EXPERIMENTAL ANALYSIS OF SPECIFIC AUDITORY-LIGHT SAFETY BELT REMINDER SYSTEMS AND SAFETY BELT BEHAVIOR: "PRODS" OR "PROMPTS"

by

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(ABSTRACT)

Safety belt reminder systems are ubiquitously present in most, if not all, automobiles sold in the United States. Past research has found that the effectiveness of these reminder systems have shown minimal social benefit in the effort to increase safety belt use. The current investigation was conducted to determine if modified reminder systems could improve safety belt use. This research used an electronically equipped research vehicle sponsored by General Motors Corporation. The vehicle's research equipment allowed for the manipulation of different auditory reminder stimuli (i.e., chime, buzzer, and voice), temporal factors (e.g., presentation delays and second reminders), and the measurement of the driver's safety belt use. Three modifications were explored: the presentation of a Delayed Reminder, Second Reminder, and comparisons of different auditory stimuli. The vehicle also permitted a single subject repeated measure design and methodology that provided process analysis.

The results showed that the Delayed Reminder appeared ineffective at increasing belt use, whereas the Second Reminder was found to increase two out of nine subjects' safety belt response rates. The differential effects between the three auditory stimuli (i.e., Chime, Buzzer, & Voice) were inconclusive, though for two subjects the Buzzer and Voice were associated with safety belt increases.

Vive ut vivas

"Live that you may live."

I dedicate this endeavor to my father and mother

Thomas D. Berry III

Stephanie M. Berry

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

Historically, since the introduction of automobiles as a means of travel, more than 2 million people have been killed as the result of automobile crashes in the United States (Insurance Institute, 1974). Financially, the cumulative liabilities for auto-related accidents are greater than 60 billion dollars per year (Pabon, Sims, Smith, & Associates, 1983). Obviously, automobile accidents extract a profound cost in both lives and capital to our society.

However, safety belts when used by drivers and passengers can reduce crash related fatalities and injuries by 40 to 55 percent (Evans, 1986a; Federal Register, 1984; Robertson, 1976). Therefore, many of the approximately 40,000 deaths and 500,000 accident injuries that occur each year (Bigelow, 1982; Hedlund, 1985) involving motor vehicles could be avoided or mitigated if safety belts were used consistently (Federal Register, 1984).

Under the National Traffic and Motor Vehicle Safety Act of 1966, lap belts and shoulder harnesses in front seat positions, and lap belts in rear seat positions, were required in all new automobiles sold in the U.S., with few exceptions (Robertson, 1975b). Today, it is estimated that over 95 percent of all automobiles are equipped with safety belts (Department of Transportation, 1976). Yet, over the past 22 years U.S. drivers and passengers have been slow, if not resistant, to acquire the buckle-up habit, despite the possible risks of not using and benefits of using safety belts. In general, the national average for safety belt use during this period of time has ranged from 10 to 30 percent (Bigelow, 1982; Campbell, Waller, & Council, 1967; Council, 1969; Grimm, 1980; Robertson & Haddon, 1974), with 1983 showing a nationwide use of 15 percent (Perkins, Cynecki, & Goryl, 1984).

In the past 10 years many approaches have been attempted to increase safety belt use throughout the United States. The following four approaches should not be interpreted as mutually exclusive interventions, but rather, as a comprehensive mobilization of societal and research energies towards saving lives from vehicle crashes. It is suggested that the combined effect of these approaches has resulted in the establishment of a social norm (i.e., to use safety belts) within the different levels and infrastructures of the population (Evans, 1986b). It is assumed that each approach contributes to the solution (i.e., reduced injuries and fatalities), though separate effects may be small and statistically insignificant. See Evans (1986b) for an instructive overview of the relative contributions of the various approaches that reduce traffic fatalities.

1) Mass media campaigns have shown mixed results: either they are ineffective as shown in Canada and the U.S. (Cunliffe, DeAngelis, Foley, Lonero, Pierce, Siegel, Smutlylo, & Stephen, 1975; Geller, 1981; Nau, 1982; Robertson, Kelley, O'Neil, Wixom, & Haddon, 1974), or effective as demonstrated in Great Britain (Nichols, 1982).

2) Incentive strategies have demonstrated the potential for markedly increasing safety belt use across a variety of settings (Campbell, Hunter, Stewart, & Stutts, 1982; Elman & Killebrew, 1978; Geller, 1982; Geller, Johnson, & Pelton, 1982; Geller, Paterson, & Talbot, 1982; Rudd & Geller, 1986).

3) Legal mandates in many countries, including the U.S. indicate justification for belt legislation (Campbell, Stewart, & Campbell, 1987; Mackay, 1987; Marburger & Friedel, 1987; Matthews, 1982; Nichols, 1982; Petrucelli, 1987). Typically, following enactment of safety belt use laws, belt use increased by two to three times the prior baseline rate. Since 1984 when the first belt use laws were put into effect in the U.S. (i.e., in New York and New Jersey), belt use rose from

15 percent to levels ranging from 30 - 60 percent (Campbell, Stewart, & Campbell, 1987). Britain and Germany can boast safety belt rates of 90 percent or higher, since their belt laws took effect (Mackay, 1987; Marburger & Friedel, 1987). Apparently, the maintenance of compliance with a belt use mandate is contingent upon the interaction of law enforcement (warnings and tickets), governmental support, and educational/media campaigns (Campbell, Stewart, & Campbell, 1987; Matthews, 1982).

4) The human factors approach has contributed to safety belt use in two areas. In the first case, engineering efforts have concentrated on the design, placement, and mechanical components of the manual safety belt hardware (Chaffee, 1970; Johannessen & Vos, 1982; McElhaney, Roberts, & Melvin, 1972) and the user's ability to interface with belt systems properly and easily (Garg, Bakken, & Saxena, 1982; Johannessen & Vos, 1982). In general, the automotive industry has struggled with supplying both a system that prevents injury during vehicle crashes, and a system that is comfortable, convenient and user friendly, while meeting certain aesthetic qualities (Seat Belt Systems, 1982).

Second, auto manufacturers are required by law to provide some type of safety belt auditory-light reminder system (i.e., Federal Standard 208). The human factors perspective maintains that auditory-light displays should provide information that is visible, distinguishable (Mourant & Langolf, 1976), and meaningful (Green & Pew, 1978) to the occupants of the vehicle. (For a general review of the human factors approach to auditory-visual displays see Kantowitz & Sorkin, 1983).

Typically, safety belt reminder displays are engineered into the automobile's instrument panel (AIP) and connected electronically to a sensor in the driver's safety belt buckle or latch. In general, the function of an auditory-light safety belt reminder is to inform drivers and passengers that their safety belts are not fastened, and to prompt or to prod drivers and passengers to "buckle up". The preceding statement attempts to discriminate between two possible functions of reminder stimuli: prompting or proding. The former (prompts) define a reminder as the presentation of a nonaversive antecedent discriminative stimulus, which (if effective) sets the occasion for the driver and passengers to buckle up in order to reduce risk, to obtain social reward or to comply with a belt law.

The latter (prods) define a reminder as the presentation of aversive stimuli as a consequence for not having fastened one's safety belt. The presentation of the aversive stimuli impels the driver to terminate the aversive reminder by fastening his/her safety belt (i.e., negative reinforcement). The importance of distinguishing between prompts and prods is evident when applied to the theoretical and behavioral inferences concerning the function and purpose of safety belt reminder stimuli. This discrimination will be discussed and clarified in the following sections.

History and Analysis of Past Safety Belt Reminder Systems

In 1971, U.S. auto makers designed and installed in some vehicles a buzzer and light system to encourage belt use. This system initiated a buzzer and lighted a dashboard display reading "Fasten Seat Belts" when the ignition was started (Koval, 1971). Effective January 1, 1972 through August 14, 1973 a Federal standard required a buzzer-light system to be installed in all vehicles without passive restraint systems (i.e., passive safety belts or airbags). This buzzer-light reminder system was activated for at least one minute if belts were not fastened or if belts were not extended four inches from belt retractor mechanism when the ignition was switched on. Except for a few thousand automobiles equipped with passive restraint systems all vehicles manufactured from January, 1972 to August, 1973 were equipped with the above buzzer-light system (Robertson, 1975b).

Effective August 15, 1973, another Federal Regulation required automobile manufacturers to install what was referred to as the "ignition-interlock system". The interlock system prohibited an automobile from starting if either the driver or a front seat passenger was not buckled, or if belts were not extended 4 inches from belt retractor mechanisms. Also, if the driver or front seat occupant unlatched his or her safety belt after the start of the vehicle, a buzzer-light system was activated (Robertson, 1975b).

Comparison between ignition-interlock and buzzer-light systems. For the above buzzer-light and interlock systems, safety belt use was observed to range from 28 to 100 percent, respectively (Geller, Casali, & Johnson, 1980; Nichols, 1982; Robertson 1975b). According to Geller et al. (1980), the effectiveness of a safety belt reminder system was shown to be dependent on the duration of the reminder system (i.e., the intrusiveness of the system). Therefore, safety belt use was greater in interlock equipped vehicles as compared to buzzer-light systems due to the "unlimited" duration of the system. While seat belt use was greater in vehicles equipped with interlock systems as compared to those with the light-buzzer systems, observational measures were confounded by evidence that vehicle owners were disconnecting or defeating their reminder systems.

Robertson (1975a, 1975b), Westfeld and Phillips (1976), and Geller et al. (1980) observed that between 40 and 70 percent of observed interlock systems had been defeated. A defeated system occurred when the safety belt was buckled behind the occupant or the reminder interlock system was disconnected. Additionally, 20 percent of drivers questioned by Robertson (1975a) mentioned that the interlock system was one of the three least "liked" aspects of their new car. Further research by Geller et al. (1980) found that on average, 62 percent of "unlimited" reminder systems were defeated in observed vehicles (i.e., systems in which buzzer-light durations continue until the driver's belt is fastened, including interlocks). In fact, Geller et al. (1980) found an increasing function between the degree of intrusiveness or "aversiveness" of a reminder system and the percent of reminder systems defeated, from 23 to 70 percent.

Indicative of the high incidence of defeated reminder systems, strong negative public reaction influenced the repeal and modification of the Federal standards. Thus, both the ignition-interlock and continuous buzzer-light systems were banned as standard equipment. In 1975, the Federal law adopted the current buzzer and light safety belt reminder standard: when the driver's safety belt is not fastened, both visual and auditory reminder stimuli will initiate for a duration from 4 to 8 seconds. However, if the driver happens to buckle up during the reminder presentation only the auditory stimulus will terminate (and not the visual light reminder). This system is referred to as a "limited" reminder system due to the temporal constraints on the duration of the auditory signal.

Comparison between buzzer-light vehicles and vehicles not equipped with buzzer-light systems. Robertson (1975b) and Robertson and Haddon (1974) compared belt use in 1972 automobiles by whether or not the vehicles were equipped with buzzer-light systems. These field studies used similar methodologies. Both observed drivers' safety belt use or non-use and then matched vehicle license plates to the vehicle model in order to factor in the type of reminder system. Both studies found no significant differences in belt use between buzzer-light equipped and non-equipped vehicles. Similarly, a Department of Transportation study using rental cars with various combinations of buzzer-light and interlock systems, also showed no significant differences in belt use across the different types of reminder systems (Cohen & Brown, 1973). However, Geller et al. (1980) found differences among safety belt rates associated with different reminder systems: combined buzzer-light systems were associated with higher belt use than reminder systems that presented either a buzzer or light alone.

From the results compiled above, it is difficult to conclude if, and to what extent, safety belt reminder systems increase belt use. Clearly, ignition-interlock and continuous "unlimited" systems can "prod" people to use their safety belts, but such systems tend to motivate circumvention. On the other hand, according to Robertson and Haddon (1974), buzzer-light systems have not shown any significant effect to increase safety belt use. In fact, Robertson described buzzer-light systems as a "public health failure". If Robertson is correct that buzzer-light systems are ineffective, then auto manufacturers could have saved 200 million dollars in safety belt reminder hardware costs since 1975 (Von Buseck & Geller, 1983).

The above conclusions concerning the apparent effectiveness of buzzer-light reminder systems seem premature. The above field studies can only be considered gross examinations, with naturally occurring methodological and inferential drawbacks.

First, there was no mention made of the different types and placements of the auditory-light displays installed in the observed vehicles' automotive instrument panel (AIP). For instance, no documentation was offered regarding the type of auditory signals observed (e.g., Chime versus a Tone), where the visual display was placed on the instrument panel, or whether the light flashed or illuminated continuously.

Second, since many context specific variables (i.e., placement and types of reminder stimuli in the AIP as mentioned above) concerning the reminder systems were not documented, controlled for, or blocked, potentially relevant and true functional effects may have been washed out by the use of aggregating group design statistics (Barlow & Hersen, 1984). In the case of the ignition-interlock system, where the effects were robust, confidence in the causal inference is merited. However, conclusions about less salient reminder systems should be made carefully and with qualification. Therefore, the above studies may have been insensitive to some subtle functional effects which were imbedded in the noise of the other ineffective reminder systems. It should be noted that Geller et al. (1980) did separate various reminder systems into eight different categories, including those systems which were defeated. This resulted in a more sensitive measurement of the relative influences that different reminder systems had on safety belt use.

Third, there has been a failure to specify the behavioral purpose and function of the reminder stimuli. Generally, the assumption is that reminder systems prod an avoidance/escape response. But it is highly unlikely that all safety belt responses to reminder systems are a function of avoidance/escape. How a researcher conceptually defines the function of the reminder stimuli will in part, determine the researcher's expectations concerning the results. These expectations can influence the sensitivity of the methods and measurement procedures used, and the subsequent inferences and interpretations of the data (see later section for further discussion of this point).

It is difficult for field studies to generate the appropriate controls and precision necessary to unpack the numerous variables which influence measurements and interpretations. Still, making conclusions about the effectiveness of reminder systems without entertaining the possible context variables associated with the AIP seems presumptuous.

The purpose of the present research was to provide some of the necessary controls by standardizing the context variables across subjects. This was done by using a research vehicle equipped with electronic devices that manipulated varying reminder parameters (e.g., visual, auditory and temporal stimuli) and measured subjects' subsequent safety belt use. Thus, as subjects drove the research vehicle (a quasi-laboratory on wheels), different reminder stimuli and arrangements (e.g., delayed reminders) were evaluated for their potential to increase safety belt use. Further, this experimental and exploratory opportunity permitted process and repeated measurements. Previous research relied on single observations of individual drivers, therefore, sacrificing process analysis and examination of the individual driver. By conducting single subject repeated measure research, subject's data can guide the researcher's investigation of reminder stimuli, thus allowing the potential to demonstrate and evaluate functional control (e.g., ABAB design).

A THEORETICAL AND BEHAVIORAL ANALYSIS OF SAFETY BELT REMINDER SYSTEMS

Arranging Consequences for Safety Belt Use

Reminder systems are designed to prompt or prod drivers and occupants to use their safety belts. Reminder stimuli are supposedly associated with the possible contingent consequences of safety belt use (avoiding possible injury and death). Emphasis should be on the word "possible" because even though more than 40,000 deaths and 500,000 injuries occur each year, the probability that any individual will be involved in an auto crash during a single trip is rare. Slovic, Fischoff, and Lichtenstein (1978) estimated that approximately one in every 3.5 million trips ends in a fatal accident, and about one in every 100,000 person trips results in a disabling injury. Therefore, relating these ratios to the basic principles of operant conditioning and learning, it is unreasonable to expect people to use safety belts when the probable beneficial consequences for such a behavior are so rare. Mass media campaigns, incentive strategies, legal mandates and engineering reminder systems all attempt to bridge this temporal and probabilistic gap between the safety belt response and a possible vehicle accident, by presenting consequences for safety belt use in different forms (i.e., positive and negative reinforcement).

Reminder systems: Antecedents or Consequences ?

Avoidance/Escape behavior. It is the author's position that traditionally, reminder systems have been behaviorally conceptualized as simply presenting a stimulus of some intensity which would set the occasion for an escape response (i.e., buckling one's safety belt or disconnecting the system). Of course, the former response is preferred. As a consequence of experience with the aversive reminder system, the safety belt response becomes conditioned to particular discriminative stimuli (e.g., the vehicle's interior environment), thus shaping a conditioned avoidance response (CAR). The avoidance/escape phenomenon demonstrates the operant principle of negative reinforcement. Reminder stimuli that provoke an avoidance/escape response have been previously described in this paper as "prods".

The avoidance/escape theory applied to safety belt reminder systems seems to have some operational problems. First, in the automotive industry there has been no attempt to standardize the type or intensity level that effective reminder system stimuli should approximate. In general, current reminder systems come in many forms with differing degrees of intensity (e.g., buzzers, tones, and chimes), different visual lights (e.g., flashing versus continuous), and are displayed in a variety of dashboard contexts. The only stimulus parameters that appear to be standardized are the temporal duration of the auditory prompt (4-8 seconds) and when the reminder system is activated (i.e., upon turning the ignition key). This is consistent with Federal standards.

Second, there is the empirical question of defining an "appropriate" aversive stimulus which will "prod" an avoidance/escape response. The term "appropriate" relates to the specific intensity and quality of a stimulus that will initiate a generic avoidance/escape response among a large portion of drivers and occupants. In other words, an aversive stimulus should be defined by the population of drivers and occupants who will behave in order to terminate or avoid its presentation. Of course, by using aversive stimuli to set the occasion for negatively reinforced responses, auto makers run the risk of inciting negative reactions from consumers. Yet, reminder systems that present definably neutral stimuli in the attempt to "prod" an avoidance/escape response seem to gainsay the intention of the negative reinforcement approach and conceptualization.

Reminders as discriminative stimuli. A discriminative stimulus is defined here as a reminder that is in and of itself not a consequence for not using one's safety belt. Conceptually, this type of reminder stimuli is defined as being neutral and nonaversive, but distinctive, functioning as an antecedent discriminative stimulus (i.e., a prompt) which sets the occasion for safety belt use. Still, a question remains as to what contingent consequences, that is, what type of reinforcers are associated with a reminder stimulus which provides the behavioral conditioning.

Of course, there is no manufactured "built in" contingent consequence that renders a reminder stimulus functional. Therefore, whether reminder systems defined as discriminative stimuli function as prompts or not, depends on the driver/occupant's contemporary and historical experiences associated with the risks and dangers of driving, and the established norms of society.

In summary, the conceptual discrimination is whether reminder signals are defined (academically or in reality) as "consequences" (i.e., prods) for inappropriate behavior (i.e., not buckling up), or as "reminders" (i.e., prompts) for desired behavior. Prior research efforts that evaluated the effectiveness of safety belt reminder systems lacked this conceptual specification, thereby possibly influencing their conclusions and interpretations.

The reminder systems defined above (i.e., aversive and discriminative stimuli) both attempt to condition a three-term contingency (Skinner, 1953) between the presentation of the reminder stimuli, the use or non-use of the safety belt, and the subsequent consequence for behaving. Note that the presentation of reminder stimuli is organized within a physically and temporally dynamic context. In other words, the scheduling or the presenting of safety belt reminder stimuli is referenced or mapped against other vehicle produced stimuli and against a driver's own behavior. Therefore, in the following sections a notational system will be used to model and map the dynamic sequences of stimuli and behavior, so as to aid in the development of a theoretical rationale for specific hypotheses concerning improved safety belt reminder systems.

Application of a Notational System

One way to explore possible sources of variability in safety belt use is to diagram the multi-operant chains and associated stimuli pertaining to the behavioral sequence (e.g., a task analysis that investigates the interface between the person's behavior and his/her environment). Analyzing each concatenated unit and link that defines the behavioral-environmental phenomenon of safety belt use or non-use will aid in the discrimination of the critical events associated with safety belt reminder systems. Of course, there will always be any number of reasons why a person doesn't buckle up each instance they use an automobile. The challenge for a behavioral engineer working with stimulus components of any phenomenon is to arrange, present and investigate those components that will gain a desired level of control over behavior.

Before a behavioral engineer can begin, blueprints should be drawn in order to understand the current reinforcement schedules and stimulus arrangements that influence the target behavior. A notational system is applied (as adapted from Findley, 1963) to diagram complex multi-operant chains. The notational system is used to illustrate the current reminder system's organization juxtaposed to the other concurrent stimuli and behavioral demands of operating an automobile.

Multi-Operant Analysis

Von Buseck and Geller (1983) investigated temporal factors associated with the occurrence of safety belt use. They found that out of a sample of 959 drivers, 87.2 percent were non-users and 12.8 percent wore safety belts. The data showed that non-users were significantly more time efficient than those who buckled up, taking 4.5 seconds less from the time they entered the car to the time the car first moved. Those who buckled up either buckled before or after starting their engines, each taking relatively the same amount of time to buckle up.

Implied in this study, is the demonstration of behavioral chains and sequences. Those who wear safety belts behave according to a habit or routine prompted by numerous historical and contemporary conditions (e.g., reduced risk, reinforcement history, avoidance/escape conditioning, and social pressure). What is of import is the behavioral sequence that leads to the use or non-use of safety belts. This stimulus-response sequence can be described as a multi-operant "chain" (See Figure 1). Chains are defined as "a series of responses joined together by stimuli that act both as conditional reinforcers and as discriminative stimuli" (Reynolds, 1975). Therefore, a person responds to one set of

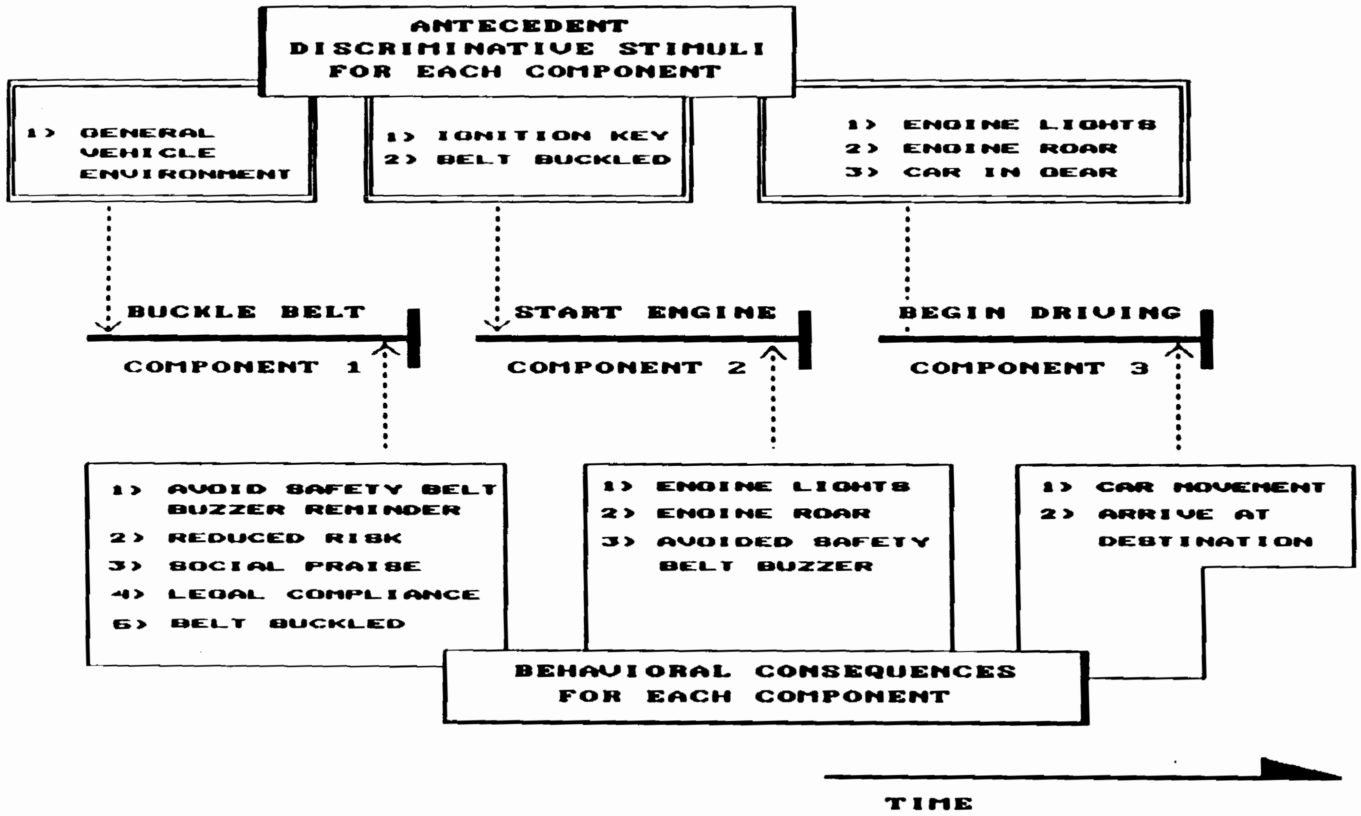


FIGURE 1. AN EXAMPLE OF A TYPICAL PATTERN FOR SAFETY BELT USE.

demands or prompts at a given time before engaging in the next set of responses. Each unit of a chain is called a component and is linked by prearranged or naturally occurring discriminative stimuli or conditioned reinforcers. A person who responds according to the behavioral consequences and associated stimuli, is said to be under stimulus control.

