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XAMINATION OF THE COMFORT AND CONVENIENCE OF 1979 SAFETY BELT SYSTEMS

Jonathan tom
Dr. William Ellis
Noami Henderson
Cecily Robbins

Verve Research Corporation
Seventeenth Floor, Unibank Building
51 Monroe Street
Rockville, Maryland 20850

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16. Abstract

This study examines the comfort and convenience aspects of safety belt systems in 1979 model cars and the user and system characteristics which affect safety belt comfort and convenience. The test design required that each of 114 test participants sit in and evaluate each of thirty test cars. A detailed discussion of the test design and the participant and car samples are presented. The statistical results are also discussed. Analysis of the evaluations showed that belt systems do have varying comfort and convenience problems and that factors such as user height, sex, number of car doors, and safety belt type do have an effect on belt comfort and convenience. In addition, analysis of the data showed that systems with windowshade devices have more incomplete retraction and excessive slack problems than belts without windowshade devices.

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Unclassified	Unclassified	98	

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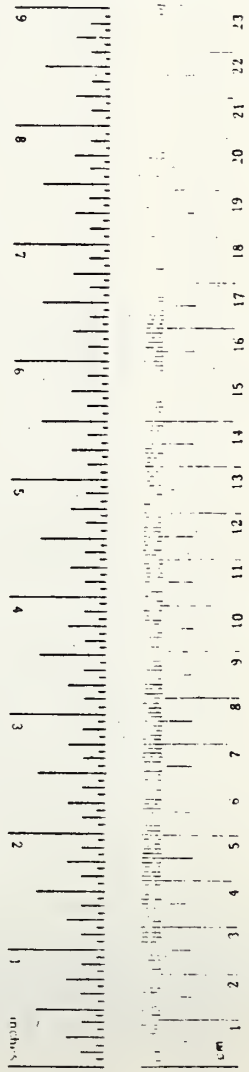
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

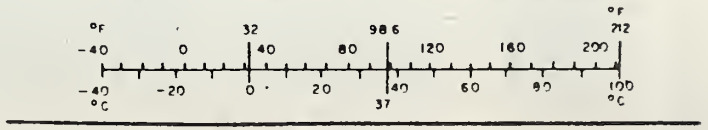
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5 9 (after subtracting 32)	Celsius temperature	°C

*1 [illegible] Units of Weights and Measures, Publication [illegible]



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9 5 (then add 32)	Fahrenheit temperature	°F



AN EXAMINATION OF THE COMFORT AND CONVENIENCE OF 1979 SAFETY BELT SYSTEMS

Executive Summary

Comfort and convenience problems have been one of the main reasons given for not wearing safety belts. Earlier surveys have shown that of people who do not wear safety belts between 25 and 50 percent gave comfort and convenience problems as the reason.

The purposes of this study are to learn more specifically what are the comfort and convenience problem areas and to find the factors which influence comfort and convenience. The test procedure chosen required that each person from a selected sample of automobile drivers evaluate each car from a representative group of 1979 models. The 114 participants included people of both sexes and over a wide range of ages, heights, and weights. Of the cars, 19 domestic and 11 imported were included in the test. Those models chosen represented approximately 80 percent of expected auto sales in the U.S. during 1979. Additionally, one 1975 model car was included as a "reference," since it was used in previous comfort and convenience studies and was rated highly at that time.

Each evaluation, or trial, consisted of a participant using the safety belt system of one of the test cars. As the subject was putting on and taking off the belt system, he was asked if he had problems with various comfort and convenience aspects of safety belts, and if so, to what extent.

For purposes of this study, the operation of safety belt systems was divided into these eight aspects:

Accessibility relates to reaching for and grasping the safety belt latch plate.

Extending pertains to moving the latch plate over to the buckle.

Buckling involves inserting the latch plate into the buckle.

Fit describes how the system fits the wearer.

Pressure relates to the pressure of the belt on the wearer's chest and shoulder.

Comfort pertains to how the system responds when the wearer reaches for the glove box or looks out the rear window.

Releasing involves releasing the latch plate from the buckle.

Retracting relates to how conveniently the system retracts out of the user's way.

In addition, excessive slack in the shoulder belt, belt twisting, and improper retraction were noted during each trial.

