

slow down and be cautious. The least frequently given error choices were the Signal Ahead symbol sign (MUTCD W3-3), the Signal Ahead word sign (MUTCD W3-3a), and the Merge Left word sign (MUTCD W9-2).

CONCLUSIONS

Based on these data, the authors have concluded that

1. Driver errors in recognizing signs once a sign is detected in the visual field are lower for signs that require a stop action by the driver than those that require a driver to either slow down or move laterally. This finding implies that failures to respond to Stop message signs are likely due to factors other than perceptual operations.

2. Errors in recognizing signs decrease sharply with very small increases above threshold presence or absence detection exposure durations. Errors in perceptual recognition operations are likely to occur within the first 50 msec of viewing time after which recognition errors tend to level off.

3. The formats of some signs tend to produce many recognition errors with other sign messages (Merge Right) whereas other signs infrequently occur in recognition errors (Signal Ahead).

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Abridgment

Restraint Usage at Child Care Centers

DANIEL S. TURNER, MICHAEL C. ROBERTS, and
WILLIAM J. WHALEN, Jr.

ABSTRACT

A pilot project was conducted by the University of Alabama to study child restraint usage at two child care centers. Rewards were used to encourage parents to transport their children in approved safety devices, and the usage characteristics were examined. A traditional ABA study (baseline--intervention--return-to-baseline) indicated that usage increased from 48 to 72 percent at one center, and from 11 to 54 percent at the other center. These results soundly demonstrated that psychological learning theory was extremely effective in increasing safety seat usage. A major thrust of the project was the study of pertinent characteristics of parents and children. Age, sex, arrival time, vehicle type, and place in vehicle were found to influence restraint use. Overall, the pilot study provided a sound beginning for an intensive program to increase child restraint usage.

This paper outlines an innovative study conducted at the University of Alabama. A lottery reward system was investigated as a potential way to enhance restraint usage. Parents at child care centers were the target group for the study. The goals for the project were to (a) test a hypothesis, based on psychological learning theory, that positive reinforcement increases restraint use and removal of reinforcement decreases use; (b) develop data collection procedures during a pilot study; and (c) examine characteristics that affect restraint use.

RESEARCH TECHNIQUE

Study Sites

Daycare centers were designated as the study location because of the abundance of children in the targeted age group and the direct contact with parents. Two private centers were identified after an analysis of 20 competing locations. The two served different socioeconomic groups. Center 1 catered to professional parents, whereas Center 2 was heavily subscribed by blue collar families.

Methodology

A traditional ABA (baseline, reward intervention, and return-to-baseline) procedure was designated for the study. The research steps were implemented sequentially. While the B phase was underway at Center 1, the A phase was underway at Center 2 to serve as a control group.

During the intervention period, the parents of properly restrained children received rewards from a lottery pool. Adequate data were gathered to track the increase in usage by individual parents. During the return to baseline, rewards were suspended and the decrease in usage was observed. After the study was completed, several follow-up observations were conducted to monitor any long-term effects.

Data Collection

Parents and children were observed during the morning arrival period to determine whether the children were properly restrained. Observers were volunteers recruited from undergraduate psychology and engineering classes. They were trained to record 19 data items, including each vehicle's license number and the sex of the driver (to permit tracking of individual drivers over time), time of day, estimated age of the child, type of restraint (if any), and other pertinent data.

There were approximately 3,500 observations made continuously across the three phases at the two centers during a 9-week period. Because of the difficulty in visually ascertaining the foregoing criteria, the observers were necessarily noticeable to the parents. Observers sometimes found it difficult to determine whether a restraint was used correctly without peering into the vehicle.

Data Reliability

The data were collected by volunteer undergraduate students under the guidance of the principal investigators. Because the observers rotated shifts, and portions of the data were difficult to gather, there was some concern that the data might not be consistent. On 11 randomly selected days, second observers gathered duplicate sets of data to compare with the

findings of the primary observers. Reliability was defined as the number of times the observers agreed divided by the total observations. Of the 11 comparisons, all were strong except for a single day. This one day's data were vastly weaker than the other data, and were dismissed from the data set.

A second reliability check was made by comparing known ages of children (obtained from the centers) with ages estimated by students. Ten cross-checks were made, with nine exhibiting strong correlation. Again, one day's data were much weaker than the others and were dismissed from the data set.