For example, Figure 1, on the preceding page, illustrates how a hypothetical person may first buckle his/her safety belt before starting the engine, because he/she is cued by the general vehicle environment. They are negatively reinforced by avoiding the aversive sound of the reminder system (see component 1). Then, in component 2, starting the vehicle is cued by the completion of buckling up and conditionally reinforced by the starting of the engine which presents associated stimuli (engine lights and roar, and possible radio sounds). The reward or positive reinforcer is getting to one's destination (see component 3). Of course, the specific consequences that maintain and contribute to an individual's use or nonuse of a safety belt are numerous: historical conditioning (e.g., previously having had an auto crash injury, a driver wears a safety belt in order to reduce risk) and/or contemporary conditioning (e.g., a person takes part in a safety belt use lottery, where presentation of lottery prizes are contingent on belt use).

The question is which possible stimulus parameters of the currently manufactured reminder system are effective or ineffective in occasioning safety belt use. Figure 2 on the following page illustrates the currently employed reminder system in most U.S. cars. The diagram notates a concurrent or option schedule (Thompson & Grabowski, 1972), in which the opportunity to fasten one's safety belt occurs "after" ignition start up. Concurrent schedules involve the simultaneous arrangement of antecedents and consequences for two or more responses according to two or more schedule components (i.e., task demands or requirements for obtaining reinforcement). In general, concurrent schedules present a choice to the individual.

For example, by turning the ignition key a driver simultaneously activates an assortment of discriminative stimuli and conditioned reinforcers: the reminder lights, engine start up lights, engine roar, and possibly the radio. The driver then responds to this array of stimuli. Thus, some individuals might not respond to the current reminder system because the reminder stimuli are juxtaposed with other concurrent vehicle stimuli. The following will elaborate on two

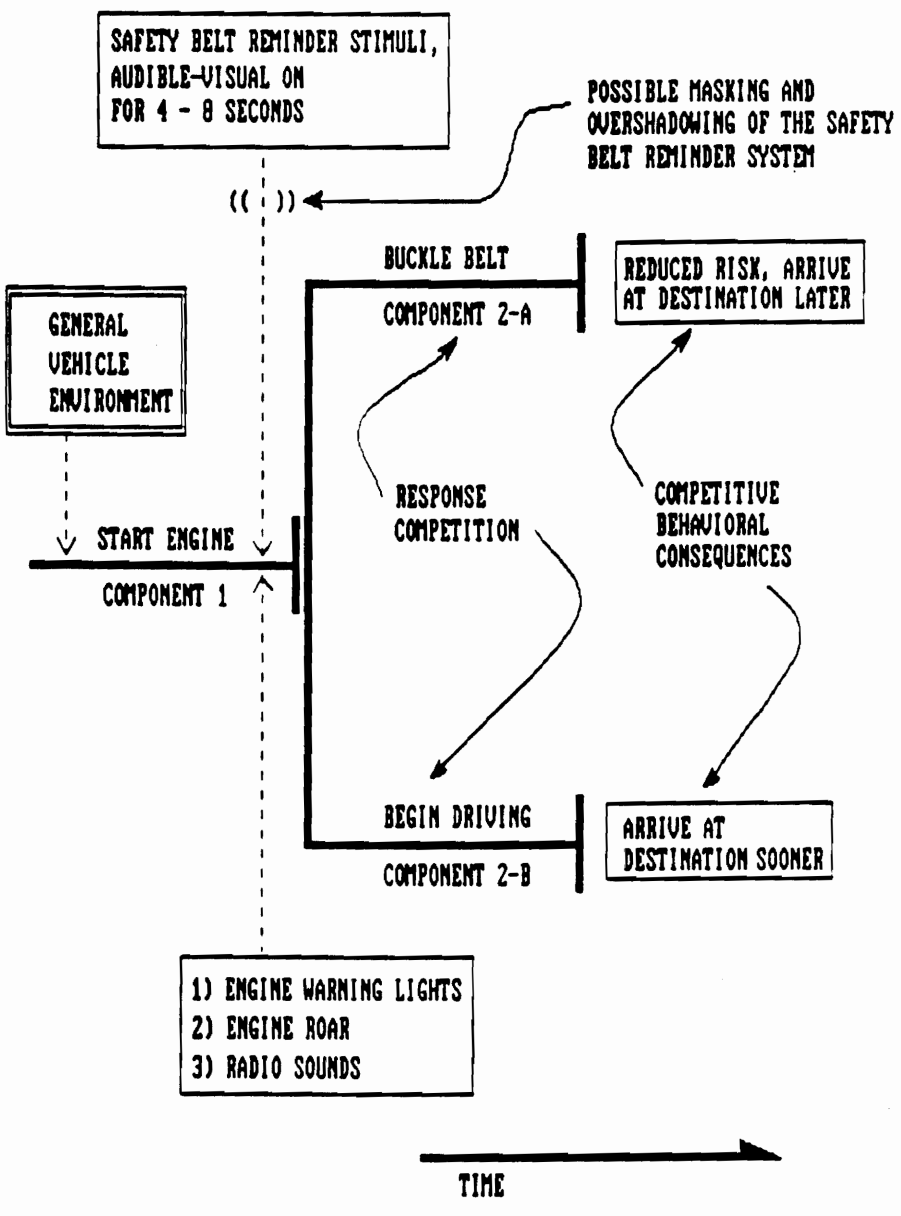


FIGURE 2. CONCURRENT SCHEDULING OF CURRENTLY INSTALLED SAFETY BELT REMINDER SYSTEMS.

possible explanations: 1) response and reinforcement competition, and 2) stimulus discrimination and competition.

First, starting a car in the presence of concurrent prompts and demands, presents a situation that occasions a choice of responses associated with dissimilar topographies and relative reinforcement values (see Figure 2). On one side of the concurrent schedule (component 2b), the stimuli associated with the general operation of the vehicle is presented, like the engine lights and roar. These stimuli occasion the behavior of driving, followed by getting to one's destination. The other side of the concurrent schedule (component 2a) presents the prompting reminder stimuli which are supposedly associated with safety belt use and followed by perhaps a perceived reduction of risk or the avoidance/escape from the aversive buzzer reminder.

Concurrent schedules present a situation where different component responses compete (e.g., starting a car versus buckling a safety belt). When the relative reinforcement value of each component of the concurrent schedule is quantified, a probabilistic statement can be made regarding its relative future frequency of occurrence. Stated earlier, Slovic, et al. (1978) calculated that one fatal auto accident occurs every 3.5

million trips and one disabling injury occurs every 100,000 person trips. If the average person makes only 1000 trips per year (Graham & Henrion, 1984), the relative negative reinforcement value for buckling a safety belt on a particular trip is astoundingly low. Thus, the relative reinforcement value in avoiding the inconvenience of buckling up, attending to the demands of driving a car and getting to one's destination relatively sooner and more than likely safely, preempts the acquisition and maintenance of safety belt use.

Second, starting a car and attending to the different stimulus characteristics of the gauges, steering wheel, relative position of the automobile, brake, gas, clutch pedals, and the engine roar and lights present a formidable array of manipulanda and stimuli. These discriminative stimuli set the occasion for driving behavior and arriving at a destination. Unfortunately, as shown in Figure 2, the current safety belt reminder stimuli (i.e., auditory-light) are presented concurrently with the stimuli associated with driving and subsequently arriving at a desired destination. In fact, the light-buzzer could be accidently paired with behavior engaged in starting and driving the automobile, rather then prompting a response to buckle up.

From the above analysis, three potential explanations for the ineffectiveness of current reminder systems in occasioning safety belt responses are proposed: (a) the principle of masking, (b) a spurious association, or (c) the principle of overshadowing. Masking is defined as stimuli (e.g., engine roar & lights) that obscure the stimulus control of a second stimulus (the reminder light and buzzer), even though it can be shown that the second stimulus when presented alone does demonstrate control (Mackintosh, 1977).

A spurious association is the accidental pairing of functionally unrelated stimuli and behaviors, as when one assumes the safety belt reminder stimuli is actually a warning signal for when the headlights are left on. The principle of overshadowing may also be applicable in that it occurs when the presence of a stimulus interferes with the acquisition of control of a second stimulus (Mackintosh, 1977). In this case, the reminder stimulus has not yet been conditioned or paired with the safety belt target response.

In summary, the above three threats to stimulus control can contribute to the ineffectiveness of current safety belt reminder systems. Thus, masking, overshadowing, and spurious association may all result from a reminder system that is not sufficiently "distinguishable" from the background of other concurrently presented stimuli. Three possible alternative modifications are hypothesized that might mitigate the above stimulus detection and control problem.

First, maintain the present temporal concurrent configuration of the reminder stimuli and ignition start up, but employ a more "distinctive" (or intense) reminder signal that over-rides masking and overshadowing.

Second, maintain the original reminder stimuli, but change its onset by delaying it for some interval of time from the ignition start up. Since Von Buseck and Geller (1983) found that drivers who buckled after starting the ignition took an average of 4.4 seconds to reach for their safety belts, these authors recommended that a more effective reminder system might be delayed 4 or 5 seconds in order not to compete for the driver's attention.

Figure 3 on the next page exemplifies how a delayed reminder might occasion a driver's response to buckle up relative to other driving behaviors and stimuli. Essentially, this scheduling is an attempt to develop a multi-operant chain that attenuates the stimulus masking and overshadowing effects of the current buzzer-light

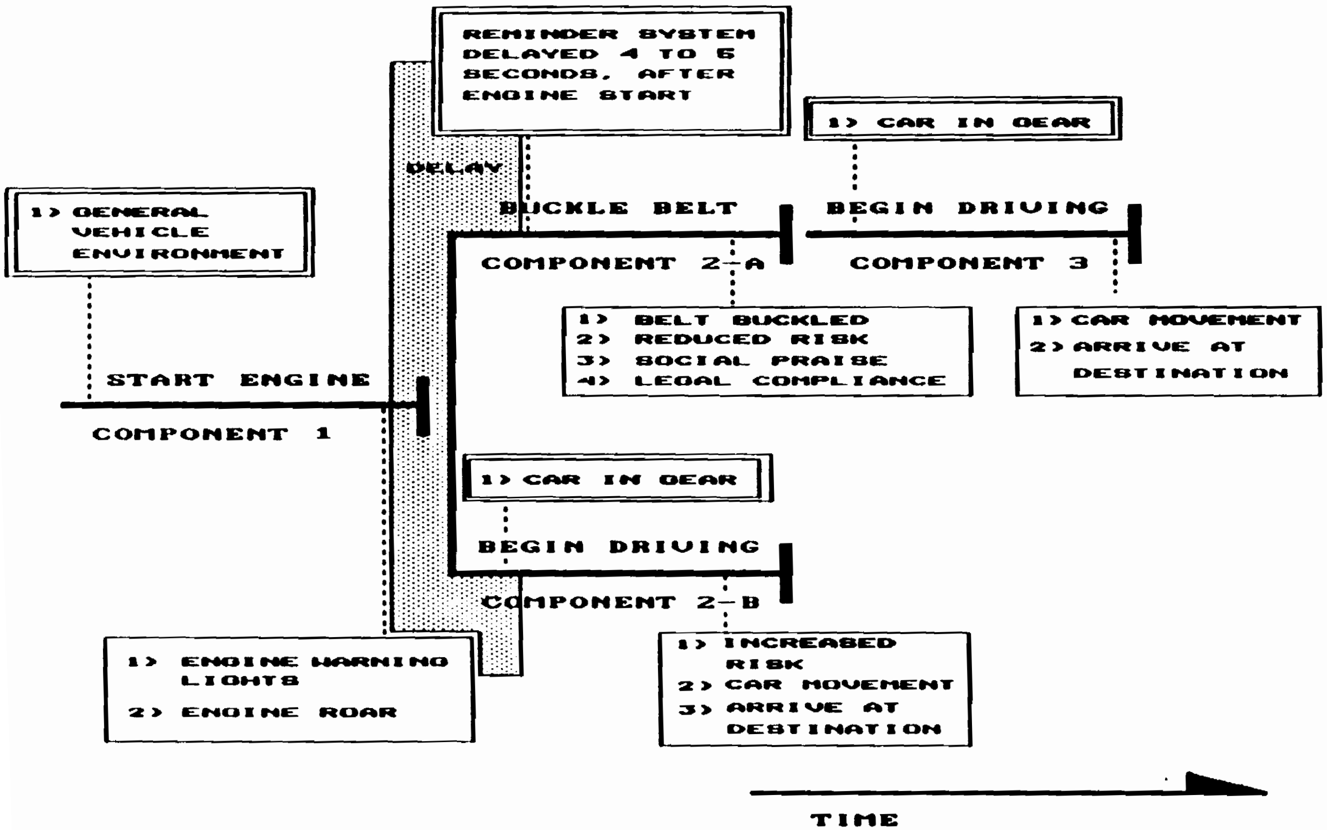


FIGURE 3. DELAYED REMINDER SYSTEM: 4 TO 5 SECONDS AFTER ENGINE START.

reminder system (as seen in Figure 2). Hypothetically, Figure 3 illustrates an orderly flow of chained responses (i.e., from component 1, to 2-A, then to component 3), without the inherent stimulus competition proposed in the concurrent reminder system. There is still the problem of response competition and competitive behavioral consequences (e.g., getting to drive the car sooner if you don't buckle up versus taking the time to fasten your safety belt and then drive off).

Third, present a "Second Reminder" after some interval of time following the first reminder. Of course, the Second Reminder should be designed so it can occur during some safe and appropriate moment (i.e., with limited response competition) that will allow the driver to fasten his or her safety belt. For the purpose of this research the Second Reminder has been engineered to initiate at the first complete stop after the research vehicle has travelled over 20 mph.

Examination of the scheduling of the Second Reminder reveals some interesting properties and issues. Assuming that the first reminder was ignored or masked, the Second Reminder presents itself during each trip at an unspecified time (see Figure 4 on following page),

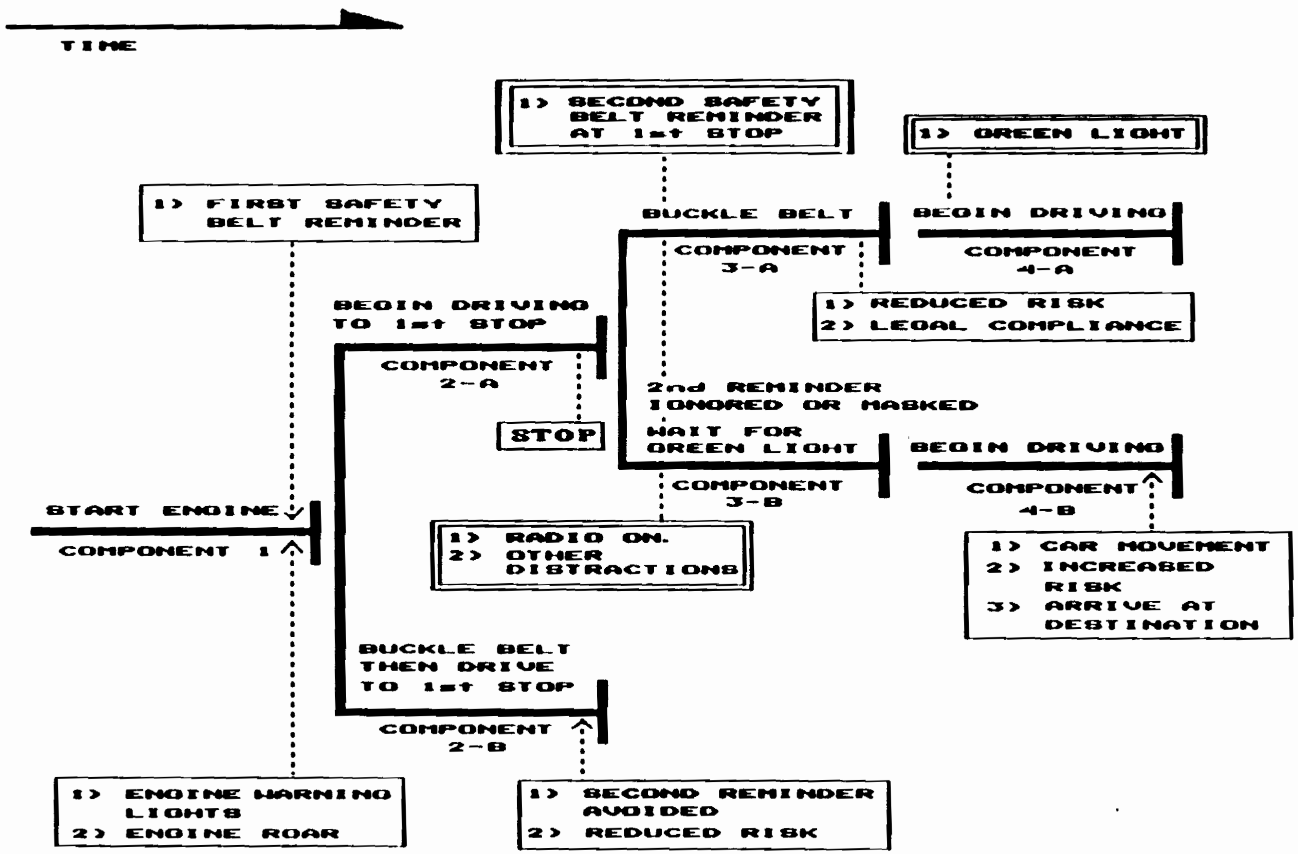


FIGURE 4. SECOND REMINDER SYSTEM RELATIVE TO OTHER CONCURRENTLY PRESENTED STIMULI AND CHOICES.

similar to a "variable time" schedule (Zeiler, 1977). Therefore, a principle characteristic of the Second Reminder is its temporally "novel" initiation, which is referenced against when the vehicle was started, the destination of the driver, and the immediate demands of the driving task. In general, it is assumed that the instrument panel (when the car is at a complete stop) will be static, so some visual stimulus competition is reduced. Yet, stimuli related to the engine, radio, A/C and other background noises might reduce the saliency of the reminder.

Other unknown factors can also potentially mitigate the Second Reminder's effectiveness. First, since the system is novel, unspecified, and perhaps intrusive, it may be interpreted as annoying, thus generating negative reinforcement and negative consumer reactions, especially by consistent nonusers of safety belts. Secondly, the Second Reminder's effectiveness will probably depend on the behavioral demands occasioned at the time of initiation (i.e., response competition). Theoretically, assuming that the temporal duration of the first stop (i.e., when the Second Reminder is activated) is the principle predictive factor, two hypotheses can be made: 1) if the stop is made at a relatively long traffic light, when driving demands are low, the effectiveness of the reminder system is enhanced (response competition is low); 2) If the stop is relatively self paced, such as occasioned by a stop sign and no impeding traffic, the reminder may suffer from both stimulus and response competition.

In general, the three proposed improvements (mentioned above) in reminder system stimuli are all vulnerable to compromises of many unknown and uncontrollable vehicle/driver situational variables. The primary goal of the following research was to investigate how these reminder systems compare and function despite the above compromises, which actually contribute to the external validity of this study. In conclusion, this study investigated: 1) whether reminder systems actually function to increase or set the occasion for safety belt use, 2) if delayed or Second Reminders improve effectiveness, and 3) whether different types of auditory signals can be differentiated according to specific effects.

Method

Subjects

Thirty undergraduate college students (17 females and 13 males) participated as subjects/drivers in what was called the "Cadillac Project". The ages of the subjects ranged from 18 to 26 years, with the mode and median age being 20 years. Subjects' driving experience ranged from 2 to 10 years with the mode and median being 4 years. Subjects reported (in a preliminary survey) that they averaged between 21 to 30 driving trips per week. Of the 30 subjects, 16 said they own or usually drive a small to subcompact car, while 12 indicated that they own or drive a mid-size to large vehicle.

The above subjects were selected from a double sampling procedure. First, subjects signed up to take a "Driving History, Habits and Energy Conservation Survey" (see Appendix A.). Over the course of nine months, 219 subjects filled out the above mentioned survey. For filling out the survey, subjects were compensated with 1 extra-credit point toward a currently enrolled psychology course. From these survey respondents, subjects were selected for the opportunity to drive the Cadillac. Their selection was based solely on their answers to Question 52 of the Survey: "Over the past month, what average percent of the time did you wear a safety belt while driving ?" Out of 215 subjects answering Question 52, 78 percent (n=167) indicated that they used their safety belts between 90 - 100 percent, 13 percent (n=29) said they used their safety belt between 20 - 80 percent, and 9 percent (n=19) were between 0 - 10 percent. Initially subjects who responded to Question 52 and answered between 20 and 80 percent were selected as potential participants in the "Cadillac Project".

The purpose for restricting the selection process was to eliminate hardcore nonusers and consistent users of safety belts. Presumably, students indicating that they always or never buckle up would be most resistant or insensitive to the experimental variables (i.e., the safety belt reminder prompts). Since, the principal research purpose was to assess variations in safety belt use as related to reminder stimuli and systems, it was important (at first) to focus on subjects who reported a moderate level of baseline use. The reasoning was that moderate users have acquired the behavior, but still have not formed a resistant or consistent habit of either always or never fastening their safety belt.

Later, subjects who responded between 0 to 10 and 90 to 100 percent were randomly selected from the sample who originally took the Survey. This was done in order to test the full population range (i.e., that is the extreme tails) in regards to answers given in Question 52. This was thought necessary after reviewing question 52's highly skewed distribution of measures. Therefore, testing allowed for the above assumptions to be confirmed or disconfirmed (regarding social desirability and experimental demand characteristics) and to investigate any effects occasioned by the experimental reminder stimuli and systems.

Selected subjects who agreed to participate were given a project brochure (see Appendix B) that explained the project's purpose, responsibilities, and options. Subjects were told that the purpose of the project was to investigate driving habits that influenced fuel efficiency. This deception was to prevent response bias. After the project was completed subjects were sent a letter disclosing the experiment's true purpose.

Subjects who accepted the opportunity to drive the Cadillac were asked to sign the consent form, commitment card and emergency card included in the project brochure. Out of 30 subjects who participated, 17 subjects indicated in Question 52 that they use their safety belts between 20 to 80 percent, with the mode and median being 50 percent. Eight subjects were selected from the 0 to 10 percent category, and 5 subjects were selected from the 90 to 100 percent category. See Figure 5 on the next page for a breakdown of the distribution of subjects from Question 52.

Subjects agreeing to participate were then scheduled to drive the Cadillac. Subjects were given the option of committing themselves to drive the Cadillac for either 6 or 9 separate days, with each day representing a single experimental session.

For each completed experimental session, subjects were compensated one extra-credit point toward a psychology course offering extra-credit. At the start of each subject's first session, he/she was familiarized with the driving course, the toggle switch routine and the Cadillac itself (to be discussed below in the Procedure section).

Apparatus

The experiment was conducted in a 1984 GM Cadillac Seville outfitted with electronic equipment. Figure 6 (see page 39) illustrates the electronic organization of the safety belt reminder and usage monitor system. The electronic equipment was housed in a lockable metal box located in the trunk of the vehicle. A control panel inside the box allowed the selection of different reminder stimuli and arrangements.

