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Do “Kids at Play” Signs Reduce Vehicle Speed?

Summary

In this paper, we examine the effect of “Kids at Play” signs on vehicle speed. Our experiment was conducted across three cities in Oregon, California, and New Jersey. We utilized clustered regression as our primary analysis method and found that signs induced a decrease in speed of approximately 1.6 MPH in a 25 MPH zone. While this decrease was statistically significant, effectiveness paled in comparison to other speed management techniques. Finally, we propose studies that could be used to further expand on our results.

Background

Frequently sighted in neighborhood streets across the US are signs warning drivers to slow down because children may be nearby. They usually say things like “Slow! Children at Play!”. Parents presumably purchase these signs to help ensure a safer environment for their children while playing on or near a road.

Reduced vehicle speed is certainly conducive to a safer environment for children, so the desire to encourage passing cars to slow down is understandable. Slower speeds give drivers more chance to react to kids and kids more chance to react to moving vehicles, and reduce harm resulting from an accident.

Our research objective is to determine if these signs are effective, and if so, to what degree. Manufacturers claim or imply that these signs create a safer environment for kids, and we seek to either back up that implication or expose any false sense of security that they may create.

Experimentation is necessary in this case because an experiment is the only method by which a causal relationship may be established. Through experimentation, we can establish to some degree of certainty whether or not the presence of these signs alone result in a reduction of passing vehicle speeds. After collecting data about vehicle speed

and various other relevant factors, we can use multivariate linear regression to identify the presence, and degree of, the relationship between these signs and vehicle speed, as well as the same sort of relationship for other important factors, such as the visible presence of children or other pedestrians.

We predict that these signs will cause a statistically significant reduction in vehicle speed. The null hypothesis that we seek to reject is that the presence of “slow kids” signs will yield no change in vehicle speed.

Experimental Design

Because this experiment was conducted in the US, the chosen measurement unit is the typical local speed measurement of Miles per Hour (MPH). We measured speed using Bushnell Velocity Speed Gun Model 101911, which has an accuracy of +/- 1.0 MPH. The primary decision to use this particular model of speed gun was based on cost and availability while maintaining the ability to covertly monitor speed.

The treatment consisted of any commercially available sign made to indicate the presence of children for the purpose of reducing vehicle speed. Signs used were similar to the following:

Figure 1: “Slow kids” sign example

Treatments were applied in multiple locations across three different US states, and the images below in Figure 2 are representative of the setup used in each instance.

Notice that the distance between subjects and data collectors was far enough that the presence of speed detection equipment is not noticeable to the subject. Data collection at all locations was performed from inside a parked car. This provided some degree of concealment from subjects that would not have been afforded to an experimenter sitting

on a chair and pointing a radar gun at passers by. This effort to conceal data collection efforts was crucial because of the possibility that drivers could react to the knowledge that they were being monitored in a way that would obscure the true effectiveness of the sign.

Figure 2: Experimental setup, including measurement location for control and treatment, sign placement, and distance between experimenter and subject

Because the measurement location was stationary, we were not able to follow any given subject to determine their behavior both with and without treatment. This leads to an experimental design requiring a comparison of averages between subjects (as opposed to within). Using the common "ROXO" notation, control and treatment are very straightforward:

Experimental group	R X O
Control group	R - O

Due to the logistics of providing the treatment, randomization was accomplished by design. Set periods of time, not exceeding one hour, were blocked, and each block was split evenly into one treatment and one control cluster. This design makes the assumption that there are no meaningful differences between adjacent time periods; for example, the average driver on Saturday afternoon at 2:15pm versus 2:45pm. We believe this assumption is reasonable.

Locations were selected by the experimenters in their local area. The selection criteria for the location were:

- it was reasonable to believe that children could be playing on the street,
- location had a clear and unobstructed view of the sign/location for measurement,
- there was enough traffic to allow sufficient data collection, and
- there was not so much traffic that collecting data on individual vehicles becomes too difficult.