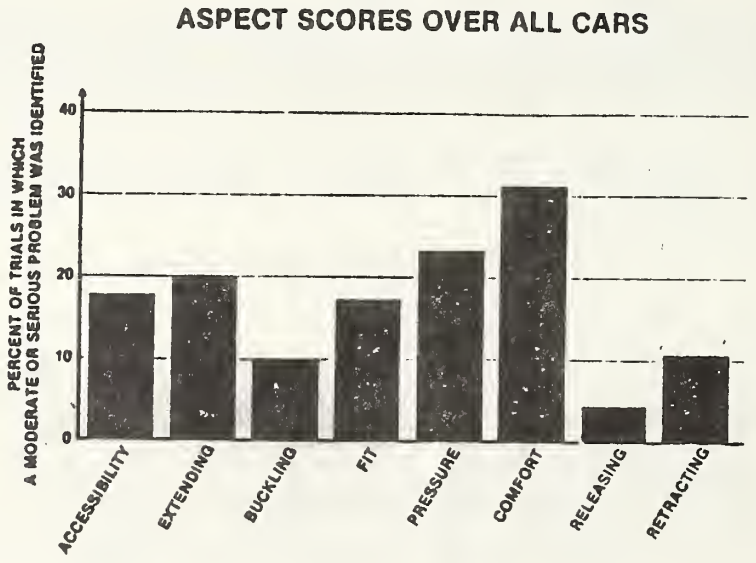
To determine areas of comfort and convenience for the test cars, an index for each of the eight aspects had to be developed. The rating systems selected for this study are "summated" ratings and "moderate-serious" ratings.

The summated rating is the average of the responses to all evaluation questions pertaining to a particular comfort and convenience aspect. The range of scores for a particular aspect is zero to three. The higher the score, the less confort or convenience is indicated.

The moderate-serious rating scheme is based on the percentage of trials which have at least one "moderate-or-serious problem" response to the questions relevant to each particular aspect. Since the comfort and convenience aspects are given almost identical relative scores by both scoring shcemes, only the results for the moderate-serious rating will be shown in this summary.

Figure 1 shows the frequency of moderate-to-serious problems encountered during the entire test for each aspect of comfort and convenience evaluation.

Figure 1



The chart shows that the main problems with 1979 safety belt systems as a whole are comfort (associated with upper torso movement), pressure (of the belt on occupant), extending the latch plate to the buckle, accessibility, and fit. Buckling the belt, releasing the latch plate from the buckle, and belt retraction created the fewest problems.

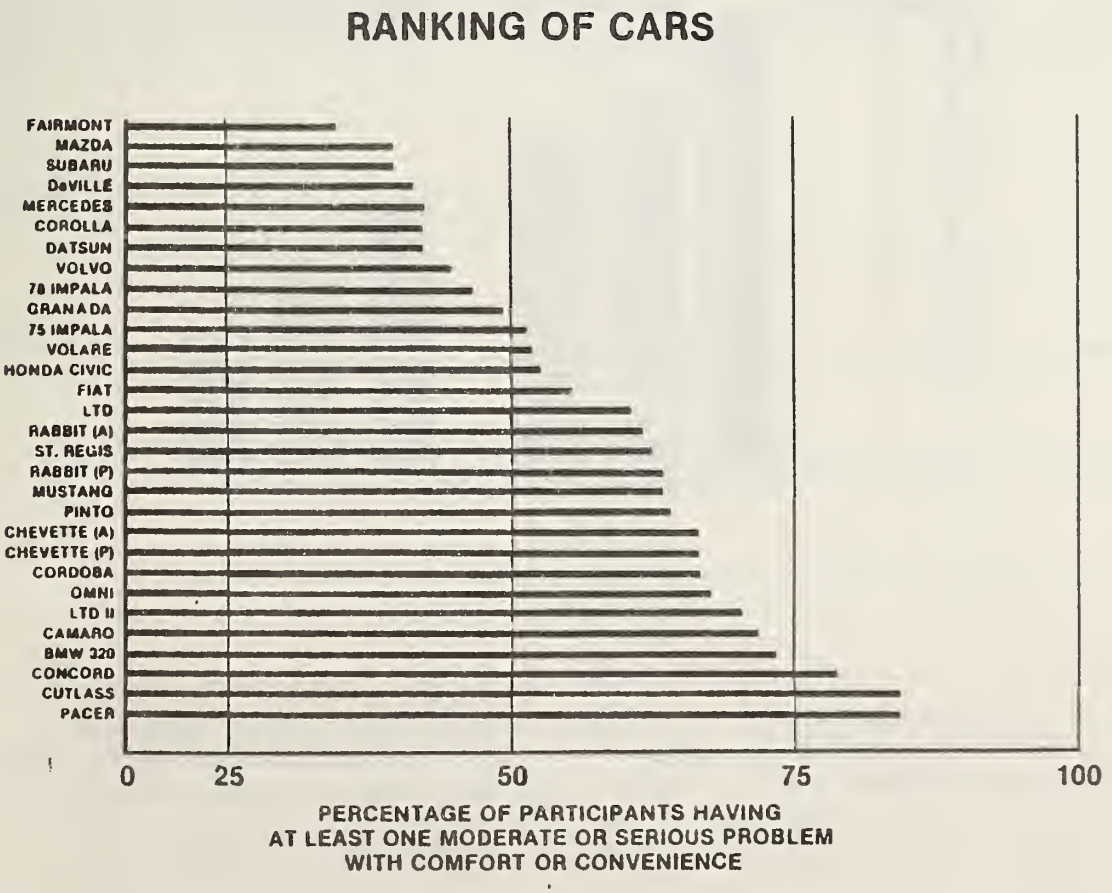
In almost 1 of 5 of the trials, the shoulder belt was twisted after the participant buckled the belt. This twisting causes both additional comfort problems and potential retraction problems when the belt is removed. It may also have an effect on the crash protection afforded by the belt.