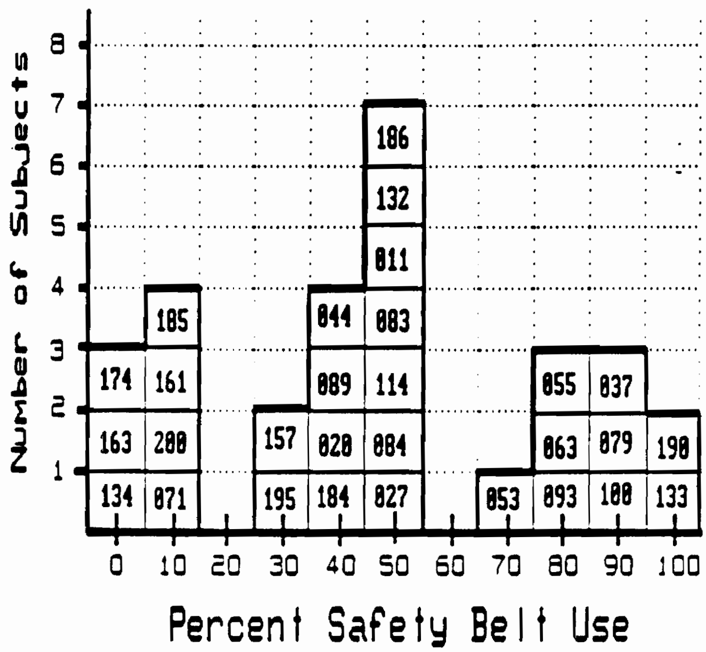


FIGURE 5.

__Distribution of subjects regarding self reported use of safety belts, see Question 52 of Survey.__

Note. N = 29, with one subject missing. Distribution has a mean of 4.79, median of 5.00, mode of 5.00 and standard deviation of 3.22

| # | = Subject's identification number.

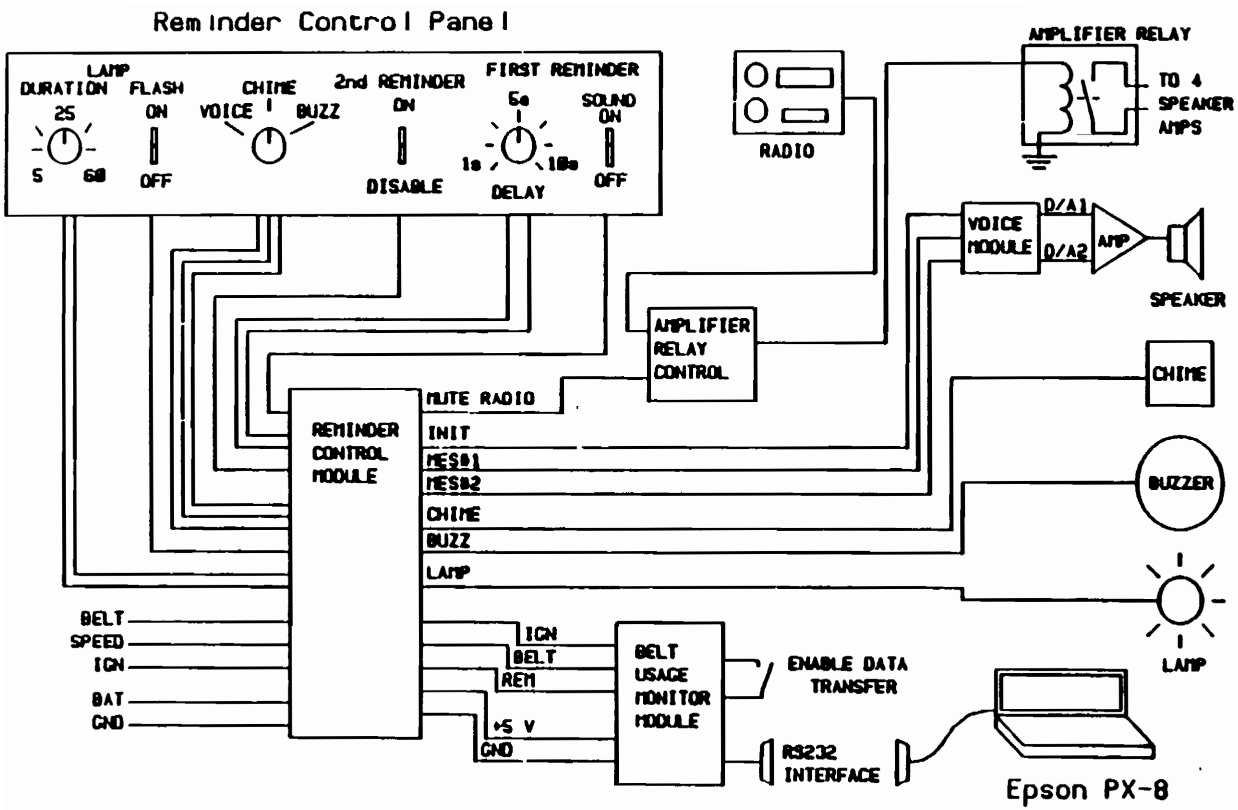


FIGURE 6. Seat Belt Reminder and Usage Monitor System.

The vehicle's monitoring system consisted of computer hardware located in the car that interfaced with a portable computer (Epson Geneva-PX-8). The portable computer was used for collecting and transfering data to a larger computer with storage and printing capabilities. Software to use an IBM-PC for printing and storing the data was included with the system from GM Corporation. The safety belt reminder and monitoring system was designed and built by the Environmental Activities Staff of General Motors Corporation.

The function of the safety belt reminder hardware system was divided into two main modules: 1) the reminder control module (independent variables), and 2) the usage monitoring (dependent variables).

Independent variables. The reminder control module allowed for the arrangement of certain stimulus parameters for each session. A description of the possible stimulus variables are given below:

Timing:

- auditory and visual reminders initiate after a 1 to 10 sec. delay following ignition of engine. Ignition-stimulus delay is selectable in 1 sec. increments.
- a Second Reminder on the first complete stop after car has exceeded 20 mph.

Auditory Reminder (4 to 8 sec.):

- No auditory
- Chime
- Buzzer
- Voice reminder and consequence: "Please fasten your safety belt" and "thank you".

Visual (light):

- Duration = 5, 10, 15, 20, 30, 40, 50, or 60 sec.
- Flashing
- Continuous
- Visual reminder only during initial reminder.

In general a particular reminder system was defined as: 1) a "No auditory", only a visual reminder light or 2) consisting of both an auditory and visual reminder light arrangement. A reminder was activated after the ignition key was turned to the "on" position or after a specified delay. The duration of delay was selectable between 1 to 10 seconds. When the Second Reminder was selected, the Second Reminder prompt was activated only when the vehicle came to its first complete stop after exceeding approximately 20 mph. Note that the occurrence of the Second Reminder after the first, did not have a simultaneous visual reminder light paired with it.

When the driver's safety belt was not fastened, a reminder was activated. The selected auditory reminder would come on for 4 to 8 seconds. For this study, the duration of the safety belt signal light was always set for 10 seconds without flashing. If the safety belt was fastened during a reminder, the reminder light and auditory stimuli turned off. If the voice reminder was selected, a "Thank You" message was given at any time the belt was fastened after the "Please Fasten Your Seat Belt" message occurred. During the presentation of an auditory reminder, radio and tape player sounds were engineered to be muted automatically.

Dependent variables. The safety belt use monitor collected data for each trip, a trip being defined as any time the ignition was "on" for longer than 1.5 minutes and then turned "off". Trips were stored in the order they occurred. The monitoring system could store data for up to 100 trips. The following data were stored for each trip:

- belt of driver fastened or not.
- belt fastened before or after the onset of the safety belt reminder.

Procedure

Training. Training began by familiarizing individual subjects to the driving course. Using a map of the course, the experimenter guided a subject through each trip, pointing out the location of each stop, traffic lights and the correct turns. The experimenter explained that a trip was defined as driving to a designated location, parking the research vehicle, turning the ignition off, exiting the vehicle and opening the rear trunk. With the trunk open, subjects were instructed to follow this routine:

1). Find the control box that has a toggle switch and two lights on top.

2). Switch the toggle to the "on" position associated with the green light.

3). When the red light appears, turn the toggle switch to "off", the original position.

4). Then, close the trunk and re-enter vehicle and drive to the next designated stop of the driving course.

Subjects were instructed to repeat the above sequence at each location of the driving course. Instructions for the toggle operation were attached to the toggle box. The experimenter explained to the subjects that the purpose for switching the toggle at each location was to "transfer fuel efficiency data" to the host computer. Subjects were further reminded to enjoy themselves and simulate their own regular driving habits when driving the research vehicle.

Before driving the research vehicle for the first time, a subject was shown where the headlight, wiper, A/C switches, and so on, were located and their operation. Subjects were also checked out on the operation and performance of the brakes and the toggle switch routine. On all experimental sessions, subjects drove alone throughout the driving course.

After the first day of training, the subject picked up the keys and went unescorted to the Cadillac. At the start of the session the subject was advised to re-adjust the mirrors and seat before driving, and to remember the toggle switch routine. When a subject arrived from finishing a session he/she returned the keys to the research office. These efforts were made to reduce the impression and apprehension that subjects were being observed and evaluated.

Driving course. The driving course was designed to take subjects through a sequence of six trips and four locations (two locations were repeated), representing highway, town, and suburban drives to community stores and campus driving (see Table 1, for a breakdown of the driving course). Completing six trips defined the driving course and represented one experimental session. Each trip took varying lengths of time to complete, ranging from three to nine minutes. The driving course took on average 31 minutes to complete.

Criteria for choosing the stop locations included: 1) widespread specific familiarity amongst college students, 2) access and exit ease, 3) visibility from the road, 4) avoidance of undue complexity that might result in getting subjects lost or confused while driving, and 5) a benign routine for the driver. It was expected that this routine would attenuate and not contribute to the already novel experimental situation, and therefore, facilitate habituation. Also, subjects were told that the driving course was to simulate a typical driving episode, such as running errands, going shopping and to school.

Subjects were informed that a map of the driving course and cue cards concerning each leg of the course would be present in the trunk besides the toggle switch control box. The intention here was to avoid compelling subjects to use a map inside the vehicle, and to provide a way for subjects to refresh their memory and prevent subjects from getting lost.

TABLE 1.

Breakdown of Driving Course: Order, Locations, Route, and Time Duration of Individual Trips.

ORDER OF TRIPS	LOCATION OF STOPS	ROUTE DESCRIPTION	TIME DURATION OF TRIP (IN MIN.)
0	START FROM CAMPUS		
1	UNIVERSITY MALL	THRU CAMPUS	3.00
2	GABLES MALL	THRU TOWN STREETS	8.00
3	UNIVERSITY MALL	HIGHWAY DRIVING	9.00
4	FOODLION GROCERY STORE	SUBURB STREETS	4.00
5	UNIVERSITY MALL	SUBURB STREETS	4.00
6	CAMPUS PARKING LOT	THRU CAMPUS	3.00

TOTAL DURATION APPROXIMATELY = 31.00 MIN.

Toggle switch. The principle function of the toggle switch control box was to provide an "excuse" for the subjects to turn off the ignition and exit the vehicle. This served several important purposes:

> First, stopping the car and turning off the ignition, fulfilled the computer's definition of a single trip (see Apparatus section for details).
> Second, subjects left the vehicle, thus providing the physical and topographic sequence of operants leading to their entering the car, starting the ignition and activating the independent variable (the reminder stimulus). The intention was to recreate the antecedent environment and behavior repeatedly for 6 occasions per experimental session.
> Third, the stimulus-response sequences were standardized across subjects. In this way, we attempted to control for extraneous variables that may mask and overshadow the independent variables. Therefore, it was assumed that by designating the same experimental context, per subject, it would be easier to interpret the results both within and between subjects.

Subject compliance in stopping the vehicle and turning off the ignition was examined by checking the data collected from the computer at the end of each experimental session. If the data read six trips, a subject was assumed to be following the course and routine. Additional verification was provided by the odometer reading, which should show an increase of 14 miles (the length of the complete driving course).

Design and subject assignment. The effects of the different reminder stimuli were evaluated using varying forms of the A-B-A reversal designs used in single subject operant experiments (Barlow & Hersen, 1984; Johnston & Pennypaker, 1980). The basic design strategy is characterized by what is called "response guided research" (Edgington, 1983).

Initially, subjects from particular self-report categories of safety belt use (0 - 10%, 20 - 80%, and 90 - 100%) were randomly assigned to one of three auditory conditions (No Auditory, Chime, and Buzzer). Halfway through the experiment, the fourth auditory condition (i.e., Voice reminder) was added to the assignment procedure. For Phase 1, 11 subjects were assigned to the "No Auditory" group, 8 were assigned to the Chime condition, 7 to the Buzzer condition, and 4 to the Voice condition.

Table 2 displays the initial subject assignment for Phase 1 across auditory reminder conditions. Listed in each condition are the subjects' identification numbers. Selection for counterbalancing the delayed reminder parameter was also randomly determined within the auditory conditions.

Since the experimental procedure was response guided, intervention and testing of the effectiveness of particular reminder stimuli was contingent upon the subject's prior baseline performance. There were four basic design configurations that depict the varying permutations that were a consequence of a subject's safety belt behavior in Phase 1. Table 3 shows the four design configurations, using a simple binary code label and independent variable blocking illustrations.

In Case 1 subjects were presented the No Auditory reminder across two Phases, only the reminder light was present. Case 2 represents individuals given an auditory reminder in Phase 1, then the No Auditory (i.e., only a reminder light) in Phase 2 . The purpose of Phase 2 (the No Auditory condition) was to examine the effects of withdrawing of the auditory reminder and studying the persistence of the safety belt response rate.

TABLE 2.

Initial assignment of subjects into audible reminder conditions:

	PHASE 1
NO AUDIBLE (N)	053 079 084 093 120 132 133 161 190 195 200 N = 11
CHIME (C)	011 037 055 071 083 114 174 186 N = 8
BUZZER (B)	020 027 044 063 089 100 185 N = 7
VOICE (V)	134 157 163 184 N = 4

For Case 3, individuals were presented with the reminder light and an auditory reminder throughout Phases 1 and 2. Finally, in Case 4 subjects started out with the No Auditory condition (only a reminder light) and then were intervened with an auditory reminder and reminder light.

The above mentioned, basic configurations were the bases for more extended design variations. In other words, a subject's rate of safety belt use (in regard to a particular safety belt reminder arrangement) in Phase 2, determined the type of reminder stimuli presented in later phases. In general, implementation of reminder stimulus arrangements were presented in a progressive stepwise fashion, from least salient to most salient. The following is the order in which reminders were presented: 1) the presentation of an auditory reminder, 2) a 4 - 5 second delay of the auditory was applied, and 3) the Second Reminder was introduced. Of course, the stepwise presentation was contingent upon the subject's response to each segment. When any consistent increase in safety belt use corresponded with the presentation of a particular reminder variable, a reversal was attempted in order to demonstrate functional control (i.e., a withdrawal of the reminder variable assumed to influence safety belt response).

TABLE 3.

Basic Design Configurations for Presenting Reminders across Phases 1 and 2

	Phase 1	Phase 2
Case 1:	No Auditory Light On	No Auditory Light On
Case 2:	Auditory On Light On.	No Auditory Light On
Case 3:	Auditory On Light On.	Auditory On Light On.
Case 4:	No Auditory Light On	Auditory On Light On

Note. When the Second Reminder was selected the reminder light was Off during the second presentation of the auditory signal.

Table 4 offers the Subject Assignment Matrix which displays how subjects were distributed from the first phase into the second phase of reminder stimulus conditions. The notation below each subject's number represents the additional reminder parameters presented to that subject during that or later phases. Note that the shaded areas on the matrix represent stimulus changes across phases [from one auditory sound (e.g., Buzzer) to another (e.g., Chime)] that were assumed to affect experimental demand characteristic, and thus were avoided.

Functional description. The number of sessions defining a phase was determined by: 1) the subject's response level and stability, and 2) time constraints. Within each phase, the author attempted to allow steady state performance to occur. This was difficult due to time and other uncontrollable factors influencing a subject's participation. In order to collect more data from some subjects, the author paid subjects (i.e, five dollars per hour) to drive additional sessions. Attempts were made to limit time intervals between sessions (within a particular phase) to 24 hours. However, subjects' class schedules did not always permit this. Similarly, attempts were made to schedule time intervals between phases to a minimum of four days.

TABLE 4.

Subject Assignment Matrix for Secondary Phases

Phase 1	
N	053 079 084 093 120 132 133 161 190 195 200
C	011 037 065 071 [083] [114] 174 186
B	020 027 044 063 [089] [100] 185
V	134 157 163 184

Phase 2 Audible Conditions

Phase 1	N	C	B	V
N	[079] [093] [120] [133] [161] [190] [195]	[053] 2, [200] 2	084	132
C	037 065 [083] [114] 186	[011] 2, [071] 2, [174] 2	░	░
B	[044] [063] [089] 100	░	[020], [027] 2, [185] 2	░
V	163 184	░	░	[134] 2, [157] 2

NOTE. ░ = Reminder stimulus changes which may affect demand characteristics.

[ ] = Subjects presented Delayed Reminder.

2 = Subjects presented Second Reminder.

Again, the experimenter had to work around subjects' class schedules. The above temporal guidelines attempted to satisfy assumptions of independence between sessions and phases. In general, a subject arrived at the same time for each session. Also, each subject's offhand remarks pertinent to the research were recorded in the experimenter's log. Log entries were used as data to complement the subjects' safety belt use information.

Follow-up survey. A follow-up survey (see Appendix C) was given to each subject after he/she finished their driving commitments. The purpose of the survey was to assess a subject's: a) awareness of the experiment's real purpose, and b) experiences that might have influenced their usual driving behavior. Also, the survey conducted manipulation checks that examined whether subjects attended to the relevant safety belt reminder stimuli.

Reliability checks. Reliability checks of the safety belt reminder hardware and measurement device were conducted approximately every third day of testing. A research assistant recorded on a paper form what reminder stimuli were to be presented and whether he/she buckled up on each trip. These data were then compared to the equipment settings defining the particular reminder system and the results for safety belt use. Over the course of the experiment, 32 reminder checks were taken and each reliability check found the equipment to be 100 percent correct (i.e., reliable).

Results

Subjects' data were graphed as percentages of safety belt use for each experimental session. Data analysis concerning the effectiveness of a reminder prompt on a single subject required only visual inspection of the raw data. Therefore, inferences were based on robust effects and the appearance of stability (Barlow & Hersen, 1984). Counter-balancing of the delayed reminder arrangement (i.e., across subjects) was also examined to detect order bias. As shown in Figures 7 through 36 (starting on page 61), note that the numbers "above" and "below" each data point represent how many times the safety belt was fastened "before" and "after" (respectively) the designated time the reminder signal was activated. Also, note that the connected day boxes indicate successive days.

The following results are divided into three main sections: 1) withdrawal of auditory reminders, 2) presentation and intervention of reminder-independent variables, and 3) process analysis and manipulation checks. The first two sections differentiate a subject's baseline (Phase 1) use of safety belts, whereas the later section examines indirectly whether subjects attended to the experimentally relevant stimuli.

Withdrawal of Auditory Reminders

In Phase 1, across all auditory conditions (including the No Auditory condition), inspection of the data revealed that 18 out of 30 subjects used their safety belts between 90 and 100 percent (i.e., ceiling effect). In Phase 2, these 18 subjects were then assigned to the No Auditory condition, see Subject Assignment Matrix for subject distribution (Table 4, column "N"). Assigning subjects to the No Auditory condition in Phase 2 was an attempt to test: a) whether individuals first presented an auditory reminder would be effected by its withdrawal, and b) whether subjects originally presented the No Auditory in Phase 1 would persist to buckle up over repeated measures. A discussion of the two tests follows.

In Phase 1, 11 of the above 18 subjects emitting high baseline safety belt use were originally assigned to one of the three "auditory" conditions (i.e., Chime, Buzzer, or Voice). These 11 subjects were then assigned to the No Auditory condition in Phase 2. In Phase 2, 10 out of the 11 subjects were unaffected by the withdrawal of their auditory reminder (see Figures 7 thru 17 on pages 61 to 66). Table 5 (page 60) provides an overview of subjects mean percent use and change across phases. Subjects 184, 186, and 044 (Figures, 17, 11, & 12, respectively) are representative of the subjects whose safety belt use was continuously between 90 and 100 percent (ceiling effect), despite the withdrawal of an auditory reminder. Only subject 089 (see Figure 14) showed a marked decline in safety belt use when the auditory reminder was withdrawn, from 100 percent during the reminder presentation to zero percent during withdrawal.

In Phase 1, out of 11 subjects assigned to the No Auditory condition, 7 subjects showed a ceiling effect. In Phase 2, these 7 subjects were again assigned to the No Auditory condition (see Table 4, the Subject Assignment Matrix, column "N" by row "N", and Table 3, Case 1). All 7 subjects' data showed continued and persistent safety belt use between 90 to 100 percent throughout their participation (see Table 6, page 67, for an overview and Figures 18 thru 24 on pages 68 to 71). Note that subject 093 (see Figure 19) was intervened in Phase 3 with the presentation of the Buzzer. This was done to probe whether the Buzzer might occasion an avoidance response. During Phase 3, no avoidance responses were indicated by the subject's data. However, in the follow-up survey this subject did indicate the least liked aspect of the Cadillac was the "obnoxious" seat belt prompt.

TABLE 5. MEAN PERCENT USE FOR SUBJECTS SHOWING CEILING EFFECT DATA.

Subject's Mean Percent Use and Change Across Phases. Subject's Receiving the No Audible Condition in Phase 2, after presented an Audible in Phase 1.

SUBJECT'S I.D. NUMBER	TYPE OF AUDIBLE	SELF REPORT BELT USE	MEAN PERCENT USE: PHASE 1	MEAN PERCENT USE: PHASE 2	PERCENT CHANGE FROM PREVIOUS PHASE	
037 SP	C	90 %	92%	100 %	+8 %	FIG. 7
055 SP	C	80 %	100%	100 %	0 %	FIG. 8
083 SP	C	50 %	100%	100 %	0 %	FIG. 9
114 SP	C	50 %	100%	83 %	-17 %	FIG. 10
106 FL	C	50 %	100%	100 %	0 %	FIG. 11
044 SP	B	40 %	88%	96 %	+8 %	FIG. 12
063 SP	B	80 %	100%	100 %	0 %	FIG. 13
089 SP	B	40 %	100%	76 %	-24 %	FIG. 14
100 SP	B	90 %	100%	100 %	0 %	FIG. 15
163 FL	V	0 %	100%	96 %	-4 %	FIG. 16
104 FL	V	40 %	100%	100 %	0 %	FIG. 17

Note. C = CHIME B = BUZZER V = VOICE

FIGURE 7.