A pilot was performed for two hour-long blocks in one location. Based on the pilot, it was determined that the experiment was logistically sound and finalized the capture of the following covariates/block details in addition to the outcome variable (speed) :

- Presence of children
- Presence of pedestrians
- Direction of car travel
- Side of the street the sign (treatment) was placed on
- Time of day (approximate start time of each block)
- Date

- Location
- Day of the week
- Visibility

After completion of the pilot, each experimenter collected a total of 4 hours worth of data at their own convenience. Pilot data, since successful, was included in the final data analysis set. The experiment workflow diagram is shown in Figure 3. Note that the N below is described in terms of individual vehicle measurements.

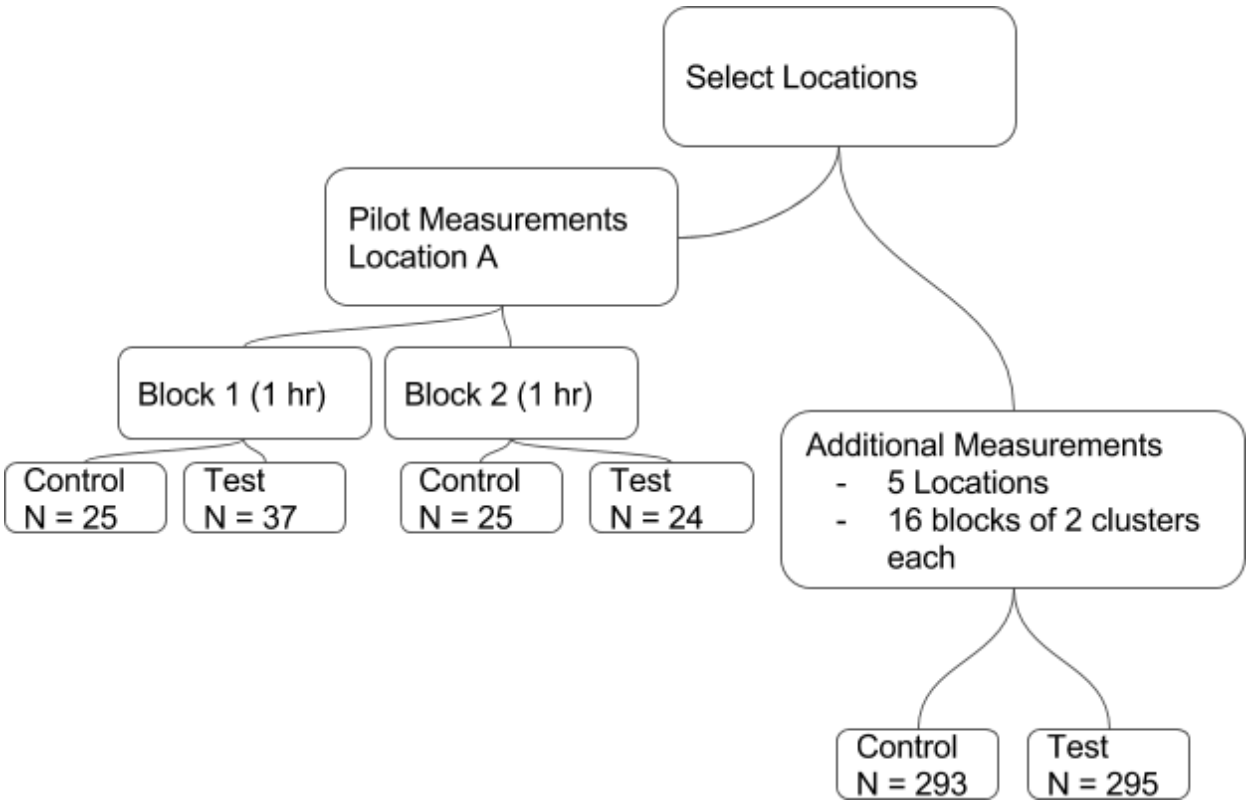

Figure 3: Experiment Flow Diagram

Analysis and results

A complete set of the data collected and analysis performed can be found at: https://github.com/letslego/KidsAtPlay. Note that for privacy reasons, actual locations at which the data was gathered have been masked with a generic identifier.

The outcome measure distributions of speed for control and treatment groups are shown in Figure 4 below. The treatment group, who drove past a slow kids sign at the point of measurement, is visibly shifted to the left of the control group, indicating that slower speeds appear to be associated with treatment.

