## ABCs for Lone Workers:

# A Behavior-Based Study of Bus Drivers

By RYAN OLSON and JOHN AUSTIN

Effective implementation of behavior-based safety processes involves several generally agreed-upon phases. These can be categorized as follows: 1) *assessment,* during which safety records are reviewed and employees are interviewed in order to identify targets for behavioral observations; 2) *process development,* during which behavioral techniques to be used are identified and outlined in detail; 3) *process implementation,* during which participants are trained in how to implement techniques and during which a kickoff meeting is held; and 4) *continuous improvement,* during which the behavior-based process is evaluated and refined as necessary to ensure continued acceptance and effectiveness (McCann and Sulzer-Azaroff 279; McSween 29).

Although each phase is important for effective implementation, behavior analysis is the foundation of all behavior-based safety initiatives. It involves a skill set that is not easily mastered; however, without these skills, participants in any performance improvement process will find it difficult to develop creative techniques designed to change behavior.

Since behavior change is critical to the success of a behavior-based intervention, and since behavior analysis is critical in developing interventions that can effectively change behavior, it makes sense to help participants become better behavior analysts. Indeed, without significant behavior change, injuries cannot be reduced and the goals of the safety process will remain out of reach.

This article provides an example of one type of structured behavioral analysis—ABC analysis (see Austin); it describes the safety of bus drivers based on a study conducted at Western Michigan University (Olson and Austin). The study examined the performance of four highly experienced bus drivers (20.5 years' average experience) on four safety targets: complete stopping; remaining motionless for at least two seconds when loading/unloading passengers; checking both side mirrors after loading/unloading passengers; and correctly positioned stopping so the door opens after the bus is completely stopped and no cars can pass on the right.

The study was conducted over a relatively short five-week period; this was due in part to the route stopping for seasonal reasons (it did not operate during spring and summer months). Driver performance was measured on a daily basis during two experimental conditions: 1) a no-treatment (baseline) condition; and 2) a self-monitoring and posted-feedback condition where drivers estimated their safe performance twice each day and signed feedback graphs based on self-monitoring data posted in the drivers' lounge. Via radio communication, dispatch supervisors prompted participants to complete self-monitoring forms; they also conducted a special observation of each participant to measure target performances.

Both drivers and supervisors were unaware of experimental observers who measured each participant's performance on a daily basis by riding as passengers. To assess the reliability of the measurement system, two independent observers measured performance on 30 percent of experimental observations. Interobserver agreement scores for these sessions averaged 89.8 percent. A multiple baseline design across performances was used to assess the effects of the intervention on the four performance targets.

The intervention resulted in a 12.5 percent average increase in overall safe performance for the group, with average behavior changes on specific targets ranging from six to 22 percent. Individual increases in specific areas ranged from three to 41 percent. When supervisors conducted their observations, data showed that drivers generally made additional improvements beyond levels achieved during "self-monitoring only conditions." This effect occurred only for those behaviors that drivers knew supervisors were observing. No drivers were involved in an accident/collision during the course of the study, although this cannot be interpreted as a reduction in accidents or collisions due to the small number of participants and the study's short duration.

## TABLE 1 Analysis of Rolling Stops

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Traffic is approaching rapidly. | Acquire position in traffic without waiting. | PIC |
| Hear aversive sound of squealing brakes. | Aversive sound less intense and of shorter duration than during a complete stop. | PIC NIC value may have been altered by intervention. |
| Bus approaches a stop sign with pedestrians or vehicles nearby. | Bus strikes a pedestrian or hits a vehicle or site of a near miss. | NIU (very uncertain) |
| Bus approaches stop sign. | Forward motion continues. | PIC NIC value may have been altered by intervention. |
| Pedestrians approach intersection to cross in front of bus. | Pedestrians stop and wait for bus to pass because it rolls through intersection. Driver avoids a delay. | PIC NIC value may have been altered by intervention. |
| Bus approaches stop sign with or without a police officer or supervisor present. | Traffic ticket or disciplined for a moving violation. | NIU, NFU (the presence of an officer or supervisor increases the certainty of these consequences—but still uncertain.) |
| Bus approaches stop sign. | Minimal muscular exertion on brake pedal. | PIC |
| Bus approaches stop sign. | Estimates a low percent safe score or is dishonest. | NFC (within hours) |
| Bus approaches stop sign. | Sees low percent safe score posted in drivers' lounge. | NFC (next day) |
| Bus approaches stop sign. | Talks about at-risk performance with coworkers at a meeting. | NFC |