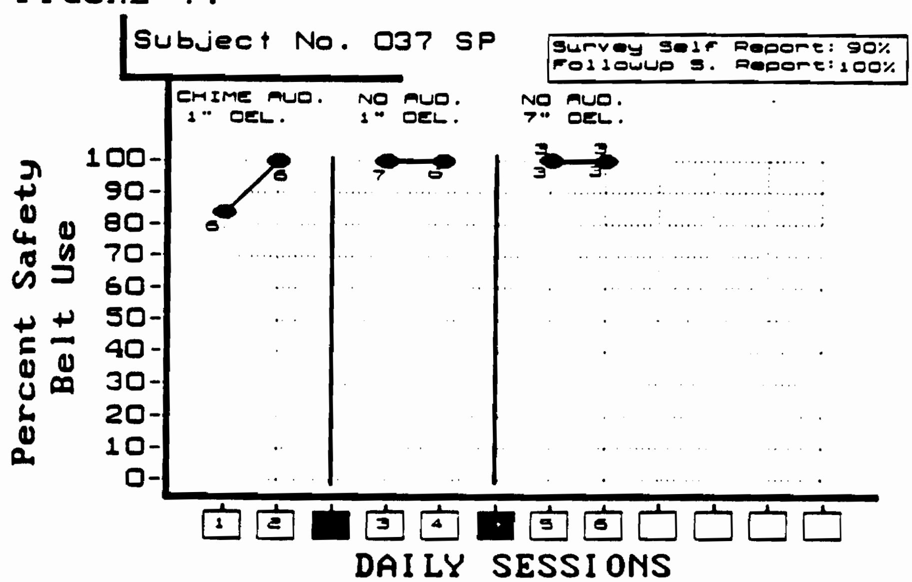
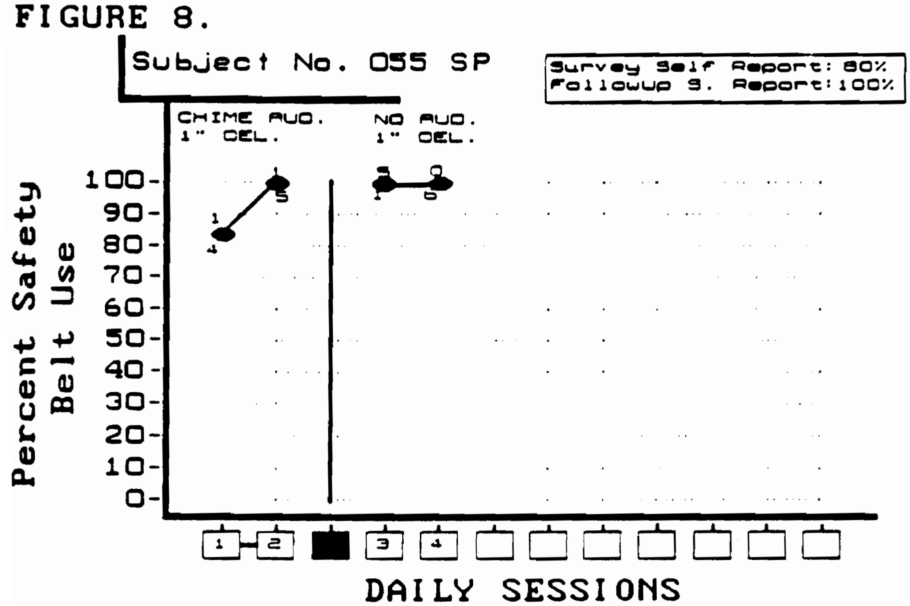


FIGURE 8.



Figures 7 & 8. Percent safety belt use.

FIGURE 9.

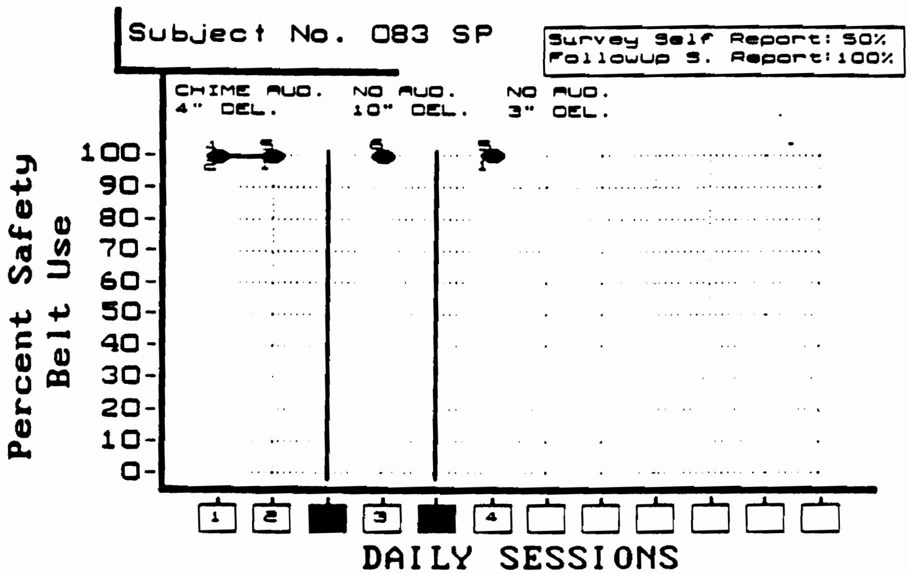
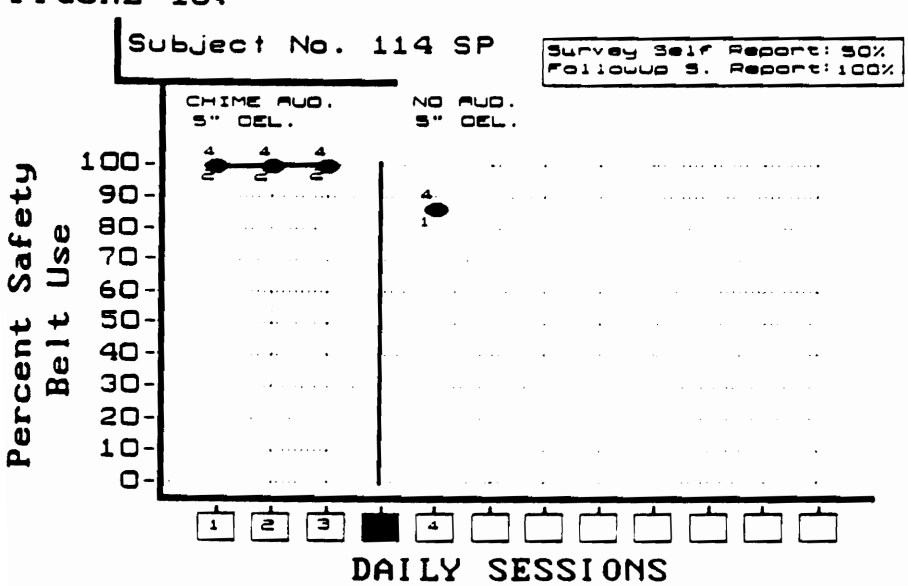


FIGURE 10.



Figures 9 & 10. Percent safety belt use.

FIGURE 11.

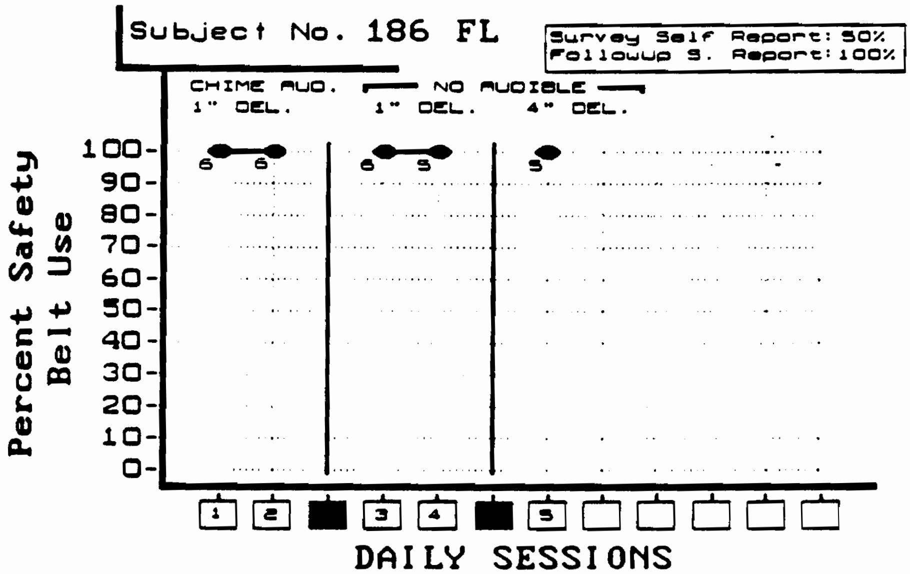
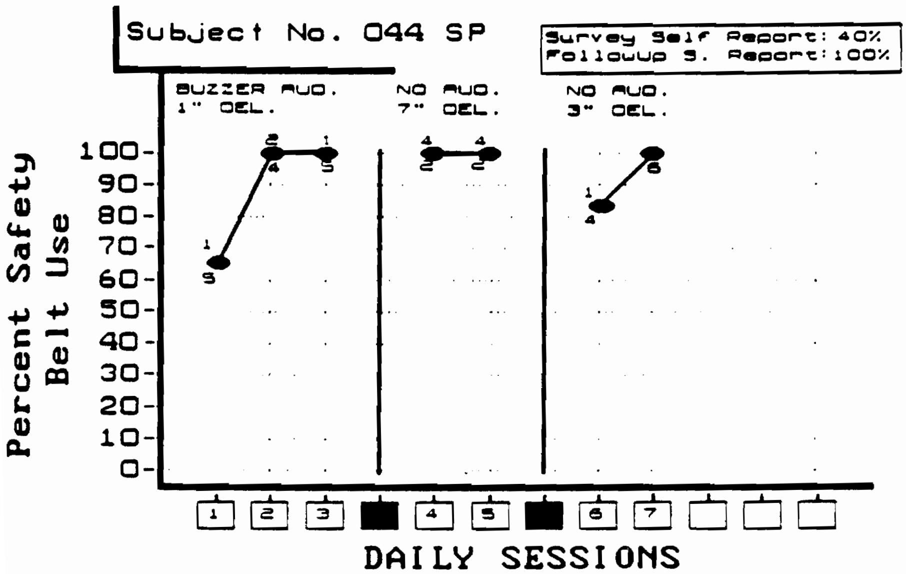


FIGURE 12.



Figures 11 & 12. Percent safety belt use.

FIGURE 13.

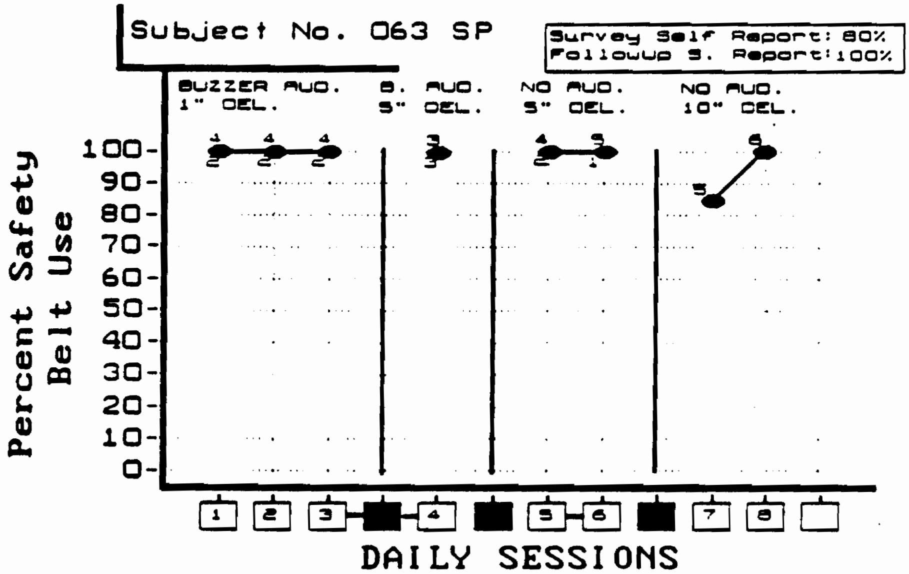
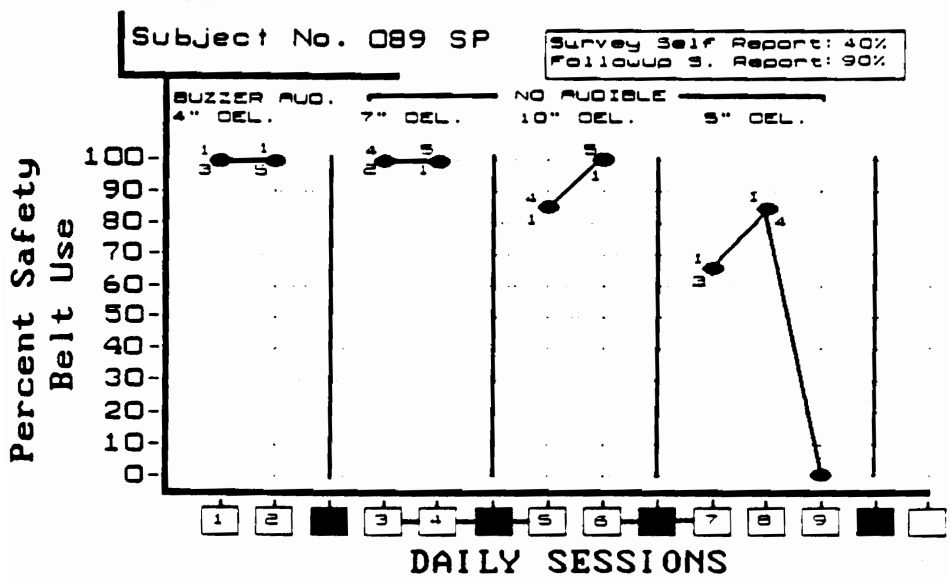


FIGURE 14.



Figures 13 & 14. Percent safety belt use.

FIGURE 15.

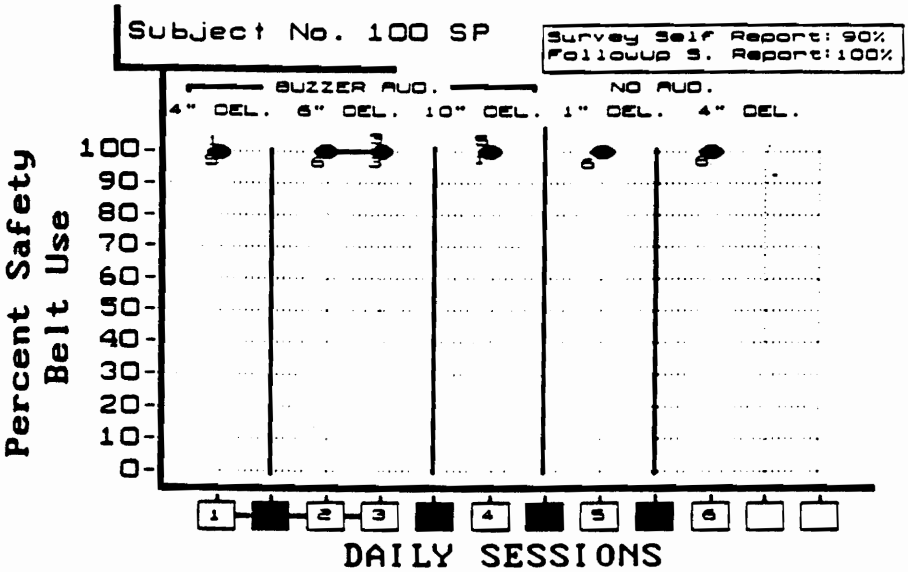
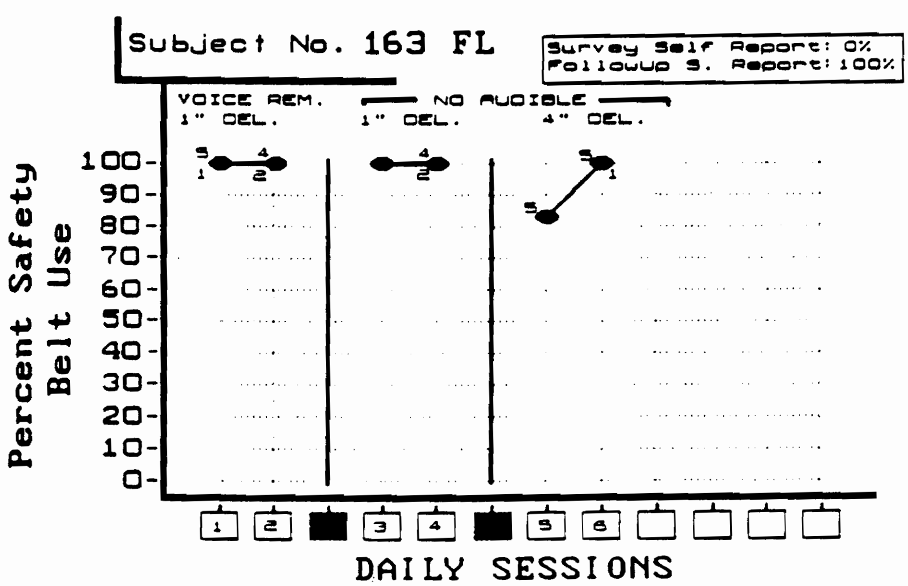


FIGURE 16.



Figures 15 & 16. Percent safety belt use.

FIGURE 17.

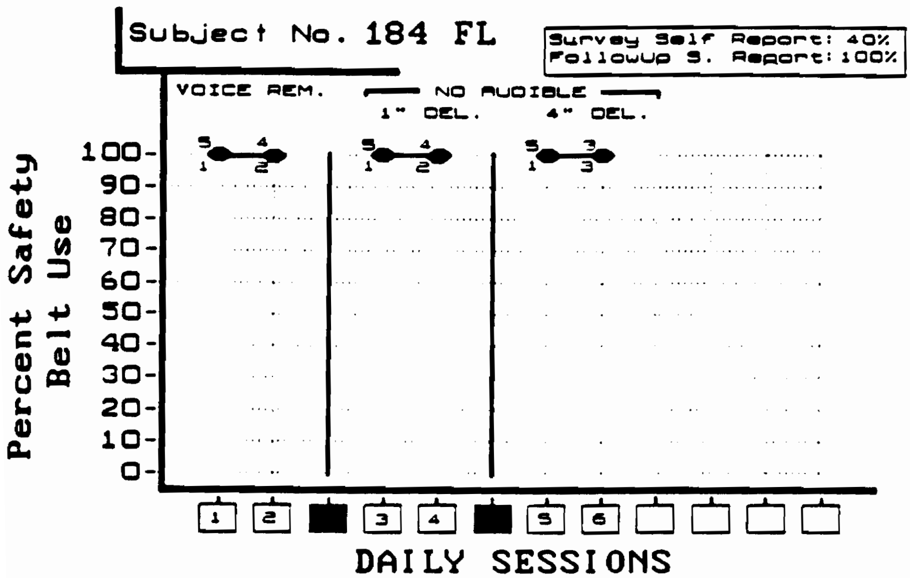


Figure 17. Percent safety belt use.

TABLE 6. MEAN PERCENT USE FOR SUBJECTS SHOWING CEILING EFFECT DATA.

**Subject's Mean Percent Use and Change Across Phases.
For Subject's receiving the No Audible Condition in both
Phase 1 and 2.**

SUBJECT'S I.D. NUMBER	TYPE OF AUDIBLE	SELF REPORT BELT USE	MEAN PERCENT USE: PHASE 1	MEAN PERCENT USE: PHASE 2	PERCENT CHANGE FROM PREVIOUS PHASE	
079 SP	N	90%	100%	100%	0%	FIG. 18
093 SP	N	80%	100%	100%	0%	FIG. 19
120 FL	N	N.R.	100%	100%	0%	FIG. 20
133 SS	N	100%	100%	100%	0%	FIG. 21
161 FL	N	10%	90%	92%	+2%	FIG. 22
190 FL	N	100%	100%	100%	0%	FIG. 23
195 FL	N	30%	100%	100%	0%	FIG. 24

Note. N = NO AUDIBLE

FIGURE 18.

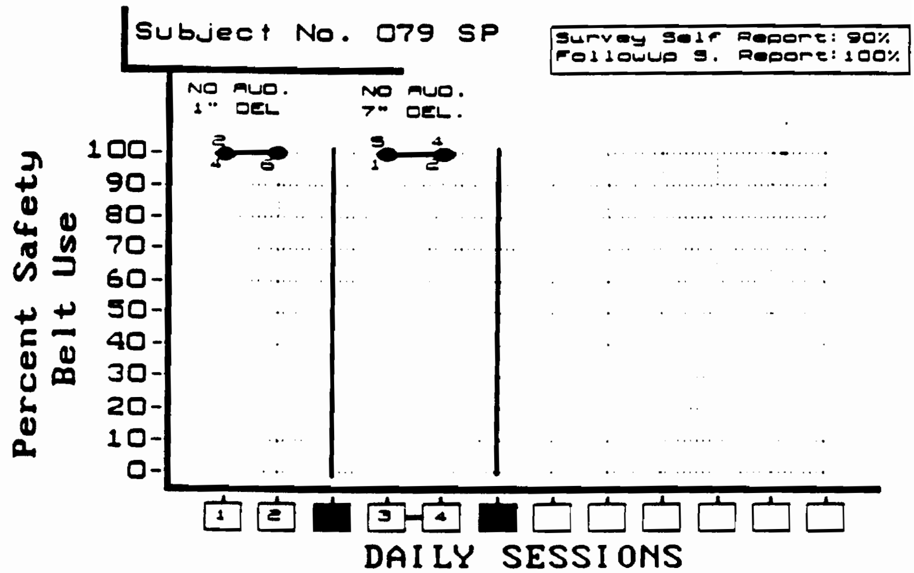
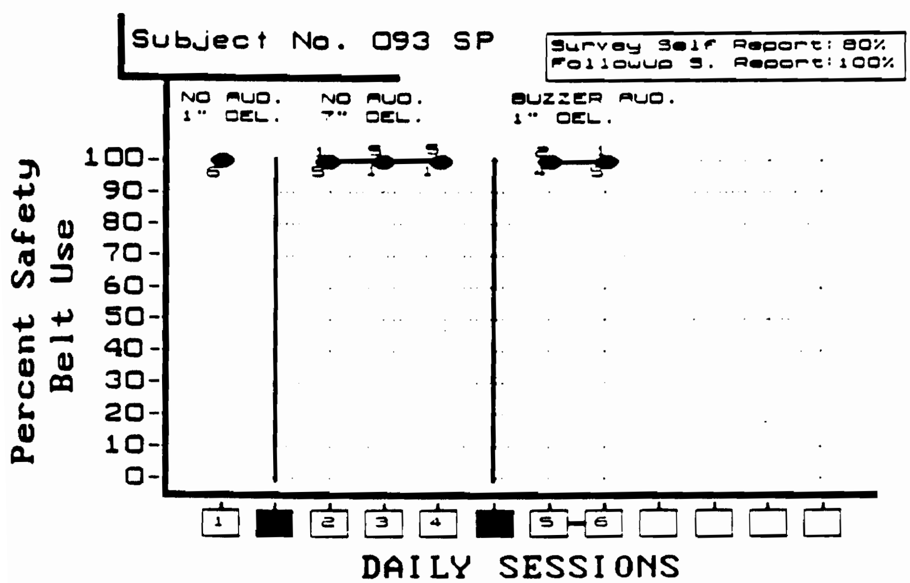


FIGURE 19.



Figures 18 & 19. Percent safety belt use.

FIGURE 20.

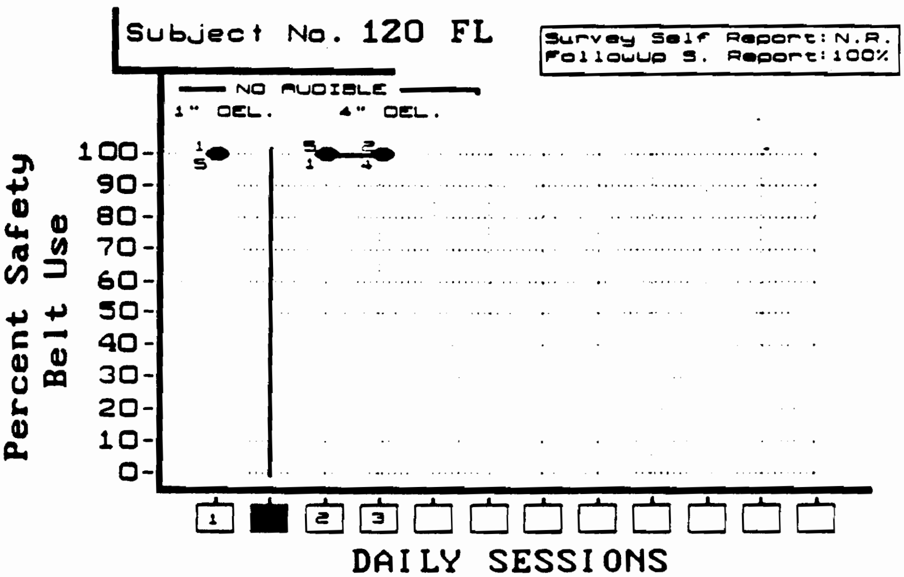
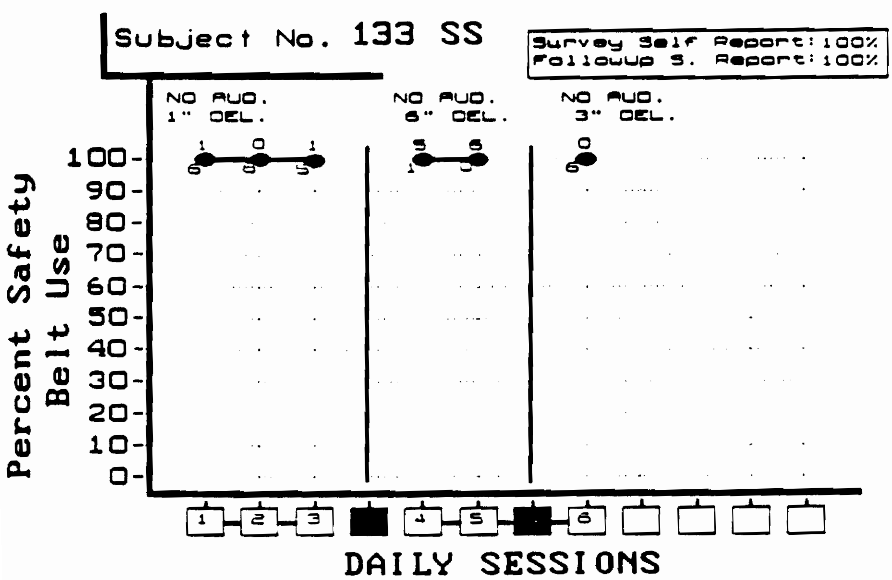


FIGURE 21.