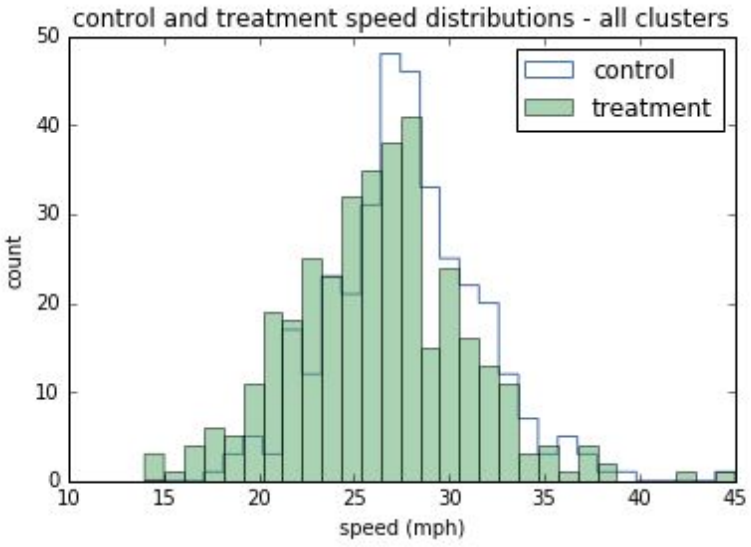

Figure 4: Outcome measure distribution

A covariate check was used to determine whether randomization occurred correctly and validated that there was no relation between the covariates and the treatment variable, thus confirming our initial assumption that no meaningful difference exists between average drivers in a given location separated by 30 minutes or less. There was some imbalance between in the treatment variable between the various blocks. However, this was considered to be acceptable as the imbalance is accounted for by using clustered regression for analysis.

We also performed a secondary randomization check by attempting to predict whether the vehicle was driving on the same side of the road with the treatment variable and covariates that we were planning to use for our result analysis as a placebo test. This check confirmed that our randomization strategy worked correctly with a p-value of 0.74.

Results analysis was performed using a clustered regression using the following covariates: direction of travel, block, whether the car was traveling on the same side of the street as the sign, the presence of children, the presence of pedestrians, and the day of week. Note that visibility and speed limit were not included in the regression as they were the same for all data points (clear, 25 MPH, respectively). Results are shown in Figure 5.

The treatment outcome had a statistically significant decrease of approximately 1.6 MPH in comparison to the control group. It should also be noted that both the presence of children and pedestrians demonstrated a statistically significant reduction in speed of 3.4 and 1.4 MPH, respectively.

```
                       Estimate Std. Error t value  Pr(>|t|)
(Intercept)            28.42843    0.89032 31.9307 < 2.2e-16 ***
d$Treatment            -1.55878    0.30999 -5.0285 6.342e-07 ***
d$Direction2n          -0.86971    1.13816 -0.7641   0.44505
d$Direction2s          -1.11976    1.25625 -0.8913   0.37306
d$Direction2w          -0.85460    0.62848 -1.3598   0.17435
d$BlockCA-C-0717-1940 -0.82048    0.81719 -1.0040   0.31573
d$BlockCA-D-0718-1710  1.73614    1.64797  1.0535   0.29249
d$BlockCA-D-0718-1740  2.09897    0.84853  2.4737   0.01362 *
d$BlockCA-D-0718-1810  1.94486    1.09092  1.7828   0.07507 .
d$BlockCA-D-0718-1840  0.63291    1.32914  0.4762   0.63410
d$BlockCA-D-0718-1910  0.46190    1.34813  0.3426   0.73199
d$BlockNJ-E-0722-1500 -0.53066    1.22745 -0.4323   0.66564
d$BlockNJ-E-0722-1520  2.19191    0.97330  2.2520   0.02464 *
d$BlockNJ-E-0722-1540  1.55489    0.79330  1.9600   0.05040 .
d$BlockNJ-E-0722-1600  1.48799    0.88671  1.6781   0.09379 .
d$BlockNJ-F-0722-1620  1.99490    0.83262  2.3959   0.01685 *
d$BlockNJ-F-0722-1640 -0.16845    1.08534 -0.1552   0.87670
d$BlockNJ-F-0722-1700 -0.42958    1.11881 -0.3840   0.70113
d$BlockOR-A-0701-1400 -0.74118    0.79958 -0.9270   0.35428
d$BlockOR-B-0709-1400  0.77878    0.95568  0.8149   0.41542
d$BlockOR-B-0709-1500  0.22532    0.83393  0.2702   0.78710
d$SameSide            -0.14228    0.36973 -0.3848   0.70049
d$Children            -3.36877    0.80590 -4.1801 3.297e-05 ***
d$Pedestrians         -1.37379    0.63927 -2.1490   0.03199 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 5: Clustered regression estimates and standard errors.

A clustered interaction model was tested to see if the presence of children or pedestrians gave a heterogenous treatment effect (Figure 6), especially because in the original analysis, these covariates were statistically significant. The interaction terms were not statistically significant, and when compared to the model without interactions was not statistically better ($p = 0.07$). Therefore, we can conclude that the effects of having children and pedestrians are additive to the treatment effect.