*Highlighted areas represent intervention conditions.*

### ABC ANALYSIS OF BUS DRIVER SAFETY

To explore possible reasons for the effectiveness of the self-monitoring intervention used in this study, Daniels' system was used to analyze the driving performances measured (Daniels 37). Daniels suggests analyzing problem (at-risk) performance first, then desired (safe) performance. An ABC analysis entails identifying relevant antecedents and consequences for behavior, where antecedents are stimuli or conditions that precede behavior and set the stage for or prompt it to occur, and consequences are stimuli or conditions that follow a behavior and change the probability that it will recur.

Such analysis consists of listing antecedents and consequences for both at-risk and safe performances, then rating each consequence according to its behavior-strengthening or behavior-weakening qualities. Using a structured method (such as ABC analysis) to hypothesize about which variables cause behavior can stimulate the problem-solving process and suggest strategies for the continuous improvement of safety-related performance management systems.

Both Daniels and Krause have suggested similar coding systems for describing consequences for specific target performances (Daniels 41; Krause). Both systems examine three key issues: 1) value of consequences; 2) immediacy of consequences with respect to the target performance; and 3) probability of consequences. Rating consequences with a coding system can reveal whether the environment or organizational context generally favors at-risk or safe performance. Once the balance of consequences is made clear, analysts can create more-effective behavior change strategies.

In Daniels' ABC analysis, each consequence is rated as either positive or negative (P/N), immediate or in the future (I/F), and certain or uncertain (C/U) (Daniels 41). Positive, immediate and certain (PIC) consequences tend to maintain or increase behavior and likely act as positive reinforcement. Negative, immediate and certain (NIC) consequences tend to decrease or eliminate behavior and likely act as punishment. Future and uncertain consequences typically have little effect on behavior, unless they are of great value or highly unpleasant.

Table 1 shows an analysis of the at-risk performance "rolling stop" and consequences hypothetically available for that

## TABLE 2 Analysis of Complete Stops

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Traffic is approaching rapidly. | Opportunity to merge is delayed. | NIC |
| Hear aversive sound of squealing brakes. | Aversive sound more intense and of longer duration than during a rolling stop. | NIC PIC value may have been altered by intervention. |
| Bus approaches a stop sign with pedestrians or vehicles nearby. | Sight of vehicle or passenger in an unsafe position in relation to bus (potential accident avoided). | PIU |
| Bus approaches stop sign. | Forward motion completely stops. | NIC PIC value may have been altered by intervention. |
| Passenger approaches intersection to cross in front of bus. | Passenger crosses in front of bus, causing the driver to wait several seconds. | NIC PIC value may have been altered by intervention. |
| Bus approaches stop sign. | Maximal muscular exertion on brake pedal. | NIC PIC value may have been altered by intervention. |
| Bus approaches stop sign. | Estimates a high percent safe score and enjoys being honest. | PFC (within hours) |
| Bus approaches stop sign. | Sees high percent safe scores graphed and posted in drivers' lounge. | PFC (next day) |
| Bus approaches stop sign. | Talks about safe performance with coworkers at a meeting. | PFC |