Figures 20 & 21. Percent safety belt use.

FIGURE 22.

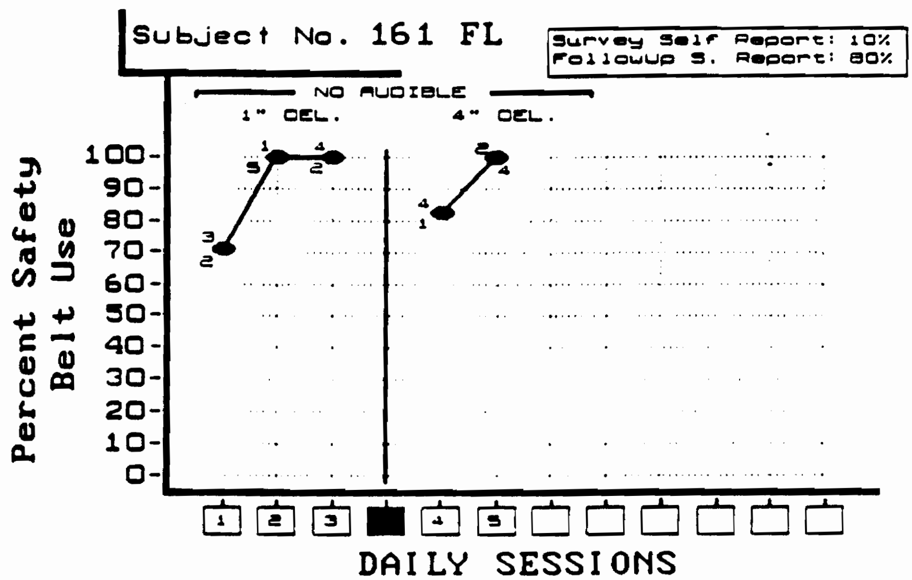
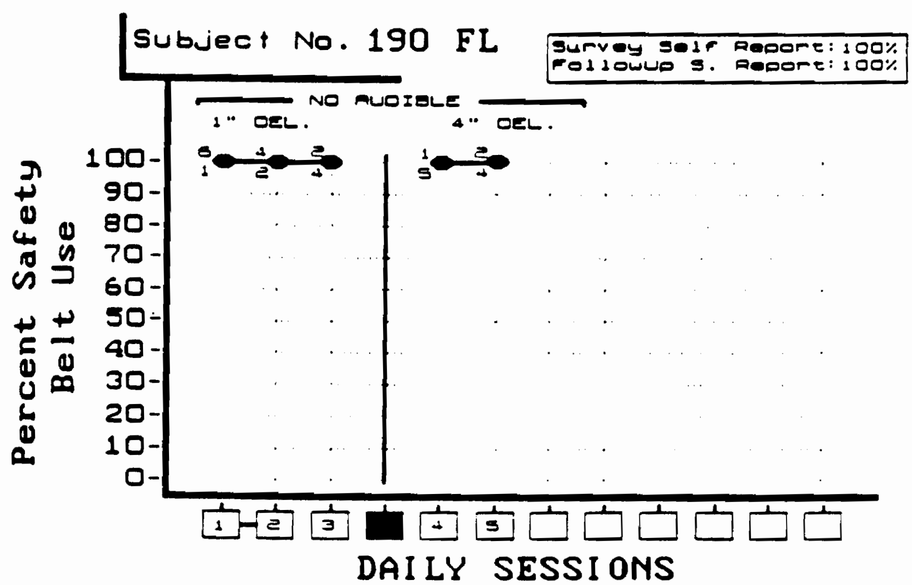


FIGURE 23.



Figures 22 & 23. Percent safety belt use.

FIGURE 24.

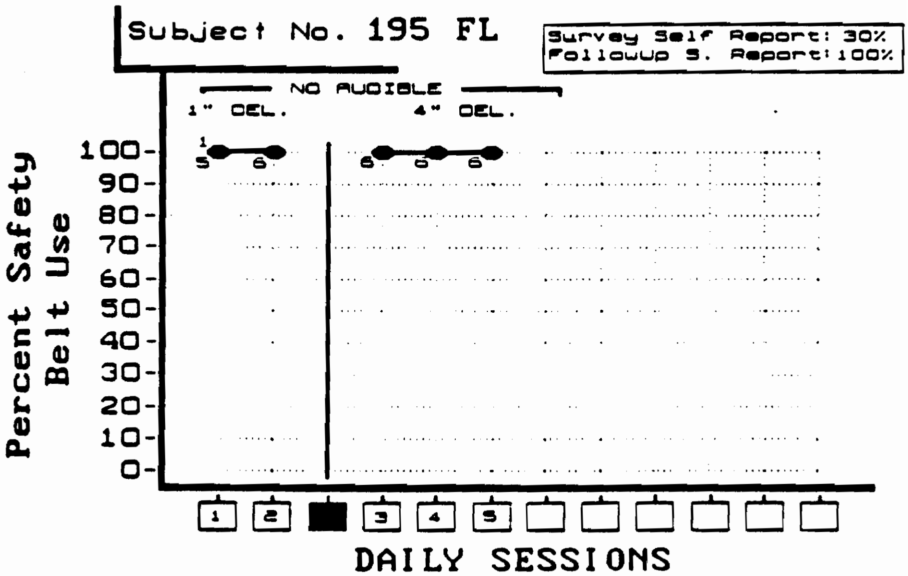


Figure 24. Percent safety belt use.

Note that during Phase 2, subjects demonstrating persistent high safety belt use under the No Auditory condition, did however, receive a solid reminder light. Since this reminder light could not be turned off in order to test its effect, its onset was then delayed over subsequent phases. Inspection of the data indicated that a delayed light showed no systematic effect on safety belt use. For example, the delay alone did not seem related to the decline in belt use of Subject 089 (see Figure 14).

Presentation and Intervention of Reminder Variables

In Phase 1, across all auditory reminders, 12 out of 30 subjects' baseline use of safety belts was either consistently low, between 0 to 10 percent (a floor effect) or varied around a mean of 50 percent (Figures 25 - 36). These low to moderate baseline response levels permitted the opportunity for reminder variables to show positive effects (i.e., an increase in safety belt use). Therefore, these 12 subjects were assigned in the secondary phases to one or more of the following independent variables: 1) delay of auditory reminder, 2) a second auditory reminder, and 3) an auditory reminder (see Table 4: columns "C", "B", & "V" of the Subject Assignment Matrix). Each of these variables is discussed below.

Delayed Reminder. Out of 12 subjects showing low to moderate levels of safety belt use, 8 subjects received a 4 to 5 second Delay (see on the following pages Figures 25 thru 32, and Table 7 for an overview). Inspection of the data indicated that the Delay had no effect, across Chime and Buzzer auditory reminders (see footnote 1). For example, Subject 020 (see Figure 25), showed a mean baseline percentage of 25 percent when presented a Buzzer reminder, with a decreasing trend towards zero percent. Presentation of the Delay in the second phase showed no consistent effect, though her range was great (one session she buckled up 100 percent, while all other sessions her belt use was zero). Subjects typically responded to the Delay like Subject 053 (see Figure 31). After receiving a Chime reminder which resulted in no safety belt behavior (zero percent), Subject 053 then showed no safety belt responses regarding the implementation of the Delayed Reminder (zero percent belt use).

(1). The voice reminder was left out of this test due to its built in Delay (a Chime lead-in to the verbal prompt). Subjects assigned to the voice reminder will be discussed in the following sections.

TABLE 7. EFFECTIVENESS OF DELAYED REMINDER.

Subject's Mean Percent Use and Change Across Phases.

Subject's receiving the Delayed Reminder After presented an Audible in Prior Phase.

SUBJECT'S I.D. NUMBER	TYPE OF AUDIBLE	SELF REPORT BELT USE	MEAN PERCENT USE: AUDIBLE PHASE A	MEAN PERCENT USE: DELAYED REMINDER PHASE B	PERCENT CHANGE FROM PREVIOUS PHASE	
020 SP	B	40%	25%	16%	-9%	FIG. 25
185 FL	B	10%	16%	16%	0%	FIG. 26
011 SP	C	50%	60%	0%	-60%	FIG. 27
174 FL	C	0%	5%	0%	-5%	FIG. 28
027 SP	B	50%	0%	0%	0%	FIG. 29
071 SP	C	10%	50%	16%	-34%	FIG. 30
053 SP	C	70%	0%	0%	0%	FIG. 31
200 FL	C	0%	0%	0%	0%	FIG. 32

Note. C = CHIME B = BUZZER V = VOICE

FIGURE 25.

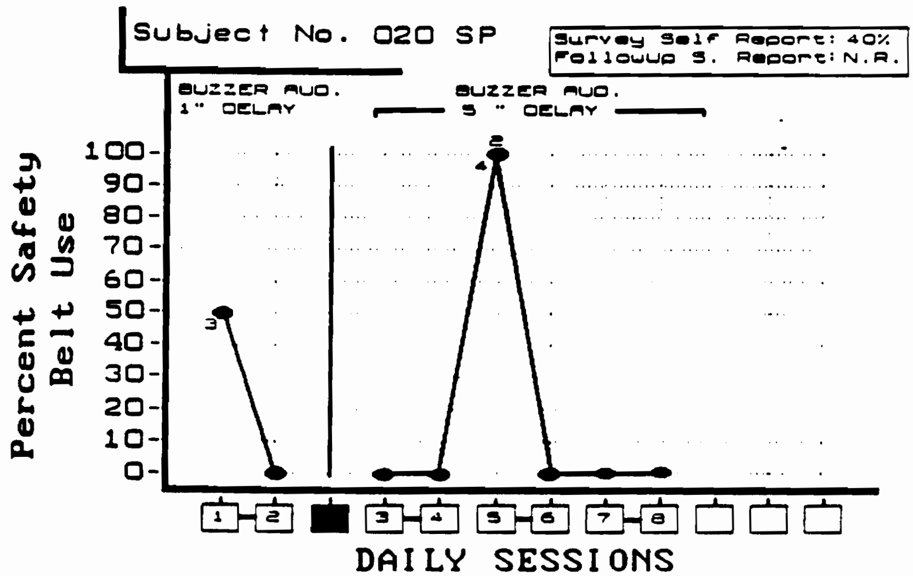
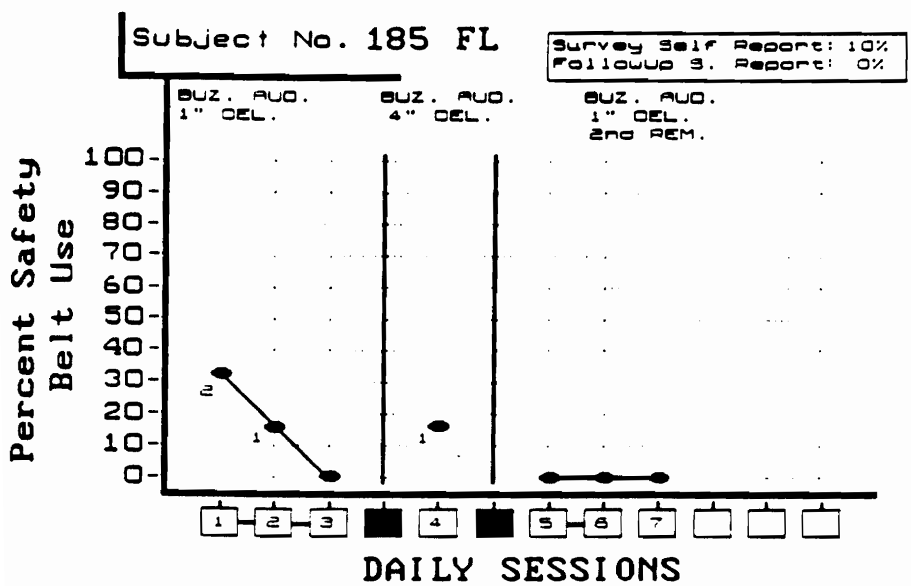
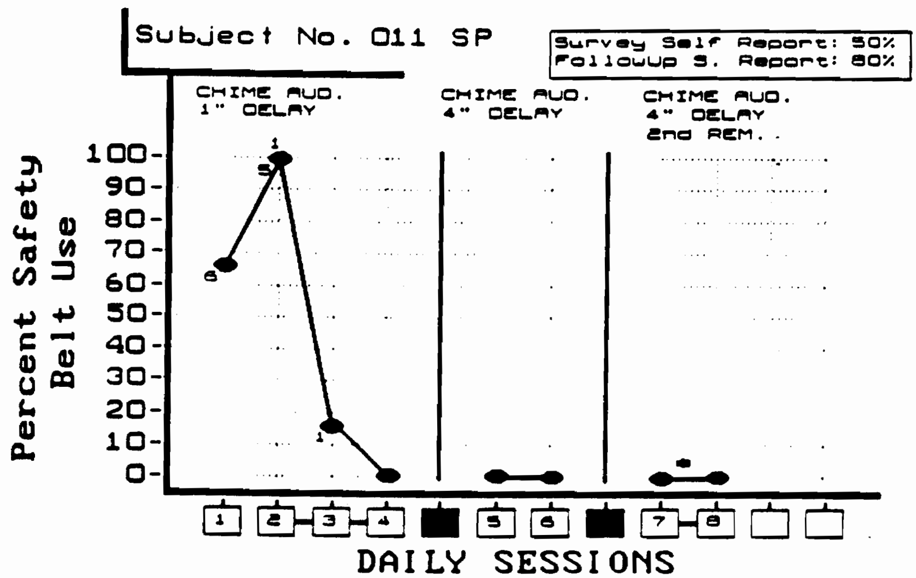


FIGURE 26.



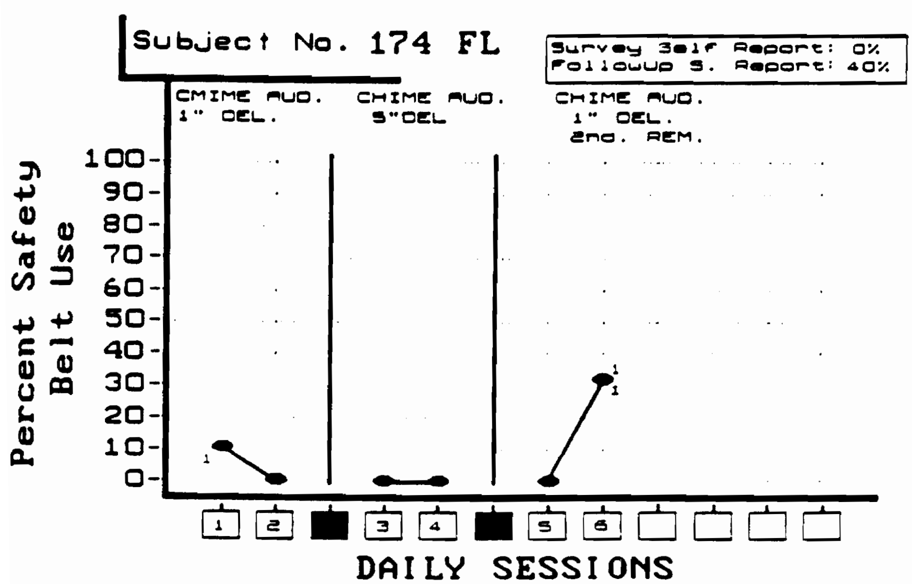
Figures 25 & 26. Percent safety belt use.

FIGURE 27.



Note. * = subject disengaged second reminder by fastening safety belt behind her.

FIGURE 28.



Figures 27 & 28. Percent safety belt use.

FIGURE 29.

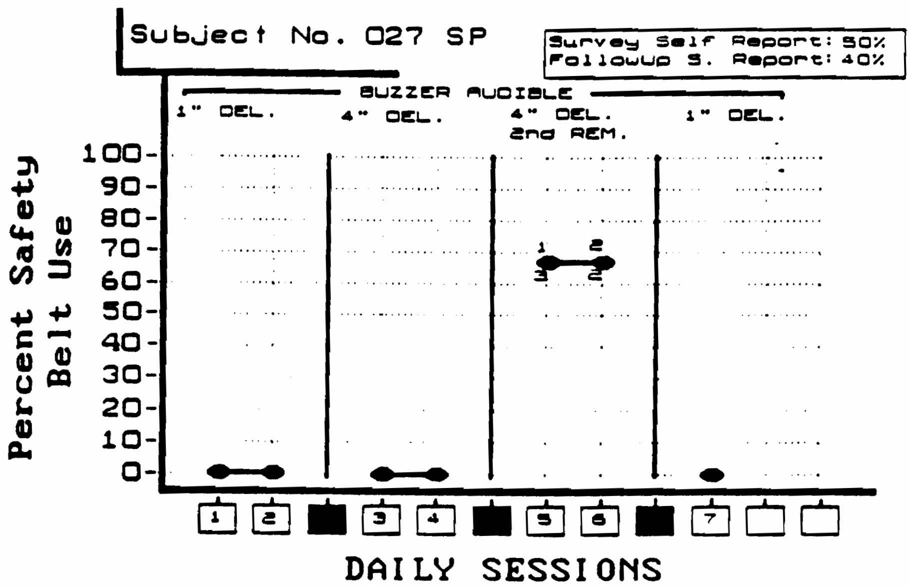
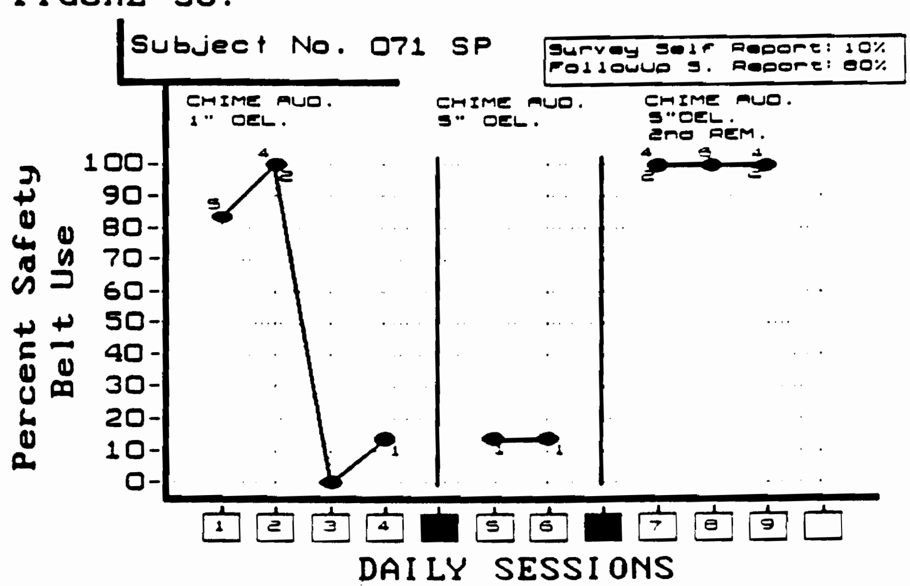


FIGURE 30.



Figures 29 & 30. Percent safety belt use.

FIGURE 31.

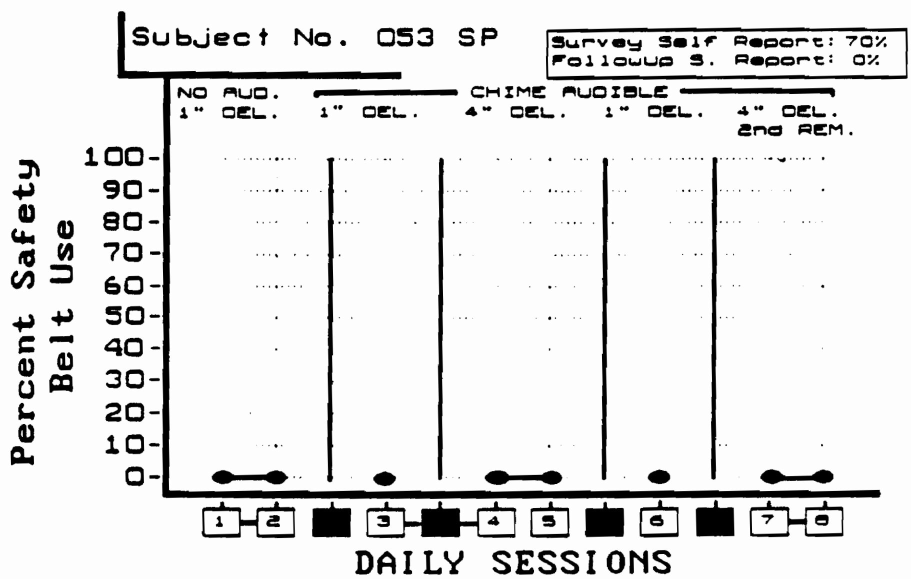
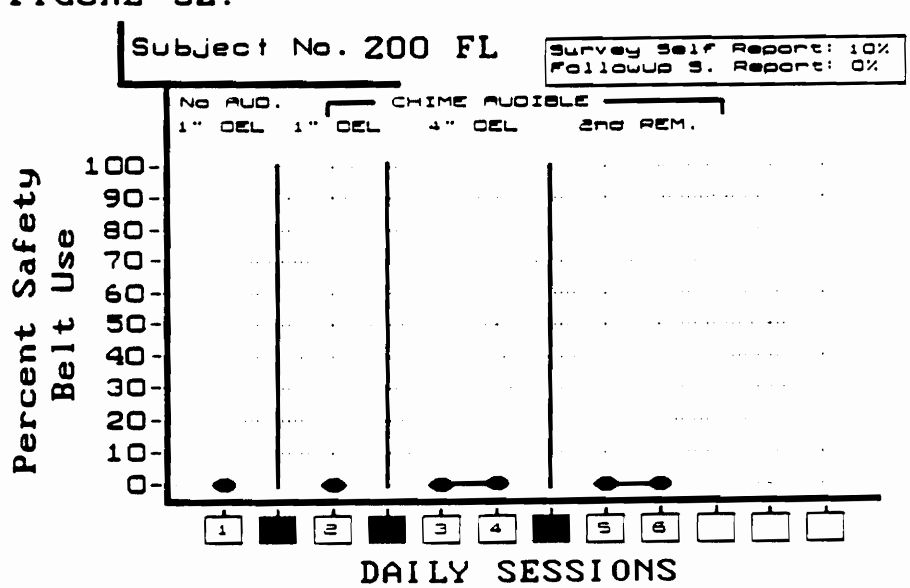


FIGURE 32.



Figures 31 & 32. <u>Percent safety belt use</u>.

Counterbalancing the Delayed reminder was conducted with subjects 083 and 114, within the Chime condition and subjects 089 and 100, within the Buzzer condition. These subjects were presented the Delayed reminder in Phase 1. All four subjects' safety belt use was 100 percent (a ceiling effect). Therefore, each subject was assigned to the No Auditory condition in Phase 2. Despite the withdrawal of the auditory and the Delay parameters, subjects still continued to buckle up throughout their participation (see previous Figures 9, 10, 14, & 15).