```
                            Estimate Std. Error t value  Pr(>|t|)
(Intercept)                28.551608   1.100830 25.9364 < 2.2e-16 ***
d$Treatment                -1.228569   0.369475 -3.3252 0.0009316 ***
d$Children                 -4.173981   1.233789 -3.3831 0.0007584 ***
d$Pedestrians              -0.533554   0.707197 -0.7545 0.4508353
d$Direction2n              -1.104755   1.352450 -0.8169 0.4143003
d$Direction2s              -1.365719   1.475442 -0.9256 0.3549683
d$Direction2w              -0.839789   0.620264 -1.3539 0.1762155
d$BlockCA-C-0717-1940      -0.962331   1.038360 -0.9268 0.3543730
d$BlockCA-D-0718-1710       1.613995   1.650825  0.9777 0.3285788
d$BlockCA-D-0718-1740       2.144174   0.966898  2.2176 0.0269166 *
d$BlockCA-D-0718-1810       2.094070   1.211016  1.7292 0.0842348 .
d$BlockCA-D-0718-1840       0.367202   1.367316  0.2686 0.7883531
d$BlockCA-D-0718-1910       0.495236   1.459575  0.3393 0.7344887
d$BlockNJ-E-0722-1500      -0.797180   1.272587 -0.6264 0.5312491
d$BlockNJ-E-0722-1520       2.084215   1.002900  2.0782 0.0380705 *
d$BlockNJ-E-0722-1540       1.625676   0.895791  1.8148 0.0700007 .
d$BlockNJ-E-0722-1600       1.466815   0.997103  1.4711 0.1417378
d$BlockNJ-F-0722-1620       1.700392   1.045199  1.6269 0.1042352
d$BlockNJ-F-0722-1640      -0.639472   1.193587 -0.5358 0.5923038
d$BlockNJ-F-0722-1700      -0.679261   1.323473 -0.5132 0.6079509
d$BlockOR-A-0701-1400      -0.757352   0.914961 -0.8277 0.4081103
d$BlockOR-B-0709-1400       0.463164   1.109613  0.4174 0.6765115
d$BlockOR-B-0709-1500      -0.056168   1.049175 -0.0535 0.9573214
d$SameSide                 -0.180262   0.359420 -0.5015 0.6161584
d$Treatment:d$Children      1.862453   1.747495  1.0658 0.2869032
d$Treatment:d$Pedestrians -1.963480   1.052354 -1.8658 0.0625046 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 6: Clustered regression with interactions with the presence of children and pedestrians - estimates and standard errors

