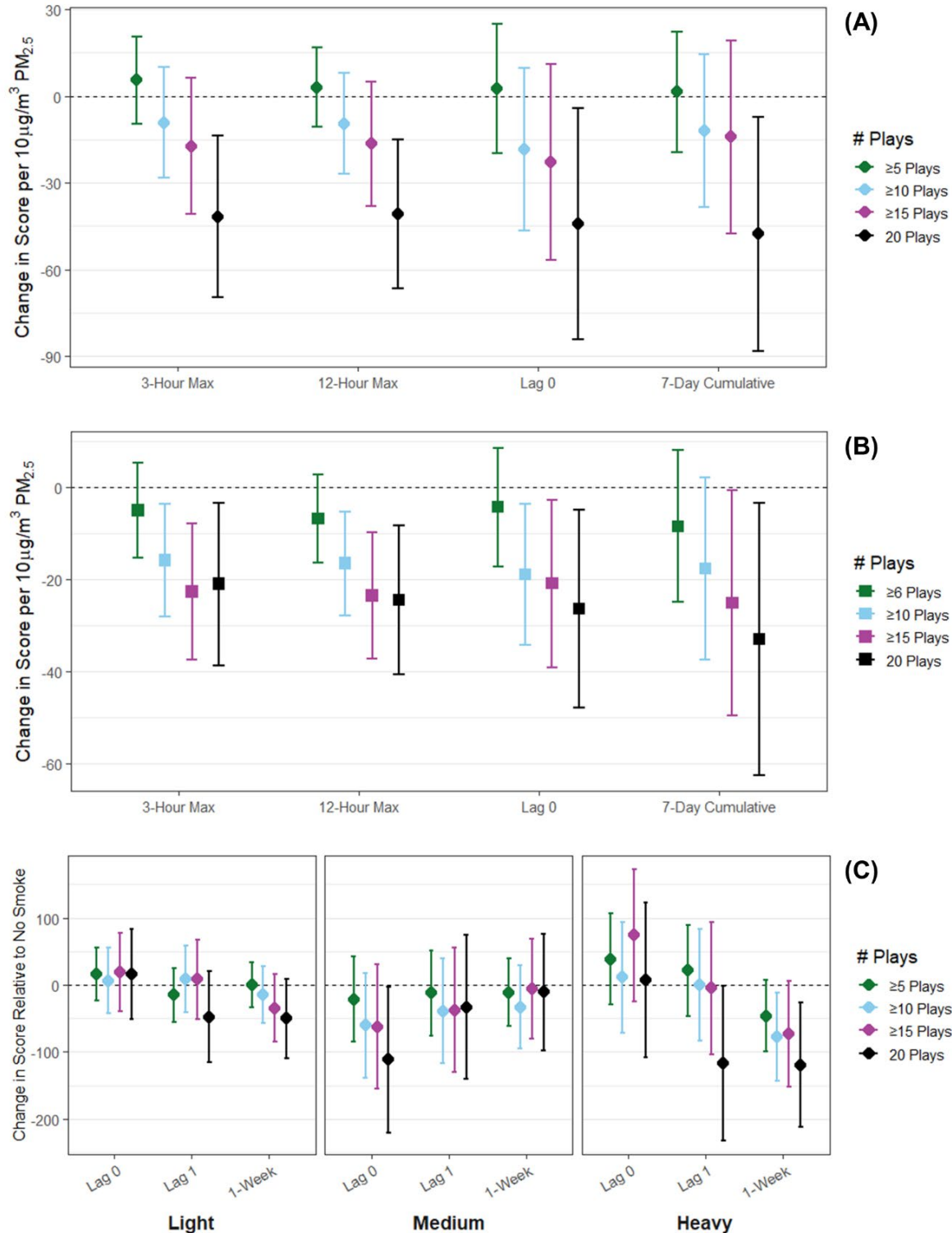


Figure S13. Sensitivity of the observed associations between attention score and (A) $\text{PM}_{2.5}$ in the western U.S., (B) $\text{PM}_{2.5}$ in the contiguous U.S., and (C) smoke density in the western U.S. to the number of plays required in the user inclusion criteria (i.e., users who completed less than 20 plays). To allow for comparison, users still must have completed each play across unique dates (e.g., a user with 18 plays must have completed the plays across 18 unique dates).

References

1. Lumos Labs. 2021. Lost in Migration Instructions. Lumosity. Available: <https://help.lumosity.com/hc/en-us/articles/360048973634-Lost-in-Migration-Instructions> [accessed 24 January 2022]