Second Reminder. The "Second Reminder" was presented to 10 subjects across all auditory reminders: the Chime, Buzzer, and Voice reminders (see Figures 26 thru 34). Table 8 provides an overview of the results concerning the Second Reminder, with subjects' mean percent use and change across phases. The Second Reminder, in general, was presented to subjects after the Delayed Reminder demonstrated no effect. Out of 10 subjects who received the Second Reminder, only 2 subjects showed consistent and robust increases in safety belt use (see subjects 027 & 071, Figures 29 & 30).

Subject 027 was assigned to the Buzzer reminder in Phase 1 (baseline), and to the Delayed Buzzer reminder

TABLE 8. EFFECTIVENESS OF SECOND REMINDER.

Subject's Mean Percent Use and Change Across Phases.
Subjects receiving the Second Reminder after presented the Delayed Reminder in Prior Phase

SUBJECT'S I.D. NUMBER	TYPE OF AUDIBLE	SELF REPORT BELT USE	MEAN PERCENT USE: AUDIBLE OR DELAYED R. (PHASE A)	MEAN PERCENT USE: SECOND REMINDER (PHASE B)	PERCENT CHANGE FROM PREVIOUS PHASE	
185 FL	B	10%	16%	0%	-16%	FIG. 26
011 SP	C	50%	0%	0%	0%	FIG. 27
174 FL	C	0%	0%	33%	+33%	FIG. 28
027 SP	B	50%	0%	67%	+67%	FIG. 29
071 SP	C	10%	16%	100%	+84%	FIG. 30
053 SP	C	70%	0%	0%	0%	FIG. 31
200 FL	C	0%	0%	0%	0%	FIG. 32
134 SS	V	0%	4%	0%	-4%	FIG. 33
157 FL	V	30%	25%	17%	-8%	FIG. 34

Note. B = BUZZER C = CHIME V = VOICE

FIGURE 33.

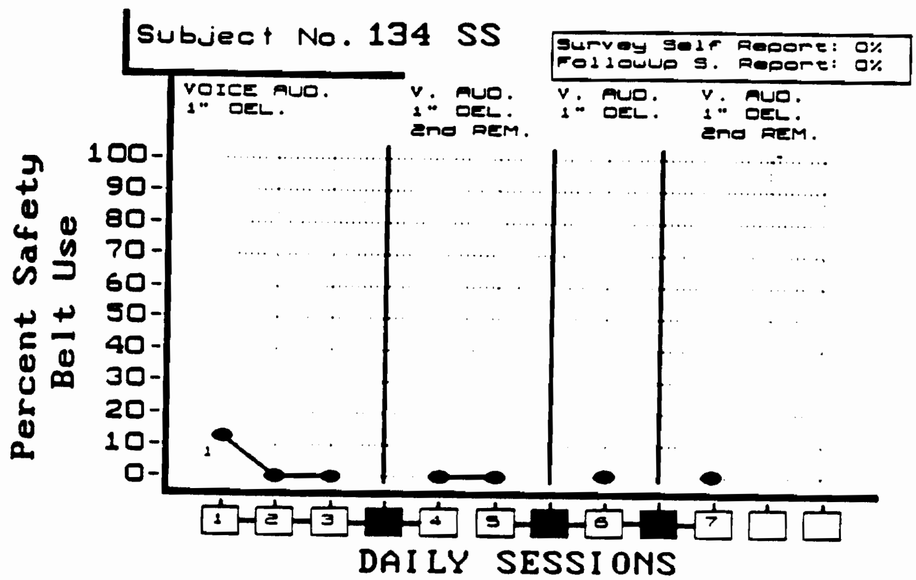
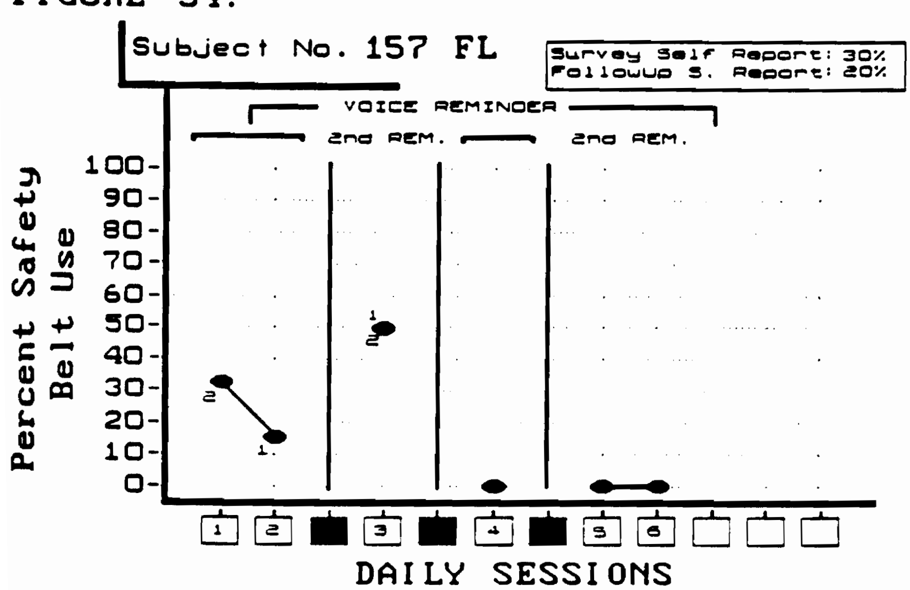


FIGURE 34.



Figures 33 & 34. Percent safety belt use.

in Phase 2. During these two phases Subject 027's belt use was zero percent. However, this subject's safety belt behavior increased under the Second Reminder condition to 67 percent (see Figure 29, Phase 3). A reversal was then employed by withdrawing the Second Reminder and presenting the original baseline reminder conditions (i.e., the auditory Buzzer). Subject 027's safety belt use fell to zero percent during this reversal, comparable to his original baseline use. The above step-wise intervention of the reminder variables and withdrawal illustrates an A-B-C-A design.

Subject 071 (see Figure 30) received a Chime reminder during baseline. His baseline data indicate that his safety belt use ranged between 0 and 100 percent, but with a steep decreasing trend toward zero percent. The initially high safety belt response suggests novelty and social desirability factors that habituated over the four sessions. When presented a Delayed Reminder during Phase 2, this subject's mean percent belt use was 16.7 percent, which actually indicates one buckle up response per session. When the Second Reminder was presented (3 weeks later), this subject's safety belt use increased to 100 percent. Time constraints did not permit a reversal attempt.

Eight subjects (unlike 071 & 027) who were given the Second Reminder did not show any significant and consistent changes in safety belt behavior (see Figures 26 thru 28 and Figures 31 thru 34). Subject 174 (see Figure 28) did show an absolute increase of 33 percent during one session when presented the Second Reminder. However, time constraints did not permit an opportunity to follow up this trend.

Subject 011 (see Figure 27) showed some inconsistent safety belt use during baseline (under the Chime condition), and no response to the Delay of the Chime reminder in Phase 2. When presented with Second Reminder, Subject 011 also was not prompted to fasten her safety belt. She did however comment to the experimenter about her reaction to the Second Reminder Chime. She thought the "Chime reminder was broken", so she decided to fasten the safety belt behind her to avoid the "obnoxious" second occurrence of the Chime reminder (see asterisk in Session 7 of this subject's data, Figure 27). A research assistant assured her the reminder system was working properly. However, during Session 8, subject 011 did not circumvent the Second Reminder by fastening the safety belt behind her, instead she just didn't buckle up.

Subjects 134 and 157, both assigned to the Voice Reminder, showed low to no safety belt use during baseline. Remarkably, Subject 134 (see Figure 33) only buckled up once during her total participation, which included 60 verbal prompts to "please, fasten your safety belt". Even the second verbal reminder did not persuade this subject to wear her safety belt. Subject 134's reaction to the Second Reminder was similar to that of Subject 011. She said she thought "something was wrong", that the "car kept on talking to me". Again, a research assistant informed her that the system was working properly.

Subject 157's initial response to the Voice Reminder was somewhat more variable (see Figure 34). Her response in Session three to the Second Reminder was an increase in safety belt use, from 25 percent to 50 percent. A reversal during Session four showed a decline in belt use to zero. However, when the Second Reminder was reinstated in Phase four (Sessions five & six), no increase in safety belt behavior occurred.

Presentation of an auditory reminder. The four subjects who fell into this category (see Figures 30, 31, 35, & 36) originally received in Phase 1 the No Auditory condition. Each subject's baseline safety belt use was near zero percent. Subjects were then randomly assigned to one of three auditory reminder conditions (i.e., two subjects to the Chime condition, and one subject each to the Buzzer and Voice conditions, see Table 4). For an overview see Table 9, which provides subjects' mean percent use and change across Phases.

Subjects 053 and 200 (see Figures 30 & 31) were assigned to the Chime Reminder condition in Phase 2. Both subjects, when presented the Chime auditory reminder showed no belt responses (zero percent). In stepwise fashion, the presentation of the Delayed Reminder (Phase 3) and then, the Second Reminder arrangements (Phase 4), also resulted (for both subjects) in no safety belt use.

Subject 084 (see Figure 35, on page 87) was presented in Phase 2 with the Buzzer reminder. This subject's data indicate a dramatic increase in his safety belt response (from near zero to 100 percent). A reversal seven days later showed another dramatic change: his safety belt use fell back to the original baseline level. Reinstatement of the Buzzer reminder in Phase four resulted again in an increase in his safety belt behavior to 100 percent.

Like Subject 084, Subject 132 (see Figure 36), demonstrated a systematic change in her safety belt behavior that corresponded with the implementation of

TABLE 9. EFFECTIVENESS OF REMINDER PRESENTATION.

Subject's Mean Percent Use and Change Across Phases.
Subject's Receiving a No Audible in Phase 1 and then Presented an Audible in Phase 2.

SUBJECT'S I.D. NUMBER	TYPE OF AUDIBLE	SELF REPORT BELT USE	MEAN PERCENT USE: "NO AUDIBLE" PHASE A	MEAN PERCENT USE: "AUDIBLE" PHASE B	PERCENT CHANGE FROM PREVIOUS PHASE	
053 SP	C	70%	0%	0%	0%	FIG. 31
200 FL	C	0%	0%	0%	0%	FIG. 32
004 SP	B	50%	0%	100%	+100%	FIG. 35
132 SS	V	50%	0%	100%	+100%	FIG. 36

Note. B = BUZZER C = CHIME V = VOICE

FIGURE 35.

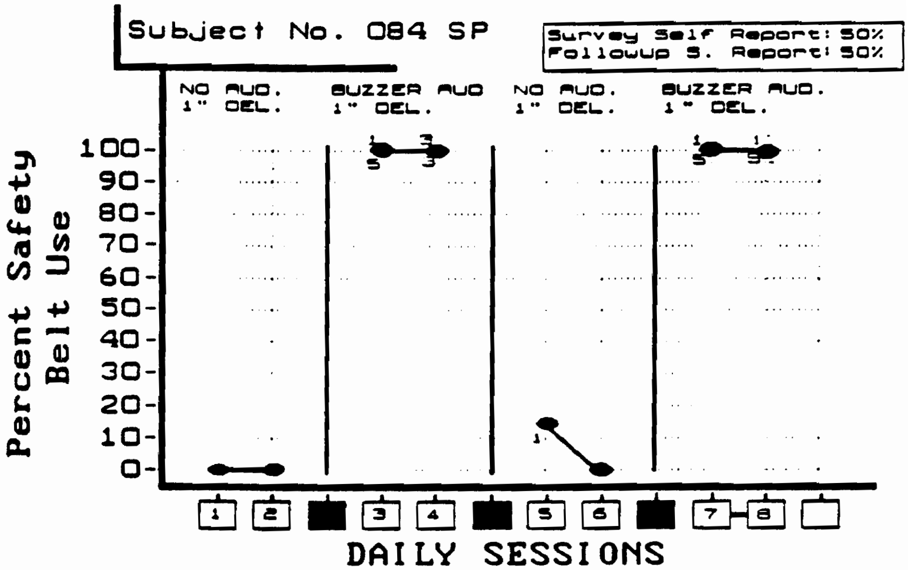
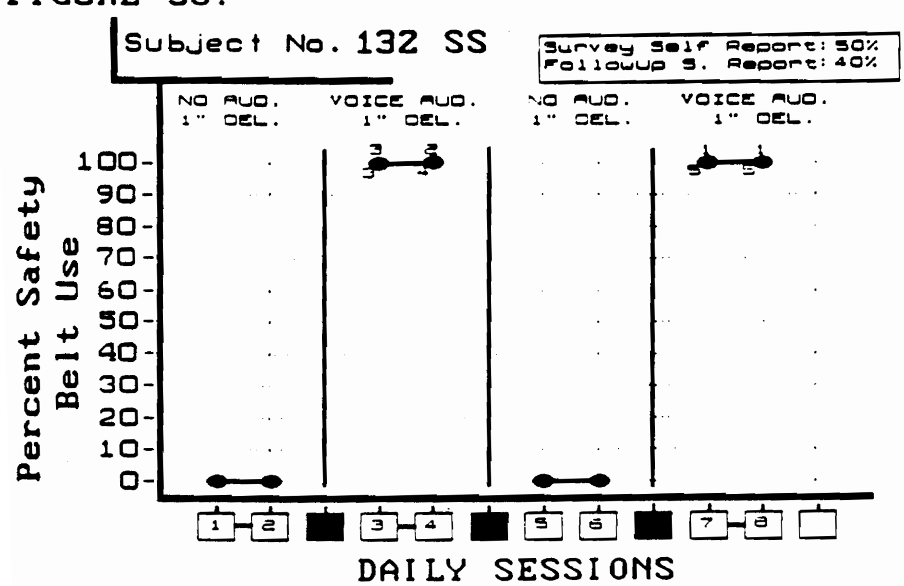


FIGURE 36.



Figures 35 & 36. Percent safety belt use.

the Voice Reminder. Subject 132's baseline use of safety belt in Phase 1 to the No Auditory condition was zero percent. When presented with the Voice Reminder in Phase 2, her safety belt response increased to 100 percent. Six days later, during the reversal (Phase 3), the withdrawal of the Voice Reminder was associated with a decrease in belt use to zero. Again, reinstatement of the Voice Reminder was followed by an increase in safety belt behavior to 100 percent.

In summary. Overall, the above data show that out of 30 subjects, 18 emitted consistently high safety belt response frequencies across all phases (ceiling effect), 8 subjects emitted no to very low safety belt response frequencies across all phases (floor effect) and 4 subjects were found to be reminder influenced (i.e., the presentation of a reminder system increased safety belt use). Of the four subjects whose safety belt use was increased, two were apparently influenced by the Second Reminder, and the remaining two by the presentation of the Buzzer and Voice reminder stimuli.

Process Analysis and Manipulation Check

The purpose of the Follow Up Survey was to answer four principle questions (see Appendix C.): first, did subjects have any experiences that influenced their usual driving behavior while participating in the field experiment. Second, subjects were asked what they thought this research was about. The third and fourth questions concerned the manipulation checks: how accurately did subjects recognize the specific auditory reminder presented to them out of a list of six auditory signals (see Audible Sound Recall Test in Follow Up Survey, page 154), and how accurately did subjects locate the safety belt reminder light on a diagram outlining the Cadillac's instrument panel (see Visual Recognition Test in Follow Up Survey, page 153).

1) Twenty-three out of 27 subjects (85 percent) who answered the question, indicated that "no" experiences had influenced their driving behavior while they participated in the project. The other 15 percent said, in general, that they were more aware of traffic, the speedometer, or the fuel computer panel.

2) Of the 27 subjects answering this question, none offered any clue that this study concerned the effectiveness of different reminder safety belt stimuli. Subjects, in general, thought this research attempted to investigate "driving skills concerning braking and turning signals" or "driving habits regarding energy conservation."

3) and 4) Table 3 on page 52 diagrams four cases of reminder configurations across two phases. The diagrams

will help explicate the following findings regarding the manipulation checks of the reminder light and the auditory reminder presentations. Since the particular configuration of reminder variables across phases was contingent upon the response rate in prior phases, then accuracy of the subjects to recognize the specific location of the reminder light and type of auditory reminder condition may be a function of the safety belt response rate. Therefore, accuracy was examined in regard to both: 1) the configuration of the reminders across phases (e.g., presentation of an auditory reminder in Phase 1 and a No Auditory in Phase 2, see Table 3, Case 2 on page 52), and 2) the subjects' level of safety belt use (i.e., reminder influenced, ceiling effected high rates between 90 -100 percent, and floor effected low rates between 0 - 10 percent).

Auditory reminder check. As shown in Table 10 on the following page, subjects in the No Auditory condition across all phases (see Case 1) were surprisingly inaccurate at recognizing the auditory condition presented to them. Only one subject out of 6 (17 percent) could acknowledge the No Auditory as the correct auditory answer. The other subjects (83 percent) who were incorrect, differentiated on what they "heard": two subjects indicated a Chime, two subjects

TABLE 10. ACCURACY OF SUBJECTS IN RECOGNIZING THE AUDITORY REMINDER BY DESIGN CONFIGURATION.

Design Configuration	Correct (C)	Wrong (W)	Percent (C) / (W)
Case 1	1	5	17/83
Case 2	4	4	50/50
Case 3	5	0	100/0
Case 4	5*	0	100/0

NOTE. * = Subject 893 added to Case 4.

said a Tone, and one subject indicated a Buzzer. Overall, subjects receiving either a Buzzer or a Chime during Phase 1 and then receiving a No Auditory in Phase 2, showed mixed results (see Table 10, Case 2). Four out of eight subjects (50 percent) answering the question could accurately recognize the auditory reminder given them in Phase 1.

Subjects assigned the auditory reminder in both phases (see Case 3) across Chime and Buzzer conditions demonstrated greater accuracy at recognizing the auditory reminder presented during their participation. All 5 subjects (100 percent) correctly acknowledged the specific auditory reminder presented to them. Also, subjects assigned to the No Auditory condition in Phase 1 and then to a auditory reminder in Phase 2 (see Case 4), showed 100 percent accuracy (5 out of 5 subjects).

The Voice auditory reminder was left out of the analysis due to its ambiguity. The Voice prompt is actually a combination of two signals (a Chime lead-in before the verbal statement). If mentioning either signal is considered correct, then these subjects were 100 percent correct in recognizing the auditory reminder.

Table 11 on the next page, illustrates how accurate subjects were in recognizing their auditory reminder, in

TABLE 11. ACCURACY OF SUBJECTS IN RECOGNIZING THE AUDITORY REMINDER BY SUBJECTS' SAFETY BELT PERFORMANCE.

Subjects' Performance	Correct (C)	Wrong (W)	Percent (C) / (W)
Reminder Influenced	4	0	100/0
Floor Effected	5	0	100/0
Ceiling Effected	5	10	33/67

relation to their safety belt performance. For reminder influenced subjects, all 4 (100 percent) accurately chose their respective auditory reminders. For those subjects showing floor effects, 5 out of 5 (100 percent) could correctly acknowledge their auditory reminders. However, for subjects demonstrating ceiling effects only 5 out of 15 (33 percent) recognized the correct auditory reminder assigned them. For subjects with high safety belt rates (ceiling effected), their inability to recognize the correct auditory reminder may depend on "when" they fastened their safety belts, that is, "before" or "after" the presentation of the reminder system. Notice that if a subject buckles "before" the initiation of the reminder system, the subject never experiences the reminder stimuli. Analysis of subjects with high safety belt rates showed on average that they fastened their safety belts 62 percent of the time "after" the initiation of the reminder system (with a range of 17 to 100 percent).

Reminder light check. Table 12 indicates how accurate subjects were in locating the reminder light with regards to the reminder configuration presented to them across phases. Out of the five subjects that received the No Auditory condition throughout their participation (see Case 1 of Table 12) not one (zero

TABLE 12. ACCURACY OF SUBJECTS IN LOCATING REMINDER LIGHT BY DESIGN CONFIGURATION.

Design Configuration	Correct (C)	Wrong (W)	Percent (C) / (W)
Case 1	0	5	0/100
Case 2	2	8	20/80
Case 3	4	3	57/43
Case 4	4	1	80/20

OVERALL Design Configurations	Correct (C)	Wrong (W)	Percent (C) / (W)
Cases 1 + 2	2	13	13/87
Cases 3 + 4	8	4	67/33

percent) could point out the location of the reminder light on a diagram illustrating the Cadillac's instrument panel. Subjects who received an auditory reminder in Phase 1 (across Buzzer, Chime, and Voice conditions) and then a No Auditory reminder in Phase 2 (Case 2), were only slightly accurate as a group. Only two out of ten subjects (20 percent) were able to find the placement of the reminder light.

Overall, 2 out of 15 subjects (14 percent) ending their participation with the No Auditory condition (see Cases 1 & 2) could find the location of the reminder light. Whereas subjects ending their participation with an auditory reminder (see Cases 3 & 4) had greatly increased accuracy. Eight subjects out of 12 (67 percent) were able to locate correctly the placement of the reminder light on the instrument panel diagram.

Table 13 presents the results of subjects' accuracy when the safety belt use of subjects is considered (i.e., reminder influenced, floor effect, and ceiling effect). Subjects' safety belt results that showed floor effects were more likely to be accurate than subjects demonstrating ceiling effects in finding the placement of the reminder light. Three out of 16 subjects (19 percent) with high safety belt frequencies correctly located the reminder light. While, six out of

TABLE 13. ACCURACY OF SUBJECTS IN LOCATING REMINDER LIGHT BY SUBJECTS' SAFETY BELT PERFORMANCE.

Subjects' Performance	Correct (C)	Wrong (W)	Percent (C) / (W)
Reminder Influenced	1	3*	25/75
Floor Effected	6	1	86/14
Ceiling Effected	3	13	19/81

Note. * = includes subjects 027 & 071. both responded to the 2nd Reminder.

seven (86 percent) of the subjects with low safety belt frequencies accurately placed the reminder light on the instrument panel diagram.

However, the four subjects who were reminder influenced (Subjects 084, 071, 027, and 132, Figures 35, 30, 29 & 36, respectively), showed unexpected results. Three out of four subjects were not able to place the reminder light, even though some aspect of the auditory reminder had influenced their safety belt behavior. One might expect that subjects influenced by the auditory reminder might associate its presentation with the simultaneous presentation of the reminder light. Closer inspection of the data indicate that two out of the three subjects who were inaccurate (Subjects 027 & 071), received the Second Reminder which corresponded with their increased safety belt use (see Figures 29 and 30). Note in the Apparatus section of the Methods (page 41) that the initiation and occurrence of the Second Reminder after the first occurs without an associated reminder light. Therefore, the association between the auditory reminder and the reminder light was not possible at this critical moment, when the subject was apparently attending to and responding to the auditory reminder prompt.

Regression Analysis: Self Report vs. Actual Safety Belt Use

Regression statistics were calculated on: 1) regression of average baseline safety belt use while driving the Cadillac on subjects' self reported use of safety belts (i.e., Question 52 of initial survey), and 2) regression of subjects' follow-up self reported use of safety belts while driving the Cadillac (i.e., Question 16 of follow-up survey) on overall average (across phases) of actual safety belt performance while driving the Cadillac. The first regression statistic examined whether subjects' self-reported safety belt response rates predicted actual response rates in the context of the Cadillac. A simple linear regression indicated that 19 percent of the variance ($p < .018$) in actual safety belt use (across subjects) in the Cadillac was accounted for by the self report measure. The large unaccounted variance is supported by a standard error of estimate (S.E.E.) of 39.60.