*Highlighted areas represent intervention conditions.*

## TABLE 3 Analysis of Inadequate Pause After Loading/Unloading

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Passengers load/unload. | Immediate forward motion with loading accomplished. | PIC<br>NIC value may have been altered by intervention. |
| Pedestrians waiting near the curb to walk in front of the bus after passengers finish loading/unloading. | Pedestrians remain at the curb and the bus continues without delay. | PIC<br>NIC value may have been altered by intervention. |
| Passengers load/unload. | A person is injured from a fall on the bus or is struck by the bus as it pulls away from the loading zone. | NIU (very uncertain; however, more likely under busy conditions.) |
| Passengers load/unload. | Passenger complains to the transit system. | NFU |
| Passengers load/unload. | Sight of pedestrians or exiting passengers in unsafe positions in relation to the bus and in danger. | NIU |
| Passengers load/unload. | Passengers are seated quickly because the bus starts moving. | PIC<br>NIC value may have been altered by intervention. |
| Passengers load/unload. | Passengers stumble and reach for support because they are standing "free" when motion starts. | PIC (passengers grab support.)<br>NIC value may have been altered by intervention. |
| Passengers load/unload. | Must estimate low percent safe score or be dishonest. | NFC (within hours) |
| Passengers load/unload. | Sees low percent safe scores posted in drivers' lounge. | NFC (next day) |
| Passengers load/unload. | Talks about this at-risk performance with coworkers at a meeting. | NFC |

*Highlighted areas represent intervention conditions.*

## TABLE 4 Analysis of Two-Second Pause After Loading/Unloading

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Passengers load/unload. | Bus remains motionless until loading is accomplished. | NIC<br>PIC value may have been altered by intervention. |
| Pedestrians waiting near the curb to walk in front of the bus after passengers finish loading/unloading. | Pedestrians walk in front of the bus, causing several seconds to a minute of delay. | NIC<br>PIC value may have been altered by intervention. |
| Passengers load/unload. | Passenger falls and is injured on the bus or is struck by the bus as it pulls away from the loading zone. | NIU (very uncertain) |
| Passengers load/unload. | Passenger pays the driver a compliment. | PFU (very uncertain) |
| Passengers load/unload. | Sight of pedestrians or exiting passengers in unsafe positions in relation to the bus (accident avoided). | PIU |
| Passengers load/unload. | Passengers take extra time finding a seat and delay the bus. | NIC |
| Passengers load/unload. | Passengers walk safely down the aisle as the bus moves. | PIC |
| Passengers load/unload. | Estimates a high percent safe score and enjoys being honest. | PFC (within hours) |
| Passengers load/unload. | Sees high percent safe scores posted in drivers' lounge. | PFC (next day |
| Passengers load/unload. | Talks with coworkers about this safe performance at a meeting. | PFC |

*Highlighted areas represent intervention conditions.*

performance, both before and after the self-monitoring intervention. Table 2 shows an analysis of the safe performance "complete stop" and consequences hypothetically available for that performance before and after intervention.

Within highlighted areas of each table and throughout the remainder of this article, it is suggested that some consequences may have changed in value because of the intervention. This speculation is based on theory and research related to the concept of an establishing operation (Olson, et al). Establishing operations are special antecedent conditions that temporarily change the value of certain consequences and evoke behaviors that have produced those consequences in the past. For example, antecedents such as rule statements or instructions have been shown to temporarily change the value of reinforcers that are often considered to have a fixed value (Hughes, et al).

Performing a complete stop is considered safe for many reasons. It is a legal requirement; creates more time to see traffic and pedestrian conditions and risks; and allows other drivers to make clear decisions about right-of-way and opportunities to proceed with forward motion.

However, consequences do not always support performance of this behavior. In fact, many consequences support the at-risk behavior of rolling through a stop sign. For example, performing a rolling stop often allows the driver to obtain a better position in traffic. When traffic is heavy and opportunities to merge are scarce, coming to a complete stop might cause a driver to miss an opportunity to proceed. So, a driver may learn to roll through a stop sign during busy traffic conditions in order to avoid delays.