One other area of investigation that we wanted to pursue was whether there was any heterogenous effect of the location where the data was acquired. We examined this potential heterogenous effect at two levels, the city and location level. Note that there were two separate locations for each city. The clustered regression model was rerun with the location and city as interaction factors and are shown in Figures 7 and 8. Note that although the data is shown below, both of these models were not statistically better than our original model, giving p-values of 0.13 and 0.12, respectively.

```
                           Estimate Std. Error t value  Pr(>|t|)
(Intercept)                27.86753    0.70845 39.3362 < 2.2e-16 ***
d$Treatment                -0.53245    0.64043 -0.8314 0.4060496
d$CityIDNJ                  0.36414    1.16914  0.3115 0.7555486
d$CityIDOR                  0.78511    0.63419  1.2380 0.2161560
d$Children                 -2.74078    0.73065 -3.7512 0.0001912 ***
d$Pedestrians              -1.44699    0.61839 -2.3399 0.0195781 *
d$Direction2n              -1.09164    0.81455 -1.3402 0.1806427
d$Direction2s              -1.32170    0.92574 -1.4277 0.1538365
d$Direction2w              -0.83062    0.63291 -1.3124 0.1898397
d$BlockCA-C-0717-1940      -0.69474    0.70208 -0.9895 0.3227536
d$BlockCA-D-0718-1710       2.00449    1.43504  1.3968 0.1629303
d$BlockCA-D-0718-1740       2.34403    0.95678  2.4499 0.0145424 *
d$BlockCA-D-0718-1810       2.49921    1.06091  2.3557 0.0187729 *
d$BlockCA-D-0718-1840       0.91132    1.70408  0.5348 0.5929723
d$BlockCA-D-0718-1910       0.80219    1.14627  0.6998 0.4842760
d$BlockNJ-E-0722-1500       0.13448    1.47641  0.0911 0.9274510
d$BlockNJ-E-0722-1520       2.76406    1.32352  2.0884 0.0371357 *
d$BlockNJ-E-0722-1540       2.64164    1.40105  1.8855 0.0597971 .
d$BlockNJ-E-0722-1600       2.16050    1.42502  1.5161 0.1299594
d$BlockNJ-F-0722-1620       2.84818    1.20060  2.3723 0.0179577 *
d$BlockNJ-F-0722-1640       0.65673    1.27808  0.5138 0.6075339
d$BlockOR-A-0701-1400      -0.73188    0.79057 -0.9258 0.3549046
d$BlockOR-B-0709-1400       0.55640    0.46366  1.2000 0.2305492
d$SameSide                 -0.14337    0.36851 -0.3891 0.6973613
d$Treatment:d$CityIDNJ     -1.83773    0.94540 -1.9439 0.0523267 .
d$Treatment:d$CityIDOR     -1.04920    0.75930 -1.3818 0.1674912
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 7: Clustered regression with interactions with city - estimates and standard errors

```
                          Estimate Std. Error t value  Pr(>|t|)
(Intercept)               27.93929    0.52663 53.0534 < 2.2e-16 ***
d$Treatment               -2.82297    0.43043 -6.5585 1.087e-10 ***
d$LocationB                0.37721    0.66375  0.5683 0.5700206
d$LocationC               -0.15980    0.81494 -0.1961 0.8446009
d$LocationD               -0.55449    0.92283 -0.6009 0.5481378
d$LocationE                1.20505    0.76920  1.5666 0.1176728
d$LocationF                0.18182    1.13242  0.1606 0.8724889
d$Children                -2.59938    0.72966 -3.5625 0.0003934 ***
d$Pedestrians             -1.42607    0.62787 -2.2713 0.0234470 *
d$Direction2n              0.25608    0.55448  0.4618 0.6443421
d$Direction2w             -0.88549    0.62843 -1.4090 0.1592859
d$BlockCA-C-0717-1940     -0.66205    0.72550 -0.9125 0.3618125
d$BlockCA-D-0718-1710      1.20450    1.34781  0.8937 0.3718195
d$BlockCA-D-0718-1740      1.54792    0.73467  2.1070 0.0354923 *
d$BlockCA-D-0718-1810      1.68227    0.87509  1.9224 0.0549785 .
d$BlockCA-D-0718-1840      0.11566    1.57962  0.0732 0.9416531
d$BlockNJ-E-0722-1500     -2.03136    0.95513 -2.1268 0.0338022 *
d$BlockNJ-E-0722-1520      0.56253    0.72028  0.7810 0.4350861
d$BlockNJ-E-0722-1540      0.62398    0.91404  0.6827 0.4950529
d$BlockNJ-F-0722-1620      2.57240    1.23597  2.0813 0.0377881 *
d$BlockNJ-F-0722-1640      0.40469    1.43806  0.2814 0.7784817
d$BlockOR-A-0701-1400     -0.60395    0.41849 -1.4431 0.1494488
d$BlockOR-B-0709-1400      0.48003    0.27832  1.7248 0.0850325 .
d$SameSide                -0.16598    0.36860 -0.4503 0.6526477
d$Treatment:d$LocationB    1.97337    0.50895  3.8773 0.0001160 ***
d$Treatment:d$LocationC    2.49078    0.82218  3.0295 0.0025440 **
d$Treatment:d$LocationD    2.20452    0.95514  2.3081 0.0212997 *
d$Treatment:d$LocationE    0.18113    0.93486  0.1938 0.8464301
d$Treatment:d$LocationF    0.97038    1.22587  0.7916 0.4288823
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 8: Clustered regression with interactions with location - estimates and standard errors