Reward (Incentive) Procedure

The rewards were coupons and gift certificates from various businesses in the community. A lottery system was used to dispense these gifts. Parents with properly restrained children (compliant with state law) were allowed to draw a token on their arrival at the center. Parents removed a Happy Face sticker from the token to determine whether they had won. Gift certificates were then given to those with winning tokens. The observers at the centers had no prior knowledge of the win or no-win status of the tokens. After the reward phase, the return to baseline was made without any tokens being given to parents, although observation of compliance continued. No prior announcement was made concerning cessation of the tokens.

RESULTS

The prominent concern was the ratio of compliant to noncompliant parents during all research phases for each daycare center. Figures 1 and 2 show the percentage of compliance for each weekday during the study. The average compliance percentage for baseline at Center 1 was 48.7 percent, with the percentage increasing during the reward period to 72.7 percent. Compliance decreased to an average of 69.8 percent during the return phase. Follow-up showed 59.6 percent compliance 2 to 3 weeks later, and 60.0 percent 3 months after the return to baseline.

For Center 2, the mean percentage of compliance for the baseline was 11.3 percent, increasing to 54.0 percent over the reward period. Compliance declined to 44.8 percent during the return-to-baseline phase. Follow-up observations conducted 2 weeks later disclosed that compliance had dropped to 17.9 percent. Additional data taken 3 months after the return to baseline indicated a compliance rate of 18.8 percent.

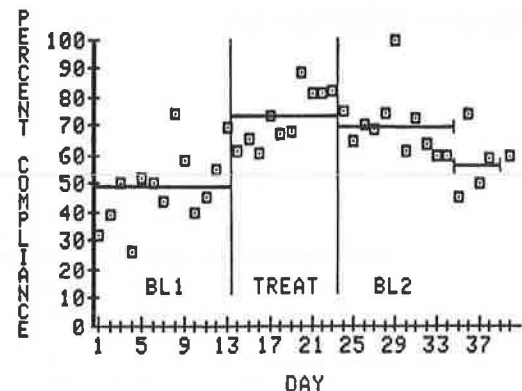


FIGURE 1 Percentage of children in child restraints at day care Center 1.

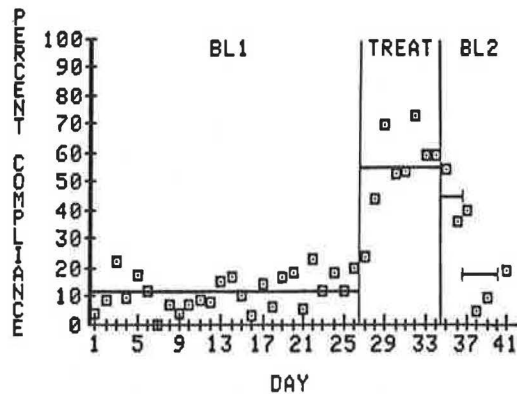


FIGURE 2 Percentage of children in child restraints at day care Center 2.

Rewards were extremely helpful in encouraging parents to "buckle up" their children. During the reward phase and immediately afterwards, the compliance rates were higher at both centers than those typically achieved by other intervention programs. With reinforcement, the desired behavior increased in frequency. After removal of reinforcement, the rate of compliance began to decay. (The rate of decay and the ultimate decay have not yet been determined.)

The findings of this study are significant for at least two reasons. First, the dramatic increases in compliance demonstrate the effectiveness of rewards for increasing safety behavior. Second, there are important health implications for reducing injuries and deaths through increased restraint usage for children. No other studies have utilized rewards for child restraint usage, and few studies can demonstrate such immediate increases in seat-belt usage regardless of the intervention.

CHARACTERISTICS OF STUDY POPULATION

The primary objectives of the project were met when the research proved that child restraint usage could be increased through a reward program. To define why these changes occurred, and to identify the characteristics of the parents and children who were in-

fluenced by the rewards, a more detailed analysis was conducted.

Ages of Children

Based on 502 observations at Center 1, the mean age was 2.21 years, with a standard deviation of 1.28 years. At Center 2, the mean age was 3.10 years with a standard deviation of 1.27 years, based on 655 observations. The ages approximated normal distributions at both locations.