Similarly, certain pedestrian traffic conditions may encourage rolling stops. For example, if a driver pauses too long at a stop sign and foot traffic is substantial, pedestrians may walk in front of the bus and cause delays. However, if a driver rolls through a stop sign, s/he may avoid a delay by moving past a crosswalk before pedestrians step off of the curb.

Another consequence observed during this study seemed to reinforce/support soft or brief application of the brakes. On many buses, braking systems make an unpleasant screeching sound; during a rolling stop (with a brief or soft application of the brakes), the noise was not as loud and occurred for a shorter duration. Thus, in some cases, braking was "punished" by the presence of an unpleasant sound, while rolling stops were reinforced by the quick cessation of that sound.

Negative consequences for rolling stops may include receiving a traffic ticket; being disciplined by the employer; or colliding with another vehicle or pedestrian—all of which are uncertain. For preintervention conditions, it was hypothesized that rolling stops were supported by at least five positive consequences and discouraged by two uncertain negative consequences. The highlighted portions of Table 1 show how intervention procedures may have created additional negative consequences for rolling stops and weakened the value of some positive consequences for them.

As Table 2 shows, it was hypothesized (prior to intervention) that complete stops were discouraged by at least five negative consequences. As discussed, performance of complete stops may have been "punished" at times by the loss of an opportunity to merge with traffic. Furthermore, lunch and other breaks throughout the workday were maximized if the bus was on time or ahead of schedule. This condition may have strengthened the value of continuous forward motion as a reinforcer, making extended pauses in forward motion unpleasant.

One positive consequence for a complete stop was identified—the sight of pedestrians or other vehicles in precarious positions in relation to the bus—but it was not literally dependent on the performance of a complete stop. A driver could have identified pedestrians or vehicles in such positions regardless of the bus's motion, since sight is dependent on head position and eye movement. However, the opportunity for these "looking behaviors" increases during a complete stop.

After considering just a few consequences related to the rolling stop behavior (at-risk) and the complete stop behavior (safe), it is clear that safe behavior was discouraged and unsafe behavior was reinforced. These dependent relationships between behaviors and consequences may have contributed to at-risk stops observed during both baseline and intervention phases of this study.

To summarize, preintervention conditions seemed to discourage the safe performance of complete stops and it was hypothesized that intervention procedures added negative consequences for the at-risk behavior (rolling stops) and positive consequences for safe performance (complete stops). Intervention procedures may have also altered the value of some naturally occurring consequences. This same general pattern was evident in the ABC analyses conducted for the remaining three target performances.

Table 3 shows an analysis of the at-risk behavior "less than two-second pause after loading/unloading passengers" and hypothetical consequences available for that performance before and after intervention. Table 4 shows an analysis of the correct performance "two-second pause after loading/unloading passengers" and hypothetical consequences

### TABLE 5 Analysis of Looking at Fewer Than Two Side Mirrors

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Passengers load/unload. | Minimal (comfortable) neck muscle exertion. | PIC<br>PIC value may have been altered by intervention. |
| Passengers load/unload. | Passenger falls and is injured on the bus or is struck by the bus as it pulls away from the loading zone. | NIU (very uncertain) |
| Passengers load/unload. | Another vehicle is struck by the bus. | NIU (very uncertain) |
| Passengers load/unload. | Sight of vehicles, pedestrians or exiting passengers in unsafe positions in relation to the bus (accident avoided). | PIU (less certain than with a safe mirror check.) |
| Passengers load/unload. | Sight of interesting things happening around the bus (not visible in mirrors). | PIC |
| Passengers load/unload. | Estimates low percent safe score or is dishonest. | NFC (within hours) |
| Passengers load/unload. | Sees low percent safe scores graphed and posted in drivers' lounge. | NFC (next day) |
| Passengers load/unload. | Talks about this at-risk performance with coworkers at a meeting. | NFC |