Comparison with U.S. Federal Highway Administration Safety Data

The Federal Highway Administration (FHA) provides a useful corollary to our effort by way of benchmarking the effectiveness of various speed control measures.[1]

There were no exact comparisons to any of the speed control measures reported by the FHA, but we identified the use of speed humps on local roads, which are installed to increase pedestrian safety, as a reasonable point of comparison. While we recognize that a speed hump and a sign are very different, the overall safety objective is very similar and both measures (signs and speed humps) are both very familiar to any regular driver.

The FHA reports that across three locations in Iowa, the use of speed humps reduced the mean speed in a 25 MPH zone from 24 to 18 MPH. This constitutes a 25% decrease in speed.

While a p-value of 0.000 is encouraging for our 1.5 MPH average treatment effect, the comparison here highlights the practical significance (or lack thereof). Our reduction in overall mean speed from 27.8 to 26.3 MPH is a difference of 5.4%, which is roughly 1/5th as effective as the hump.

Next Steps

We see several extensions to our experiment that could help further examine the treatment effect we have found. First, we would like to examine whether the treatment effect is due to having a sign or if it is due the sign being a “Kids at Play” sign. Additionally, we believe that collecting data over a wider set of locations, times, days of the week, and road conditions could improve the generalizability of our experiment. In collecting this additional data, we would also suggest employing some placebo groups as a secondary check to confirm that randomization works correctly. This would create some A vs A test conditions to further demonstrate that our randomization strategy was effective.

We would space out the placebo, treatment and control groups for the same location on similar days (e.g. weekdays when school is on) but not the same day. This will prevent

[1] U.S. Department of Transportation Federal Highway Administration. Engineering Speed Management Countermeasures: A Desktop Reference of Potential Effectiveness. https://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/2014/reducing_speed.cfm. July 2014. Accessed August 2017.

spillover effects if we are conducting the placebo and treatment back to back or treatment and control back to back.

Additionally, as more data is collected, we could explore quantile analysis to determine whether the treatment was more effective on cars that were already travelling faster than cars that were already moving at or below the speed limit. Unfortunately, due to our unit of measure, we did not have enough data to reasonably conduct quantile data analysis with the data that we collected.

Finally, due to our experimental logistics, we were unable to determine whether the treatment effect we saw was due to the Hawthorne effect or a true causal relationship. We propose that license plate numbers could be collected as a method to observe whether the treatment effect holds over time.

Conclusion

While our finding that “Kids at Play” signs result in a statistically significant decrease in vehicle speed by about 1.6 MPH in a 25 MPH neighborhood street, the practical significance leaves much to be desired. We observed a reasonably frequent occurrence of vehicles that did not seem to react at all to the signs though further research is required to make a more quantifiable claim to that effect.

When considering that the reduction in speed is important for the purpose of allowing greater reaction time for drivers and kids, as well as for reducing collision damage, we would have liked to see a more dramatic result. Perhaps, if given the choice, parents would still purchase these signs knowing how minor the effect will be. However, our findings may have a chilling effect on the marketing strategy behind their sales.

Finally, with all that said, 1.6 MPH is not nothing. If given the choice of being hit by a car traveling at 27.5 MPH or 26 MPH, the authors of this paper unanimously agree that 26 is preferable.