Figure 37 shows the regression plot of the relative distribution of individuals in regard to the reported and actual (during baseline) use of safety belts. The dark line labelled (R) represents the regression line of best fit, while the two dashed lines show the confidence intervals (CI) for predicted scores

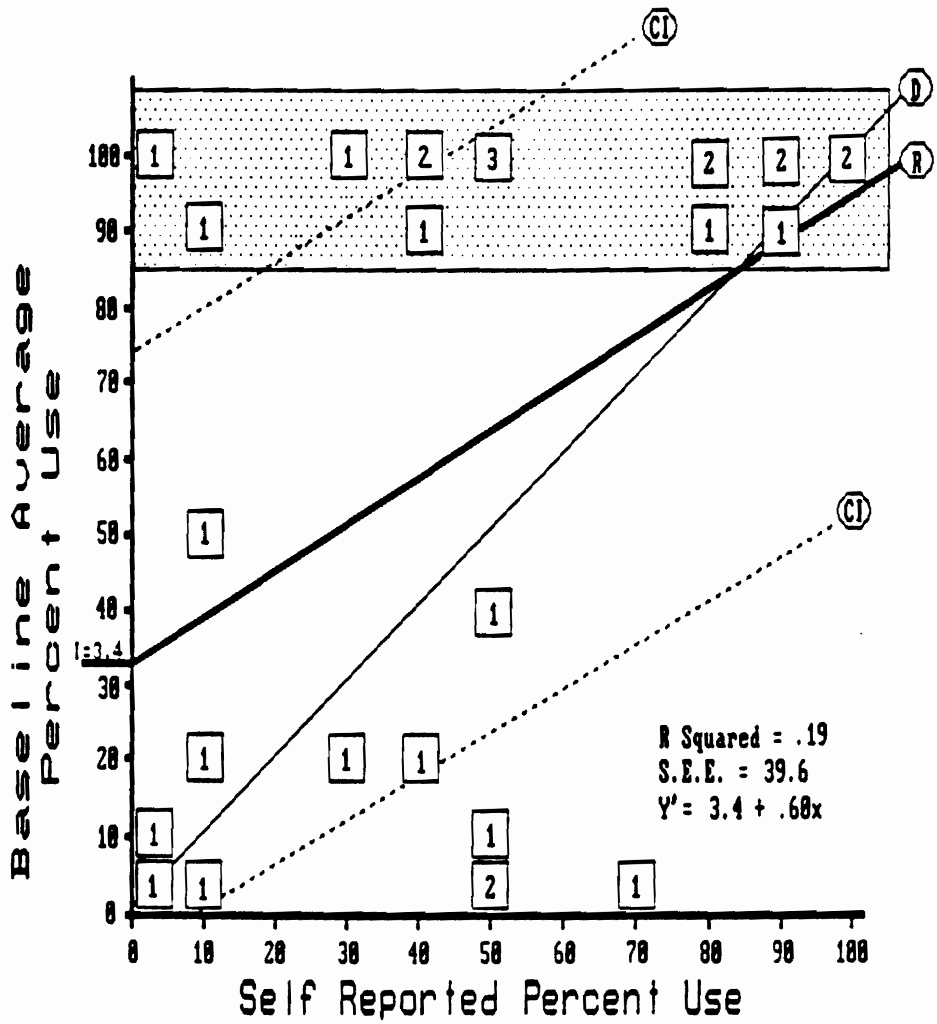


FIGURE 37. Regession Plot of Subjects' Baseline Average Safety Belt Use ON Subjects' Self Reported Use prior to Driving the Vehicle

Note. [shaded box] = subjects showing ceiling effects. (R) = Regression line. (CI) = Confidence Interval line. (D) = Diagonal Perfect Correspondence line, Above line = underestimation, Below line = overestimation.

[#] = Number of Subjects.

(Pedhazur, 1982). The grey shaded area delineates individuals showing high response rates (i.e., ceiling effects) during baseline. The diagonal line (D) signifies the perfect positive correspondence between what subjects said (self report) and did (actual safety belt behavior). In general, subjects below the diagonal line (n = 8) overestimated their actual belt use, while subjects above this line (n = 17) apparently underestimated their belt use.

The regression R squared statistic of 19 percent ostensibly casts doubt on the original survey's utility to predict safety belt use in the Cadillac. However, the lack of correspondence seems more indicative of the experimental demand characteristics inherent in the context of the research vehicle and the procedure than the validity of the self report. In general, a common concern with surveys is that subjects will give socially desirable answers. The initial survey shows some evidence of social desirability among 8 subjects whose safety belt self reports were between 10 and 70 percent, in that some individuals overestimated their self reported belt use. Note that none of the subjects who reported high belt use (80 - 100 percent) seemed to overestimate their belt behavior, which would have been indicative of social desirability.

Even more pronounced were the subjects that strongly underestimated their rate of safety belt use (i.e., see distribution of subjects in the shaded area of Figure 37). Discrepancies between self reported measures (0 - 40 percent) and actual belt frequencies (90 - 100 percent) present good indication that some other uncontrolled factors of the experimental context induced these non-correspondences.

The second regression statistic relating the overall average of actual safety belt use and the follow-up self report of belt use (while driving the Cadillac), showed a R square of 86 percent. The standard estimate of error was only 14.3. Figure 38 presents the distribution of subjects, a regression equation line (R), confidence intervals (CI) and a perfect positive correspondence diagonal line (D).

In general, most subjects had a high degree of positive correspondence between what they did and what they "said" they did in the Cadillac. Only a few subjects overestimated and underestimated significantly outside the confidence interval. Some variation can be explained by reviewing subjects' actual safety belt performance. For Subject 071 (see Figure 30) overestimation is possibly due to his 100 percent safety belt use in the last three sessions. Likewise,

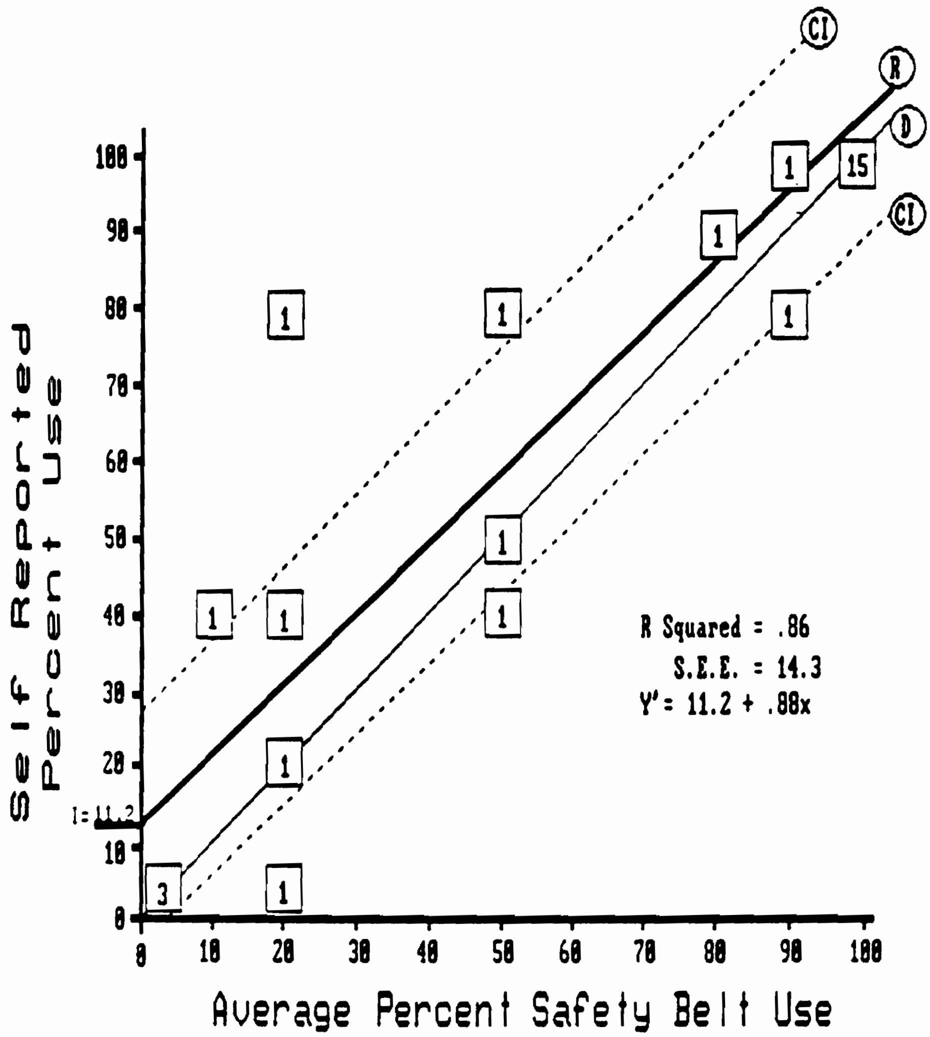


FIGURE 38. Regression Plot of Subjects' Follow-Up Survey Self Reported Safety Belt Use ON Overall Average Percent Safety Belt Use

Note. [#] = Number of Subjects. (R) = Regression line.
(CI) = Confidence Intervals.
(D) = Diagonal Perfect Correspondence line, Above line = overestimation, Below line = underestimation.

Subject 185's underestimation (see Figure 26) may be related to a recency effect of having a flat zero percent use during his last three sessions. Only subject 011 showed signs of a discrepant self report with actual belt behavior (see Figure 27). During her last 5 sessions she never buckled up, and her overall average was 22 percent belt use. Surprisingly, she claimed that her belt use was 80 percent while driving the Cadillac.

Discussion

Inspection of the data indicate that subjects exhibited two kinds of responses toward the various auditory and temporal safety belt reminder arrangements. The two responses can be described as: 1) indifferent to safety belt reminder stimuli, and 2) responsive to safety belt reminder stimuli. The terms indifferent and responsive describe changes in a subject's responding to the auditory and temporal safety belt reminder stimuli studied. These terms refer to a contingency approach; regarding whether the presentation of the different auditory and temporal stimuli across experimental phases set the occasion for different response rates of the target behavior (i.e., safety belt use or nonuse). This approach implies an interaction between subject's prior history (i.e., experiences with driving automobiles, safety belt reminder stimuli, and belt use) and the experimental safety belt reminder stimuli investigated in this study.

Indifferent responding is illustrated by subjects who consistently emitted very low or very high response frequencies of safety belt use across all phases. Consistently low safety belt use was considered indifferent after varying safety belt reminders (e.g., Delay or Second Reminder) failed to promote increases in safety belt use. It is impossible to say conclusively whether the continued low response frequency during an auditory-light reminder is a function of either the prior conditioning and history of the subject or the actual "ineffectiveness" of the reminder stimuli, or an interaction between both sources.

Consistently high safety belt use across all phases was considered indifferent when the withdrawal of an auditory reminder failed to decrease safety belt use. An attempt to distinguish between effective and ineffective reminder stimuli with high safety belt use data (i.e. ceiling effect data) is a moot discrimination since no reversal was found. Consideration also should be given to possible moderators that maintained high safety belt use other than a subject's prior history, such as experimental demand characteristics (to be discussed later).

A subject's safety belt use which was described as responsive is denoted by: 1) a correspondence between the presentation of a safety belt reminder and the subject's increased belt use, and 2) the correspondence between the withdrawal of a safety belt reminder stimulus and subsequent decreases in safety belt behavior. Subjects whose safety belt use appeared to have been modified by changes in the reminder stimuli presented across experimental phases, allowed for functional control type interpretations to be made. The difficulty and the limitation of this investigation was the inability (at this time) to unpack the interaction between a particular safety belt reminder and the contribution of a subject's driving history.

Previous group design research found that drivers behaved indifferently to safety belt reminders except when reminders were described as aversive, such as an ignition-interlock system (Cohen & Brown, 1973; Robertson, 1975a, 1975b; Robertson & Haddon, 1974). Though the results of this study support the existence of indifference to reminder systems, there is evidence that for particular persons, reminder systems (whether improved or not) do appear to influence safety belt use. The proportion of reminder-influenced subjects in this study was admittedly small, 4 out of 30 (only 13 percent). Still, the possible social impact of an improved reminder system could have substantial practical significance. In the U.S. alone, there are over 150 million registered drivers (Accident Facts, 1982). Therefore, if all vehicles were equipped with an improved reminder system and if only one percent of the population of drivers were reminder influenced, then an additional 1.5 million drivers would be belted up (Von Buseck & Geller, 1983).

The results substantiate the usefulness of response-guided, repeated measure, and single case designs. These effects would not ordinarily have been detected in traditional group designs. And, even if some aggregated statistical significance between treatments were found, process information (i.e., the repeated measure and ideographic analysis) would typically be unavailable or not considered.

Analysis of the Proposed Modifications to Reminder Systems

Of the three proposed improvements investigated (i.e., the Delay, the Second Reminder, and the presentation of alternative auditory stimuli), only two showed any relative influence. For the Delayed Reminder no increases in safety belt responses were observed. It was hypothesized that the Delay would lessen the effects of concurrently presented stimuli that potentially mask or overshadow the reminder system, and thus increase the reminder's detectability and impact. However, the testing of the Delayed Reminder system may have been compromised by the built in muting of the radio. Muting of the radio is assumed to decrease masking, and increase detectability of the reminder system. The rationale for muting the radio was to control the differential influence of the radio (when used) across and within subjects (i.e., sessions and trials). Yet, the muting of the radio may have indirectly influenced the comparison baseline, (i.e., Phase 1, the concurrent reminder system). The implication is that some subjects who did respond by using their safety belts during the baseline phase, may have ordinarily not have used their safety belts, if it were not for the muting of the radio. Therefore, if the muting of the radio is considered a meaningful stimulus component that interacted with the concurrently arranged reminder system, then it is possible that the testing of the Delayed Reminder was confounded. However, if these subjects were sensitive to the muting of the radio and subsequently buckled up, they certainly were not influenced by the later withdrawal of the auditory reminder stimuli in following phases. Future research should incorporate in the design of the apparatus the ability to switch the muting of the radio on and off, so as to test this factor's significance on safety belt behavior and stimulus masking. Therefore, all conclusions discussed herein must consider the muting of the radio when drawing inferences regarding the generality and effectiveness of the reminder systems.

Except for the radio, other vehicle stimuli were concurrently presented during baseline conditions and can be assumed to have contributed to the possible masking and overshadowing of the reminder system stimuli. In any case, the Delay showed no effect and there was no indication that subjects were responsive to its withdrawal (regarding the subjects presented the counterbalanced condition). One reason for the Delay's ineffectiveness may be due to the relative conflict between safety belt behaviors and driving behaviors (i.e., response competition). By the time the 4 to 5 seconds Delay occurred and activated the belt reminder, the driver may have already been engaged in driving behaviors incompatible with safety belt use. Interpretations of these responses may be conceived as inconvenient to the subjects when risk of injury is not a probable event during the course of the trip. An alternative explanation is that the Delay of 4 to 5 seconds did not provide any additive "distinguishability" to the system (even with a muted radio). Future research might test alternative time interval durations between the ignition start up and the initiation of the reminder system. Possibly the Delay was too long. During 4 to 5 seconds the driver may have already engaged the gears and begun certain initial driving responses (e.g., backing out of driveway). A Delay of 2 to 3 seconds may be sufficient to disassociate concurrently arranged instrument panel and audio stimuli, while initiating before more directive and focussed driving task behaviors have been started.

In contrast, the Second Reminder appears to have been responsible for occasioning two subjects out of nine to increase their use of safety belts (Figures 29 & 30). These increases were associated with both Buzzer and Chime reminder stimuli. Temporal analysis of the Second Reminder revealed that the initiation of the Second Reminder was indeterminate, in that, the first stop after exceeding 20 mph depended on the driver's route, location of traffic lights and signs, timing of traffic lights and other traffic related factors (e.g., vehicle speed and number of vehicles on the road).

The principle response difference between the Delay and Second Reminder was that the Delay activated during a time when the subject was beginning a sequence of driving tasks, whereas the Second Reminder initiated when the driver was ending a sequence and approaching a pause between two active intervals of driving response sequences. Depending on the relative circumstances of the stop (e.g., the length of the traffic light vs. a stop sign) this situation might have been suitable for effecting safety belt behavior if the first reminder has failed. For instance, at a relatively long red traffic light the hands can be free to reach grab and latch a safety belt (in other words, response competition is reduced). And only if the radio is playing would one expect any masking stimuli from the vehicle, though other general stimuli indicative of a driving context might distract the driver from the reminder system (e.g., driver observing traffic or conversing with a passenger). Note that the Cadillac's radio was automatically muted during all presentations of a safety belt reminder and therefore could not contribute to any masking affect.

At this early stage the Second Reminder shows some promise as an effective safety belt reminder. Follow-up research should investigate the significance of the duration of the first stop as a predictor for the safety belt response. There may be some drawbacks to the implementation of this system: first, the cost of engineering this system into a production line of vehicles may be prohibitive. Second, some consumers may consider this system intrusive and annoying, and thus disable it.

This research also studied whether any differential effects would be shown between the three auditory types (i.e., Chime, Buzzer, and Voice). Unfortunately, in general, across subjects and the different auditory reminder stimuli (even including the No Auditory condition) no definitive differences were found. Again, the muting of the radio may have attenuated the detection of some differences. However, data from subjects who were presented the No Auditory condition in Phase 1 and then an Auditory signal in Phase 2 (see Table 3's Case 4 and Table 4's top row of matrix: C, B, & V) suggest (all things being equal) that the Buzzer and Voice reminder stimuli did occasion safety belt use while the Chime did not. Under these experimental conditions the Buzzer and Voice were apparently more effective. A question still remains as to whether the above increases in safety belt use were a function of some aversive qualities of the associated reminder stimuli or a response to the discriminative cueing properties of the reminder. Some subjects did report in the Follow Up survey that the Buzzer was the least liked aspect of the Cadillac.

<u>Analysis of Ceiling and Floor Data</u>

Indifferent responses to various safety belt reminder stimuli are characterized by ceiling and floor effect data. The intervention and withdrawal of different reminder stimuli was found to have no influence over subjects showing consistently high belt use rates, nor for subjects consistently demonstrating no safety belt use. Some ceiling effected data may be a function of social desirability and experimental demand factors as evidenced by the non-correspondence found in the regression analysis. The regression analysis showed that the self-report of belt use by at least 9 subjects "underestimated" actual safety belt use. Note that the manipulation checks indicated that underestimation of actual safety belt use was not a function of whether these subjects knew the intent of the study (i.e., safety belt research).

However, experimental factors which might have maintained these high safety belt rates include unknown and uncontrolled "carryover" effects (Barlow & Hersen, 1984). Carryover effects can be a function of unidentified conditioned reinforcers or an unspecified naturally occurring contingency present in the experimental procedure. For instance, some subjects may have generalized that their participation was similar to a test car driver as seen on T.V. commercials which show drivers buckled up. Similarly, the experimental set-up might have projected a professional and serious atmosphere, influencing subjects to drive with undue care (i.e., consistently using ones safety belt) atypical of their own driving habits. The organization of the trips and driving course may have also contributed to this impression of seriousness, despite the fact that the author requested that subjects enjoy, relax and drive the Cadillac as if it were their own. Alternative procedures that could attenuate the above impressions of seriousness and the laboratory style of organization include: 1) allowing subjects to pick that day's driving course from a list of destinations and routes 2) encouraging subjects to bring and play their favorite music cassettes, and 3) allowing subjects to bring a passenger. The purpose of these alternatives would be to better approximate a casual and naturalistic setting (increasing the external validity), thereby allowing for the potential of these alternative reminder systems to impact the use of safety belts (i.e., induce variance). These alternatives would add certain complications to the design and analysis and would necessarily need to be documented. It is possible that these alternatives may be important variables with profound influence over the effectiveness of a safety belt reminder system.

It is recommended that when carryover factors exist, "relatively short experimental periods" should be used in order to attenuate the establishment of "new conditioned reinforcers" (Barlow & Hersen, 1984; Bijou, Peterson, Harris, Allen, & Johnston, 1969; & Kazdin, 1973). Therefore, to find an optimal design sensitivity, continued research in this area may vary the length of the sessions (e.g., from 6 to 4 trips), adjust the trip lengths and number of days that define a phase.

One possible factor that might explain why some subjects showed extremely low safety belt rates (i.e., floor effects) is that these subjects did not attend to nor detect the reminder stimuli. This explanation however, contradicts the follow up data which showed subjects who did not use safety belts were very accurate in recognizing the auditory reminder (100 percent correct) and identifying the reminder-light placement (67 percent) on the instrument panel. In fact, individuals who never used their safety belts were more accurate then subjects who always used their safety belts in identifying auditory-light reminders. This difference in accuracy between subjects with high safety belt rates and subjects with low safety belt rates may in part be a function of the number of times a particular reminder system was presented (i.e., across sessions and phases).

Note that most subjects who exhibited ceiling effects ended their participation (usually the last two sessions) with No Auditory reminder presented, whereas subjects with floor effected data received an auditory reminder across all phases of their participation. For both groups, however, the reminder light was presented throughout the sessions of each group (i.e., across all phases). Thus, one would not expect differences in accuracy in the follow-up survey's visual recognition test, between the above two groups, in locating the reminder light display. Surprisingly, subjects with ceiling effected data were much worse in locating the reminder light than subjects with floor effected data, even though the light was presented throughout their participation.

The vigilance and signal detection literature provide a possible explanation for these differences in safety belt reminder light detection and accuracy.
It has been shown that detection of dual-mode displays is superior to single-mode displays, that is, either auditory or visual signals displayed alone (Colquhoun, 1975; Gruber, 1964; Osborn, Sheldon, & Baker, 1963). Simply, dual-mode displays (e.g., auditory and visual presented simultaneously) are considered redundant in that they signal the same information, message, or

warning. For instance, studies that simulated radar vigilance tasks found auditory signals to be more effective than visual signals, but dual-mode signals were even better then auditory signals (Colquhoun, 1975). From the follow-up manipulation check data, safety belt reminder systems may share this dual-mode conditioning of concurrently presented stimuli that result in increases in discrimination efficiency.

This conclusion is threatened by the confounding of subjects differential safety belt response rate and the reminder configuration presented them. For instance, the subjects who always buckled their safety belts might have been less accurate because buckling terminates or avoids completely the presentation of the reminder system. Also, the act of buckling could have possibly distracted subjects from noticing the reminder signal. Inspection of the data revealed that, on average, subjects with high safety belt rates fastened their safety belts 62 percent of the time "after" the initiation of the reminder system (that includes both auditory-light and No Auditory reminder conditions). Out of 15 subjects, 12 were found to buckle up more often "after" the reminder system's initiation (i.e., greater than 52 percent of the time, with a mean of 71 percent).

Thus, the opportunity for the reminder light to be detected was made available to most subjects in the ceiling effect group. Another, alternative suggests that "motivational" factors (related to safety belt use) systematically effected subjects ability to identify the reminder light's placement and recognize the auditory reminder. Future research is planned to examine if dual-mode conditioning is responsible for the above mentioned differences in accurately identifying safety belt reminder signals.

Conclusions

Research in the area of safety belt reminder systems as they effect safety belt behaviors has been minimal over the past 15 years. Previous accounts of safety belt effectiveness applied field-study designs with observational methods to evaluate the efficiency of reminder systems. The research presented here represents, for the first time, an initial exploratory attempt (in a quasi-laboratory setting) to evaluate the differential effects that a variety of specific safety belt reminder stimuli and systems had on safety belt behaviors. As presented above, the effectiveness of a reminder system was defined as an interaction among the driver, the context of the vehicle, and the reminder system employed.

One challenge for designers and researchers is to determine how salient an auditory-light reminder system must be to effect safety belt behavior. The saliency of the stimuli must be conceptually specified as to what type of behavior they will effect. Prior conceptualizations defined reminders as some stimulus that could "prod" non-users into using safety belts, indicating that the safety belt reminder was designed for the non-user. The aversive reminders met with negative consumer reactions from both users and non-users of safety belts. But this of course begs the question: for whom should reminder systems be designed ?

A Change of Focus

If safety belt use gradually becomes the norm (Evans, 1986), then decision makers and researchers should probably invest their efforts in developing a reminder system that is designed for the "habitual" and intermittent user of safety belts who occasionally forgets or is distracted. Since there is the potential that users of safety belts will someday constitute the majority of the population, reminder systems should probably do just that -- "remind" (i.e., set the occasion). It is sad when a driver chooses not to wear a safety belt and is killed in a car accident. It is tragic when an individual who is committed to using his or her safety belt and forgot or wasn't adequately reminded to buckle up on the one trip that results in a fatal crash.

The cooperative efforts of researchers and auto manufacturers are needed to research, design, and supply a reminder system that is "distinctive" but not annoying. One that is not conceptualized as some isolated electronic device with low priority, attached and installed willy nilly, but is integrated into other vehicle-producing stimuli and displays, and that maximizes the probability of occasioning the appropriate behavior (i.e., safety belt use). By placing the safety belt reminder into context (e.g., the target individual and the milieu), a designer and researcher can better investigate the necessary and sufficient properties associated with an effective safety belt reminder system. Hopefully, this study, has contributed to understanding some of the properties and issues defining an efficient safety belt reminder system.