*Highlighted areas represent intervention conditions.*

### TABLE 6 Analysis of Checking Both Side Mirrors

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Passengers load/unload. | Maximal neck muscle exertion for the occasion. | NIC<br>PIC value may have been altered by intervention. |
| Passengers load/unload. | Passenger falls and is injured on the bus or is struck by the bus as it pulls away from the loading zone. | NIU (very uncertain, but even less certain when mirrors are checked.) |
| Passengers load/unload. | Another vehicle is struck by the bus. | NIU (very uncertain, but even less certain when mirrors are checked.) |
| Passengers load/unload. | Sight of vehicles, pedestrians or exiting passengers in unsafe positions in relation to the bus (potential accident avoided). | PIU<br>PIU (value may have been altered by intervention even more positive.) |
| Passengers load/unload. | Sight of mirrors without vehicles, pedestrians or exiting passengers in unsafe positions in relation to the bus. | NIC (why look if nothing is ever there?) |
| Passengers load/unload. | Estimates a high percent safe score and enjoys being honest. | PFC (within hours) |
| Passengers load/unload. | Sees high percent safe scores graphed and posted in drivers' lounge. | PFC (next day) |
| Passengers load/unload. | Talks about this safe performance with coworkers at a meeting. | PFC |

*Highlighted areas represent intervention conditions.*

## TABLE 7 Analysis of Poor Stopping Position

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Approaching loading/unloading zone. | Passenger loads/unloads quickly because door is open before bus is stopped. Forward motion begins earlier. | PIC NIC value may have been altered by intervention. |
| Approaching loading/unloading zone. | Passenger loads/unloads safely. | PIC (a little less certain than with safe stopping position.) |
| Approaching loading/unloading zone. | Passenger loads/unloads while bus is still in motion and is injured or is struck by another vehicle passing the bus on the right. | NIU (very uncertain) |
| Approaching loading/unloading zone. | Estimates a low percent safe score or is dishonest. | NFC (within hours) |
| Approaching loading/unloading zone. | Sees low percent safe scores graphed and posted in drivers' lounge. | NFC (next day) |
| Approaching loading/unloading zone. | Talks about this at-risk performance with coworkers at a meeting. | NFC |

*Highlighted areas represent intervention conditions.*

## TABLE 8 Analysis of Correct Stopping Position

| ANTECEDENTS | CONSEQUENCES | RATING |
|---|---|---|
| Approaching loading/unloading zone. | Passenger loads/unloads slowly because door is shut when s/he is ready to board. Forward motion is delayed. | NIC PIC value may have been altered by intervention. |
| Approaching loading/unloading zone. | Passenger loads/unloads safely. | PIC (very certain) |
| Approaching loading/unloading zone. | Passenger loads/unloads and is injured or is struck by another vehicle passing the bus on the right. | NIU (even more uncertain than during poor stopping position.) |
| Approaching loading/unloading zone. | Estimates a high percent safe score and enjoys being honest. | PFC (within hours) |
| Approaching loading/unloading zone. | Sees high percent safe scores graphed and posted in drivers' lounge. | PFC (next day) |
| Approaching loading/unloading zone. | Talks about this safe performance with coworkers at a meeting. | PFC |

*Highlighted areas represent intervention conditions.*

available for that performance before and after intervention.

This behavior bears some similarity in analysis to complete stops because both performances require the driver to hold the brake pedal down and keep the bus motionless for a given duration. As noted, in many cases, forward motion likely functioned as a reinforcer, given the tight scheduling of routes.

Considering the reinforcing nature of forward motion, one could conclude that keeping the bus motionless after a passenger boarded/exited would have been aversive. In addition, pedestrians could walk in front of the bus and cause further delay. Many times throughout the study drivers started forward motion of the bus immediately after passengers loaded/unloaded; consequently, pedestrians remained on the curb until the bus passed rather than walk in front of the bus.