Age Versus Compliance

The data clearly showed that younger children are more apt to be restrained than older children. This may be noted in Figure 3. Regression equations were fitted to the baseline data, with the curves displaying negative slopes. This confirms the negative age-compliance relationship. Data taken during the intervention period indicated a similar tendency. These equations were weighted to reflect the number of observations of each age group:

$$\text{Center 1, baseline:} \\ C = 84.7 - 25.1(A) + 3.0(A^2) \quad R^2 = 0.91 \quad (1)$$

$$\text{Center 1, reward:} \\ C = 75.3 + 5.3(A) - 2.5(A^2) \quad R^2 = 0.74 \quad (2)$$

$$\text{Center 2, baseline:} \\ C = 26.0 - 7.5(A) + 0.8(A^2) \quad R^2 = 0.94 \quad (3)$$

$$\text{Center 2, reward:} \\ C = 70.2 - 17.9(A) + 3.3(A^2) \quad R^2 = 0.73 \quad (4)$$

where

C = compliance (%),

A = age (years), and

R^2 = the coefficient of multiple determination.

Regardless of the location, rate of compliance, or project phase, the youngest children had the highest rates of compliance.

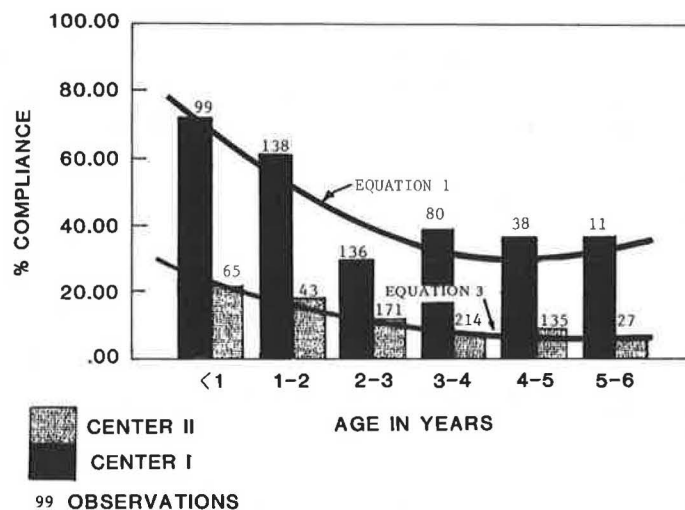


FIGURE 3 Age distribution of compliant children.

Time of Day

During their debriefing, the student observers indicated that compliance was better during some portions of the day than others. In particular, parents who seemed in a hurry or late to work usually did not have their children restrained. Early in the day (7:00 a.m.), extremely high compliance was noted, with the rate dropping as work time approached. Parents who arrived during the 7:30-7:45 a.m. period had the lowest rate of restraint usage, and seemed to be in the biggest hurry.

During the reward phase, there was some improvement from 7:00 through 7:30 a.m., but the major change occurred from 7:40 a.m. until the end of the observation period. This indicates that parents are more responsive if they have a more leisurely trip to the child care center. These findings suggest that intervention methods may not need to include fear appeals, educational material, or rewards, but may simply require the parents to work toward better time management.

Sex of Parent

Compliance by sex of parent and child is shown in Table 1. Female drivers are more likely to "buckle up" their children than are male drivers. In 1,015 occurrences, females had properly restrained their children 42 percent of the time. Male drivers had restrained their children in 35 percent of the 519 occurrences.

TABLE 1 Compliance Versus Sex

Parent's Sex	Child's Sex				Center and Study Phase
	Male		Female		
	Percent	No. of Observations	Percent	No. of Observations	
Male	35	63	41	66	Baseline, 1
Female	52	143	40	112	
Male	8	131	10	63	Baseline, 2
Female	9	137	13	217	
Male	59	80	80	51	Reward, 1
Female	70	145	66	121	
Male	44	41	50	24	Reward, 2
Female	67	61	56	79	
Male	31	315	40	204	All Observations
Female	47	486	37	529	

The second conclusion that may be drawn from the table is that parents appear partial to children of the opposite sex. For example, mothers took better care of sons than daughters (47 to 37 percent). Fathers favored daughters over sons (40 to 31 percent). These conclusions were based on all observations during the baseline and reward periods, and the sex preference was found to be significant by the chi-square test at a 95-percentile level.

Place in Vehicle

The location of children within the vehicle was examined for any consistent patterns. During the baseline phase, 69 percent of the children were in the front seat, 30 percent were in the rear seat, and slightly over 1 percent were in other locations. There were almost no changes in these ratios during the reward period (65 percent, 35 percent, less than 1 percent).

Two-thirds of the baseline children were in the front seat, but those in the back seat were twice as likely to be restrained. During the reward phase, front-seat compliance increased but back-seat children were still restrained at a higher rate. The ages of children did not seem to affect compliance by location. The various groups were found to be almost equally allocated among the seating positions.