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Appendix A

Subject Driving History, Habits, and Abilities Survey

SUBJECT DRIVING HISTORY, HABITS, AND ABILITIES SURVEY

INTRODUCTION

A research team at Virginia Tech is preparing to conduct a research project on the habits and abilities of automobile drivers . This is a preliminary survey to assess issues regarding energy conservation, navigational map reading, and in general, the driving habits, attitudes and skills of university students .

Please, help us in this preliminary step by responding carefully and frankly to each items listed below.

This survey takes on average 15 minutes to fill out. After finishing this survey return it to the research assistant's office [office number = 5092 - A].

After returning the survey please do not leave, the research assistant will have a few more questions for you to answer. PLUS, the research assistant will give you further details about earning additional credit .

If you are participating in this project for extra credit points (i.e., Psych 2000) please check this box [ ] . You will receive 1 extra credit for completing this survey. ALL YOUR ANSWERS WILL BE KEPT IN STRICT CONFIDENCE . Remember you may withdraw your participation from this project at any time .

Thank you

GENERAL DIRECTIONS:

Please follow specific directions . The following survey is made up of several types of questions: circle your answers to the (T)rue and (F)alse, (1) Yes and (2) No , and rating scale questions. Please fill in the blank when appropriate.

B A C K G R O U N D   I N F O R M A T I O N :

Name:_______________________ Date:_______ I.D. #:_______________

Home Phone #:__________________ Work Phone #:___________________

Address:____________________________________

Age:_____ Sex: M F Major:______ Other than this project, How many extra credit points have you already completed or committed yourself to ? _______

DO NOT WRITE BELOW THIS LINE. CM:[ ]. FILE #: .

1. Circle the last level of education that you completed.

   High School, College: Freshman, Sophomore, Junior, Senior, Masters or PhD.

2. Are you a licensed driver ?

   (1) Yes For how long ? _______.
   (2) No

3. From what State are you a licensed driver? _______________.

4. Do you presently own your own car ?

   (1) Yes For how long ? _______.
   (2) No

5. If you said No to the above, do you usually borrow a friends car when in need ?

   (1) Yes How often per week ? _____.
   (2) No

6. Approximately how many trips per week do you drive your vehicle? (Each time you drive and stop then get out of the car counts as one trip. So, if you drive to the grocery store and return home, that would count as 2 trips.)
   Circle the approximate category.

   0 - 10, 11 - 20, 21 - 30, 31 - 40, 41 - 50, more than 51

7. Describe the vehicle which you currently drive most often:
   List the Make, Model, Year, & Engine size

	MAKE	MODEL	YEAR	# of cylinders
Examples:	(Buick, Honda)	(Skylark, Accord)	(1985)	(4, 6, 8)
Fill in **	_________	___________	_____	_____

8. The vehicle you most often drive has which type of transmission ?

   (1) Manual stick and clutch
   (2) Automatic transmission

9. How would you describe this car ? circle your answer.

   Large Mid-size Small Compact Subcompact

10. Have you driven a large automobile like a Lincoln Continental in the past year ?

    (1) Yes, How many times in the past year? _____.
    (2) No

For each of the following, circle T for true or F for false.

11. T F I buy my gas at a "Self Service" pump at least 9 out of 10 times.

12. T F If gas prices rise above dollar 1.25 per gallon, I would drive less or take fewer trips.

13. T F I believe the speed limit on interstate highways should be raised to 65 MPH, even if gas consumption would increase.

14. T F I drive more miles during the weekend than during the week.

15. T F My driving style results in higher gas consumption than EPA ratings.

16. T F I believe that changing my driving habits would have minimal impact (less than 5 percent) on my fuel savings.

17. T F If some feature of my vehicle were designed to provide feedback about my driving style (e.g., to reduce gas consumption), I believe my driving habits would change.

18. T F I usually drive with one hand on the steering wheel, leaving the other hand free.

19. T F On the whole, I think driving is a risky and demanding activity that requires careful concentration.

20. T F On an interstate highway, I usually prefer to drive in the "fast" lane even when I have no special reason to be in a hurry.

21. How often do you personally drive a vehicle ?

(1) Every day
(2) Every other day
(3) Once in a while

22. Have you ever experienced a really dangerous close call or near accident while driving ?

(1) Yes, Approximately how many times in the last year? _____
(2) No

23. T F I believe the Government should put more emphasis on repair and maintenance of existing roads than on constructing new roads.

24. T F When traffic laws seem irrational or unreasonable to me, I usually still obey those laws even though no one is watching me.

25. T F I believe that if a customer at a bar gets drunk and then drives his or her car into another vehicle, that person (customer) should be held completely responsible.

26. T F I believe prevention of driving while under the influence of drugs or alcohol should be enforced by police checking drivers at random check points on roads.

27. T F I have not been cited for a traffic violation during the past three years (not counting parking tickets).

28. T F I would pay higher taxes for the support of Mass Transit Projects (like improved bus systems, subways, monorails and train networks) if it meant independence from foreign sources of energy.

29. T F I would support a Federal Government project that would regulate fuel prices in order to control energy consumption .

30. T F I think the Federal Government should impose a higher tax on gas.

31. T F When I buy gas, I almost always (9 out of 10 times) fill the tank.

32. T F If it wasn't for the threat of getting a speeding ticket, I would drive faster than I usually do on the highway.

33. T F I have my car tuned or serviced as often as is suggested in the owner's manual.

34. T F I check the air pressure in my tires at least once a month.

35. T F I usually pay for my gasoline purchases with a credit card, even though it cost a little extra per gallon .

36. T F I occasionally (once a month) drive my vehicle just for the pleasure or fun of it.

37. When you go home for break you usually (circle one)

(a) drive your own car
(b) get a ride with a friend
(c) fly home
(d) other ____________________.

39. Which of the following do you generally do <u>before or after</u> you start your vehicle ? (Circle all that apply and ~~add "others" if~~ appropriate).

(1) Adjust Mirrors
(2) Turn on the Radio or Cassette Player
(3) Look at Dash Board for Warning Lights
(4) Look at gas gauge for how much is in the tank
(5) Put car in gear and go
(6) Other:

40. Driving in demanding situations where my skills are tested is something that I tend to

(1) enjoy and feel satisfied about when I do well.
(2) dislike having to do and obtain no satisfaction from.

41. As a driver, I would prefer to have

(1) stricter traffic laws and more police patrols.
(2) less restrictive traffic laws and less police patrols.

42. The thought of having an accident while driving is something I

(1) rarely or never think much about.
(2) think about fairly often.
(3) crosses my mind frequently.

43. T F I support annual mandatory State auto inspections for vehicle defects and safety, even though it cost me money and time.

44. For safe driving, I think

(1) an attitude of carefulness is more important than driving skills.
(2) driving skills are more important than an attitude of carefulness.

For each of the following questions circle your answer .

45. Rate your overall level of driving skill or expertise using the scale below. 1 = lowest 10 = highest

1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

46. Of the last 10 trips driven on major highways (like I - 81 or 460), on how many did you see a police vehicle (highway patrol) ?

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

47. Of the last 10 trips driven within city limits (like Blacksburg or Roanoke), on how many did you see a police vehicle ?

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

48. Of the last 10 trips you drove a vehicle, how many of these trips did you eat food, drink or smoke a cigarette while driving ?

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

49. Of the last 10 trips you drove, on how many of these trips did you listen to the radio or cassette player ?

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

50. Of the last 10 trips you drove, on how many of these trips did you have at least one passenger ?

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

51. During the last 10 trips that you drove over a 100 miles (like a day trip or a vacation), on how many did you use a map ?

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

52. Over the past month, what average percent of the time did you wear a safety belt while driving ?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100 %

53. What percent of your driving during the week is done at night ?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100 %

54. What percent of your driving during the weekend is done at night

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100 %

55. Have you ever been in a traffic accident ? Yes No How many ? ____

56. If you were in an accident were you injured ? Yes No If No skip 57.

57. Rate the level of your injury between 1 (very minor injury) and 10 (very critical, life threatening injury).

1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

58. When driving (the automobile you most often use) on a highway (like I - 81 or 460), at what speed do you usually drive ?

45 — 50 — 55 — 60 — 65 — 70 — 75 — 80 — 85 +

59. If you were to drive your car on a high performance test road track, at what top speed do you think you could drive safely and continually for a half hour ?

55 — 65 — 75 — 85 — 95 — 105 other ________

60. How many years have you been covered by some type of automobile insurance ?

0 — 1 — 2 — 3 — 4 — 5 — other _____

61. T F In general, I find road maps very easy to understand.

62. T F I usually have a road map or road atlas in the car regardless whether I'm going on a trip or not.

63. Have you ever tried to read a road map while driving a car ?

(1) Yes
(2) No

64. When travelling to a new location, how would you rate (between 1 - 5) the helpfulness and ease of each navigational method listed below ?
1 = The easiest and most helpful ... 3 = Average ease and helpfulness ...
5 = The most difficult and least helpful .

RANK

_______ a. Verbal directions
_______ b. Written verbal directions
_______ c. A map
_______ d. Looking for landmarks
_______ e. A combination of the above, state which combination below:

(1)_________________ and (2)_________________

65. When given verbal directions, how well would you rank your usual memory of those directions ? 1 = very poor 4 = average 7 = excellent

1 — 2 — 3 — 4 — 5 — 6 — 7

The following questions will test your familiarity with the town of Blacksburg. During the course of these questions you will be asked to give the names of streets and landmarks as they are associated with certain specific places in Blacksburg. Also, we will ask you to role play as a person giving directions to a visitor of Blacksburg. If you do not know the answer to any question, leave it blank.

66. University Mall is located at the intersection of what two streets ? Name them :

(1) _________________________

(2) _________________________

67. University Mall includes two major anchor stores, one is a grocery supermarket the other is a general purpose consumer store. Name them :

(1) ______________________________

(2) ______________________________

68. The Gables Mall area where K - Mart and across the street Wade's is located is on what street ?

(1) ______________________________

69. If you wanted to travel by car from Blacksburg to Roanoke, what highways would you use to get there via Christiansburg ?

(1) ______________________________

(2) ______________________________

70. An out of town visitor asks you for directions to Foxridge Apartments. You are standing in the student parking lot outside Derring Hall, name the major street he or she will take to get there .

(1) ______________________________

71. In your estimation, name the <u>four</u> most travelled streets (or highway) in the Blacksburg area?

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

Appendix B

Project Brochure: includes

Summary and Informed Consent Form

P R O J E C T   S U M M A R Y

T I T L E :

CADILLAC PROJECT: AN AUTOMOTIVE RESEARCH PROGRAM ADDRESSING ENERGY CONSERVATION, DRIVING HABITS, NAVIGATIONAL ABILITIES AND MEMORY.

A P P R O A C H   A N D   P U R P O S E :

A PSYCHOLOGICAL AND HUMAN FACTORS APPROACH TO IMPROVE THE DRIVER-AUTOMOBILE SYSTEM & PERFORMANCE THROUGH MODIFIED INSTRUMENTATION AND COMPUTER COMPONENTS .

R E S E A R C H   S P O N S O R S :

GENERAL MOTORS RESEARCH LABORATORIES.

I N T R O D U C T I O N :

Dear Student,

You have been randomly selected and are now invited to participate in what is called the "Cadillac Project" . In general, your participation would involve driving a 1984 Cadillac Seville on a predetermined course around the town of Blacksburg.

You will be asked to memorize a destination (like University Mall) and drive to it using certain routes. Once at the destination you must exit the Cadillac and open the trunk and throw a toggle switch to transfer that trip's data. After transferring the data you then continue to the next destination .

Also present in the trunk will be cue cards and a map of Blacksburg outlining the driving course . These are to assist your memory, guide you through the driving course and help you if you get lost. However, you will not be allowed to have these present inside the Cadillac .

That's it !

Please, consider participating in this project. Driving a Cadillac will be FUN . Besides, you'll earn extra-credit points (between 7 - 10 points) if you're in Intro. Psychology.

For more details, see next page.

Sincerely,

Thomas D. Berry, Project Manager, Telephone #: 961-1002
Office #: 5092 A, Derring Hall.

HOW DO YOU JOIN THE PROJECT ?

1) To be an eligible participant, you must have filled out the "Subject Driving History Survey" .

2) If you have already completed the survey, read the attached Research Contract and Consent Form . If you agree to the terms and conditions, please sign the consent form.

3) You must decide how many extra credit hours you wish to commit yourself to : 6 or 9 . For each hour you will receive one extra credit point for your class grade .
In general, you will be scheduled to drive the Cadillac for one hour per day ... Which days you drive will be arranged between you and the Project Manager .

   Extra credit will only be given to those who complete their stated commitment (i.e., 6 or 9 hours).

WHAT IS REQUIRED OF YOU ?

1) You must drive on a pre-determined course/route through Blacksburg making scheduled stops.

2) You must read and agree to the rules and restrictions included in the "Resarch Contract and Consent Form".

3) Schedule with the Researchers what Times and Days you are available to participate and contribute to this project.

4) Enjoy riding in a luxury automobile.

WHAT ABOUT INSURANCE COVERAGE ?

1) Your use of the Cadillac is insured with liability insurance through Royal Globe Insurance Company.

*** 2) However, insurance coverage is dependent on the subjects following the rules and restrictions stated in the "Research Contract and Consent Form". Any Deliberate violation of those rules and restrictions could result in costly consequences to the participant .

IF YOU HAVE ANY QUESTIONS REGARDING THIS PROJECT, PLEASE CALL TOM BERRY AT 961-1002 .

Turn to next page.

RESEARCH CONTRACT and CONSENT FORM

Directions: 1) Read the following carefully.
2) Initial selected items where space is provided .

I, the undersigned hereby consent to participate voluntarily in the "Cadillac Project", sponsored by Virginia Tech, Department of Psychology, subject to the following terms and conditions:

1) I agree as follows:

_______ a.) To use the Cadillac solely for the purpose of participating in this project . I understand that using the Cadillac outside the expressed rules and purpose of this project are strictly forebidden. The reason is due to insurance restrictions and safety concerns .

_______ b.) To refrain from any unscheduled or unplanned stops outside the purpose of the project, including visiting friends, running errands or visiting home or your dorm building.

_______ c.) To refrain from drinking alcoholic beverages while driving the Cadillac.
In addition, I agree not to drive the Cadillac if I am under the influence of alcohol or other drugs.

_______ d.) To not lend or allow other individuals to drive or ride along in the Cadillac.

_______ e.) To follow the rules of the road, including all posted speed limits, while driving the Cadillac.

_______ f.) To exercise the same caution and prudence that I would employ in using my personally owned vehicle.

_______ g.) To take full responsibility (both financial and moral) for any violation of the above rules,

2) _______ I understand that the researchers reserve the right to withdraw the Cadillac from participants if there is evidence of physical abuse, or violation of the conditions stated above. Likewise, participants may withdraw from the project any time without obligation by notifying the project manager and immediately returning the vehicle.

3) _______ I am over 18 years of age.

4) ______ I possess a valid, current driver's license.

5) ______ I have never been refused automobile liability insurance nor has my automobile liability insurance been cancelled for whatever reasons.

6) ______ I am responsible for any traffic violations and fines due to my neglect or oversite of State or local laws, like parking tickets.

7) ______ I, hereby release Virginia Tech, its officers and employees, and all researchers associated with this project of the resposibility or liabillity in case of personal injury susained by me or others or any personal property loss sustained by me or damage to property of others caused by me during or because of my participation in this research project .

DATE: ________ SIGNATURE: ________________________

DRIVERS LIC. NO.: ____________________ STATE: ________

Hourly Commitment Contract:

You must decide how many hours you wish to commit to: 6 or 9. You will recieve 1 extra credit point for each hour but you must complete your commitment to recieve any credit . IMPORTANT, ONCE YOU HAVE MADE A DESISION FOR A SPECIFIC HOURLY COMMITMENT YOU CAN NOT MAKE CHANGES LATER. Please, decide carefully, and circle your choice below:

I agree to participate for:

1) 6 hours, and understand I will drive the Cadillac on 6 separate days.
2) 9 hours, and understand I will drive the Cadillac on 9 separate days.

DATE: ________ SIGNATURE: ________________________.

NOTE, the above hourly assignments are estimates, the researchers believe it will actually take less time then is stated.

EMERGENCY CARD

PLEASE FILL OUT THIS CARD. IN CASE OF EMERGENCY AND ACCIDENT THIS CARD WILL HELP US CONTACT YOUR RELATIVES AND FRIENDS.

Relatives Name (Parents): ______________________

Relatives Phone Number: ______________________

Relatives Address: ______________________

____

______________ ZIP. ______

Close Friend, Name: ______________________

Phone Number: ______________________

Appendix C

Follow Up Survey:

Part A and B

FOLLOW UP SURVEY: PART A.

NAME:______________________ I.D.__________________ DATE________

Directions: Please comment on the questions below.

1. During the time while you participated in the Cadillac Project, did any experience occur that may have influenced your usual driving behavior ?

2. From your own personal experience what do you think is the most important experimental issue concerning this Project ?

3. Before having an opportunity to drive a Cadillac Seville did you ever consider owning a Cadillac (if you could afford it) ?

   (1) Yes
   (2) No

4. What aspect or feature of the Cadillac did you most appreciate ?

5. What aspect or feature of the Cadillac would you change in order to improve the Cadillac's quality or "user friendliness" ?

FOLLOW UP SURVEY: PART B.

Name:______________________ Date:______ I.D. #:______________

1. T F I believe that changing my driving habits would have minimal impact (less than 5 percent) on my fuel savings.

2. While driving the Cadillac the thought of having an accident was something I

   (1) rarely or never thought much about.
   (2) sometimes thought about.
   (3) thought about fairly often.
   (4) thought about each time I drove the Cadillac.

3. T F If some feature of my vehicle were designed to provide feedback about my driving style (e.g., to reduce gas consumption), I believe my driving habits would change.

4. After having an opportunity to drive a General Motor's Cadillac Seville, would you consider ever owning an Cadillac in the future (if you could afford it) ?

   (1) YES.
   (2) NO.

5. During the time you participated in the Cadillac Project did you ever experience a dangerous close call or near accident while driving either your own car or the Cadillac ?

   (1) Yes, Approximately how many times ? _____.
   (2) No

6. Which of the following did you generally do before or after you started the Cadillac ? (Circle all that apply and add "others" if appropriate).

   (1) Adjust Mirrors
   (2) Turn on the Radio or Cassette Player
   (3) Look at Dash Board for Warning Lights
   (4) Look at gas gauge for how much is in the tank
   (5) Put car in gear and go
   (6) Other:
   ____

7. Rate the level at which you thought driving the Cadillac was a risky and demanding activity that required careful concentration.

1	2	3	4	5
VERY RISKY AND DEMANDING		AVERAGE RISK		NOT RISKY OR DEMANDING

8. Driving in demanding situations where my skills are tested is something that I tend to

(1) dislike having to do and obtain no satisfaction from.
(2) enjoy and feel satisfied about when I do well.

9. As a driver, I would prefer to have

(1) less restrictive traffic laws and less police patrols.
(2) traffic laws and police patrols to remain the same.
(3) stricter traffic laws and more police patrols.

10. While driving the Cadillac I thought

(1) an attitude of carefulness is more important than driving skills.
(2) driving skills are more important than an attitude of carefulness.

For each of the following questions circle your answer .

11. Rate your overall level of driving skill or expertise using the scale below. 1 = lowest to 10 = highest

1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

12. While driving the Cadillac <u>on major highways</u> (460), what percent of the time did you see a <u>police vehicle (highway</u> patrol) ?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100%

13. While driving the Cadillac <u>within city limits</u> (Blacksburg), what percent of the time did you <u>see a police vehicle</u> ?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100%

14. While driving the Cadillac what percent of the time did you listen to the radio or cassette player ?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100%

15. While driving the Cadillac what percent of the time did you in fact use the MPG (miles per gallon) computer display?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100%

16. While driving the Cadillac what percent of the time did you wear a safety belt ?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100%

17. While driving the Cadillac what percent of the time did you use the map and cue cards ?

0 — 10 — 20 — 30 — 40 — 50 — 60 — 70 — 80 — 90 — 100%

18. If you personally owned this Cadillac Seville, at what speed would you typically drive at on the highways (such as I - 81) ?

45 — 50 — 55 — 60 — 65 — 70 — 75 — 80 mph — other:________.

19. An out of town visitor asks you for directions to Gables Mall. You are standing in the student parking lot outside Derring Hall, name the major streets he or she will take to get there .

(1) ____________________________

(2) ____________________________

20. If you were to compare the car you usually drive with the Cadillac Seville, which would you estimate as being "in general" a safer vehicle ?

(1) The car you usually drive seems much safer.
(2) The car you usually drive seems somewhat safer.
(3) Both cars seem equally safe.
(4) The Cadillac seems somewhat safer.
(5) The Cadillac seems much safer.

21. While driving the Cadillac, do you believe the computer fuel data display (which gave you information on your "miles per gallon average") improved your driving efficiency (i.e., better gas mileage or energy conservation) ?

(1) Yes.
(2) No.

V I S U A L R E C O G N I T I O N T E S T

DIRECTIONS: Please note the display features and automotive symbols. Draw an arrow from each feature or light symbol to where that feature or symbol is located on the Cadillac's instrument panel.

FEATURES:

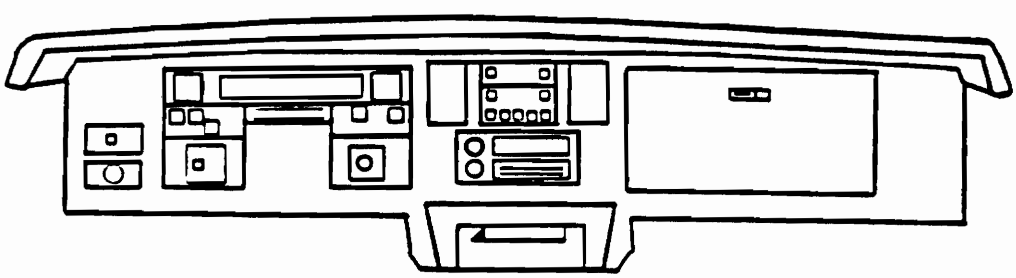
COMPUTER FUEL DATA PANEL

HEADLIGHTS

FUEL GAUGE

CRUISE CONTROL

AIR/DEFROSTER



LIGHT SYMBOLS:

FASTEN SAFETY BELTS LIGHT

TRUNK LID OPEN LIGHT

COOLANT TEMPERATURE LIGHT

NO CHARGE LIGHT

ENGINE OIL LIGHT

AUDIBLE SOUND RECALL TEST

DIRECTIONS: When the electronic sound systems were working, what audible sound type did the Cadillac possess for each situation listed below. Circle the audible sound type that you remember.

1. When leaving the keys in the ignition by mistake, what was the audible signal?
   (1) buzzer
   (2) chime
   (3) voice
   (4) no sound
   (5) click
   (6) tone

2. When the headlights were left on by mistake, what was the audible signal?
   (1) buzzer
   (2) chime
   (3) voice
   (4) no sound
   (5) click
   (6) tone

3. When using the Fuel-Data Panel/computer, what was the audible signal?
   (1) buzzer
   (2) chime
   (3) voice
   (4) no sound
   (5) click
   (6) tone

4. What was the audible signal for the safety belt reminder?
   (1) buzzer
   (2) chime
   (3) voice
   (4) no sound
   (5) click
   (6) tone

5. When the fuel level was near empty, what was the audible signal?
   (1) buzzer
   (2) chime
   (3) voice
   (4) no sound
   (5) click
   (6) tone

6. When the trunk lid or doors were left open, what was the audible signal?
   (1) buzzer
   (2) chime
   (3) voice
   (4) no sound
   (5) click
   (6) tone

VITA

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EDUCATIONAL BACKGROUND

Spring 1988 (expected)	M.S.	Virginia Polytechnic Institute and State University Blacksburg, VA. 24061 Degree in Psychology 3.83 GPA on 4.00 scale Master's thesis: Experimental Analysis of Specific Auditory-Light Safety Belt Reminder Systems and Safety Belt Behavior: "Prods" or "Prompts"
Fall 1981	B.S.	University of Florida Gainesville, FL. 32611 Major in Psychology 3.58 GPA on 4.00 scale Minor in Chinese (Mandarin)