Table 5 shows an analysis of the at-risk behavior "looking at fewer than two side mirrors after loading/unloading passengers" and hypothetical consequences available for that performance. Table 6 shows an analysis of the safe behavior "checking side mirrors after loading/unloading passengers" and the hypothetical consequences available for that performance.

Table 7 shows an analysis of the at-risk behavior "poor bus stopping position (door open early or cars able to pass on right) before loading/unloading passengers" and the hypothetical consequences available for that behavior. Table 8 shows an analysis of the safe behavior "correct stopping position (door opens after complete stop and no cars can pass on right)" and hypothetical consequences available for that behavior.

### DISCUSSION

This structured exercise revealed some possible dependent relationships between behaviors and consequences that may have been responsible for performance improvements. Each table illustrates the central safety dilemma, where "natural" PIC consequences seem to support at-risk performance while safe performance is discouraged by NIC consequences; it appears accidents and injuries were too uncertain to exert a strong influence on behavior.

In theory, the intervention was effective because of the degree to which added consequences were more power-

## As this study shows, "natural" consequences often support at-risk performance while safe performance is discouraged by negative consequences.

ful than "natural" existing consequences which supported at-risk behavior. The behavior-changing power of consequences is emphasized in structured ABC analyses because long-term behavior change requires supporting consequences, whether they are "natural" or "management planned."

Antecedents can initiate behavior, but only when that behavior produces successful outcomes (e.g., reinforcers valuable to the specific performer) will it be maintained over the long-term (Daniels). In other words, antecedent interventions such as signs, awareness campaigns, meetings and training will produce only short-term effects unless valuable consequences are produced by the behaviors prompted by these interventions.

Whether or not this intervention produced short- or long-term effects is an empirical question. Unfortunately, seasonal termination of the route, changes in route assignments and limited resources prevented an assessment of long-term behavior change. However, the researchers believe it is likely that behavior changes generated by the intervention did not last because the consequences generated by the intervention were not sustained.

A less-likely, yet possible outcome is that a driver contacted some "natural" reinforcers for the target behaviors and maintained these improvements once the intervention ceased. In other words, desired performance might have been "trapped" once the performer contacted positive, natural consequences that had always been available, yet simply were not experienced frequently enough prior to intervention (Malott, et al). For example, perhaps passengers complimented drivers on particular behaviors once they increased in frequency.

Although such an outcome would be welcome, this ABC analysis suggests that "natural" consequences for target performances might not have been so supportive on this route. Another interesting question is whether drivers changed their behavior simply because the "spotlight" was on safety. In the authors' opinion, "spotlight" effects are analogous to short-term effects of antecedents. When a new safety process is started, it may cause performers to "try out" the behaviors being emphasized in order to avoid criticism and/or to test whether the organization and their peers truly care about (will provide positive consequences for) the specified behaviors. The central research question in this study was whether a self-monitoring package would produce actual changes in lone-worker behavior. While this question was answered affirmatively, the question of whether such interventions can maintain long-term behavior change is a question to be answered through future research.

### CONCLUSION

ABC analysis was conducted after this study to better understand why the intervention was effective. However, such analysis can and should be used to develop interventions as well. To do so, one would analyze antecedents and consequences in the manner described in order to more clearly see the dependent relationships between environmental antecedents and consequences that encourage at-risk behavior and seek to create a new context that better encourages safe behavior. Typically, this is accomplished by adding PIC consequences and appropriate antecedents to support the safe behavior, while removing PIC consequences and antecedents that support at-risk behavior. Exactly which antecedents and consequences should be altered or added can be understood through thorough ABC analysis.

When used to solve performance problems, ABC analysis helps uncover process, system and/or engineering deficiencies that create at-risk conditions or encourage at-risk behavior. This is an important feature of such analysis because excellent equipment, processes and engineering solutions facilitate safe behavior and minimize risk. Using such a structured behavior analysis technique can increase the chances that safety processes remain effective and continue to improve over time, even in the face of difficult and complex challenges. ■

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