Vehicle Type

Restraint usage was related to the type of vehicle. Passenger cars had the best rates, followed by station wagons, pickups, and other vehicles including vans, respectively. Some vehicles may be more conducive to using safety seats than others. For example, the open area in the back of a van or station wagon is a natural play area for a child; consequently, children may be more reluctant to get into safety seats.

It is interesting to note that compliance shifted during the reward phase and became almost uniform regardless of vehicle type. Automobiles were at 65 percent, station wagons were at 69 percent, and pickups were at 63 percent. Apparently, incentives can overcome the inconvenience associated with certain types of vehicles.

FINDINGS

A pilot study was conducted to determine whether or not rewards would increase child restraint usage at two child care centers. The findings were as follows:

1. A data collection procedure utilizing volunteer university students as observers was shown to be very effective.

2. The reward procedures were extremely effective in increasing restraint usage. Restraint usage jumped from 48.7 to 72.7 percent at one location, and from 11.3 to 54.0 percent at a second location. This behavioral change conforms to psychological reward theory.

3. Younger children were more likely to be restrained than older children. This was clear at both centers, in both the baseline and reward periods.

4. Restraint usage was found to be related to time of day. Parents who arrived before or after the rush period exhibited higher levels of compliance.

5. Parents were more apt to restrain children of the opposite sex. Fathers favored daughters, and mothers favored sons.

6. Most of the children arrived seated in the front; however, those in the back seat were twice as likely to be restrained.

7. The type of vehicle influenced restraint use. Automobiles had the highest rates of use followed by station wagons and pickups, respectively. The reward mechanism overcame this bias.

8. Implementation of a general program of this nature could be inexpensive and could provide a substantial health benefit.

IMPLEMENTATION OF FINDINGS

The pilot program's initial success may imply future application in naturalistic settings (e.g., drive-up bank windows, gas stations, etc.). If the rate of behavior change was completely understood, it would be possible to design a reward program to achieve large, long-lasting changes in restraint usage. Refresher rewards could be issued periodically to boost decaying usage rates back to higher levels.

Before widespread implementation of reward programs, further research must be performed. Tests must be conducted to define specific rates of change, when to use refreshers, the effects of socioeconomic status, reward ratios, maintenance levels, and other parameters.

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Optimal and Minimal Luminance Characteristics for Retroreflective Highway Signs

MICHAEL SIVAK and PAUL L. OLSON

ABSTRACT

Presented in this paper are optimal and minimal sign luminance recommendations based on a review of available applied research. Optimal recommendations are based largely on peak luminance-legibility relationships. In the absence of other criteria, minimal recommendations are based on performance levels of 6 m/cm (20/23) for younger persons and 4.8 m/cm (20/29) for older persons. By using a computer sign legibility model, calculations were then made to determine the photometric characteristics of signing material required to obtain the values indicated.

One of the more significant questions facing any traffic agency is the optimum and replacement level for retroreflective signs. Caught up in this question are issues of safety, efficient movement of traffic, and costs. Because these are such important issues, a great number of investigations have been conducted to determine guidelines. The purpose of this paper is to review a selected portion of this research, and summarize the recommendations.

The review included experimental investigations pertaining to the legibility of a message on a sign constructed of retroreflective materials. Studies concerned with the relative merits of illuminated and retroreflective signs, as well as those dealing with nonlegibility issues (e.g., detection, color recognition, conspicuity, and comprehension), address a different set of problems and thus are beyond the scope of this review. Only applied research--whether on the road or in the laboratory--is covered. Purely basic research is not included.

As a first step in this work, a review of the literature was carried out. A total of 18 experimental studies were finally included. [See the original report for the detailed reviews of these studies (1).] Tabular reviews of each paper were prepared to facilitate a comparison of methods,

findings, and recommendations. A synthesis of these data was prepared and will be presented in the next section.

A SYNTHESIS OF EXPERIMENTAL FINDINGS

A synthesis of the findings of the past research in terms of optimal and replacement (minimal) luminance values is provided in this section. The two most common sign types will be considered--a sign with a nonreflective black legend on a reflective light background, and a fully reflectorized sign with a white legend. In arriving at luminance recommendations, we will use geometric means to minimize the effects of extreme values.

The retroreflectance values required to achieve the desired luminance levels will be derived in the next section. The computations of the recommended luminance (and retroreflectance) values will be based on data collected under generally ideal conditions, such as signs placed in dark environments, sober observers, and clean signs. Therefore, in a later section, several variables that contribute to the argument for higher luminance values will be listed, along with some correction factors.