One particular focus of this study has been "windowshade" tension relievers. In a retractor, these devices are designed to remove belt pressure on the shoulder and chest. The results of the trials show that systems with windowshade devices have excessive slack significantly more often than those without, despite the fact that the proper use of windowshade devices was demonstrated to all test participants. Since execessive slack reduces the protection to the wearer, a safety problem is indicated.

Another important factor affected by the windowshade device is belt retraction. When belts are released, they should return automatically to their retractors. If retraction is incomplete, the latch plate may fall behind the seat or out the door; or be caught, dirtied, or damaged in the closing door. As with excessive slack, those systems with windowshade devices had improper retraction in a significantly greater percent of the trials. Moreover, in over 20 percent of all trials, incomplete retraction was observed.

Figure 2 shows for each car the percentage of trials in which a moderate or serious problem was indicated.

Figure 2

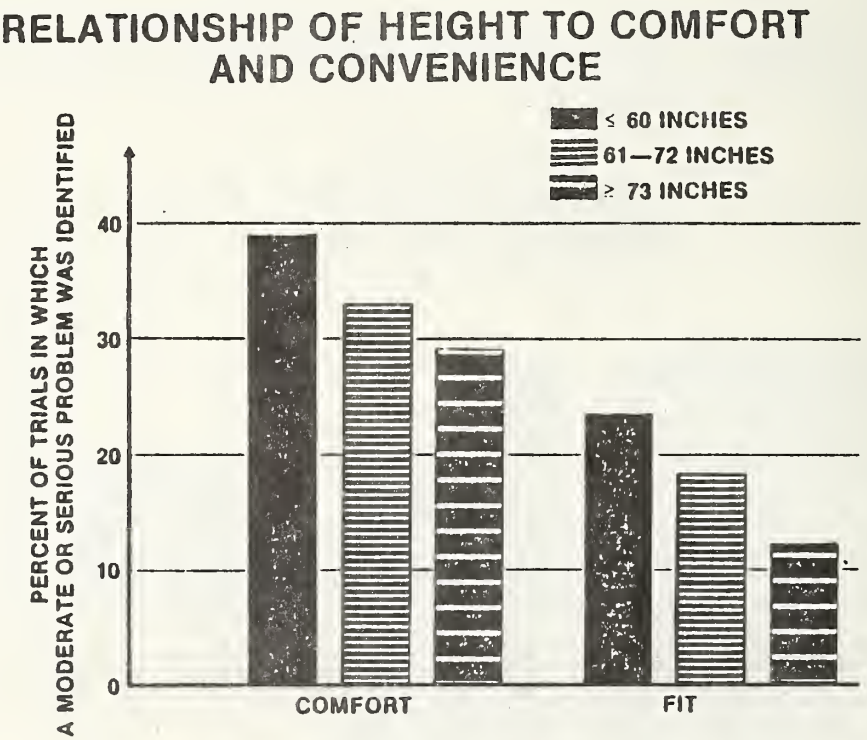


The use of this rating system was based on the assumption that good safety belt system features do not necessarily offset bad features. For example, no matter how comfortable a belt system, it will not be worn if finding, extending, or buckling the system is beyond the capabilities or willingness of the prospective user.

The resulting percentage ranged from 35 percent of the trials to 85 percent with the average overall cars at 54 percent. It is important to repeat here that any serious or moderate problem with any aspect of safety belt comfort and convenience is expected to reduce usage of the belt. And even for the best car in the sample set, 35 percent of the participants had at least one moderate or serious problem.

The second purpose of this study was to determine what car and user characteristics are related to the comfort and convenience of safety belts. For example, as shown by Figure 3, shorter users perceive more problems with the fit and comfort aspects of safety belt systems than taller users.

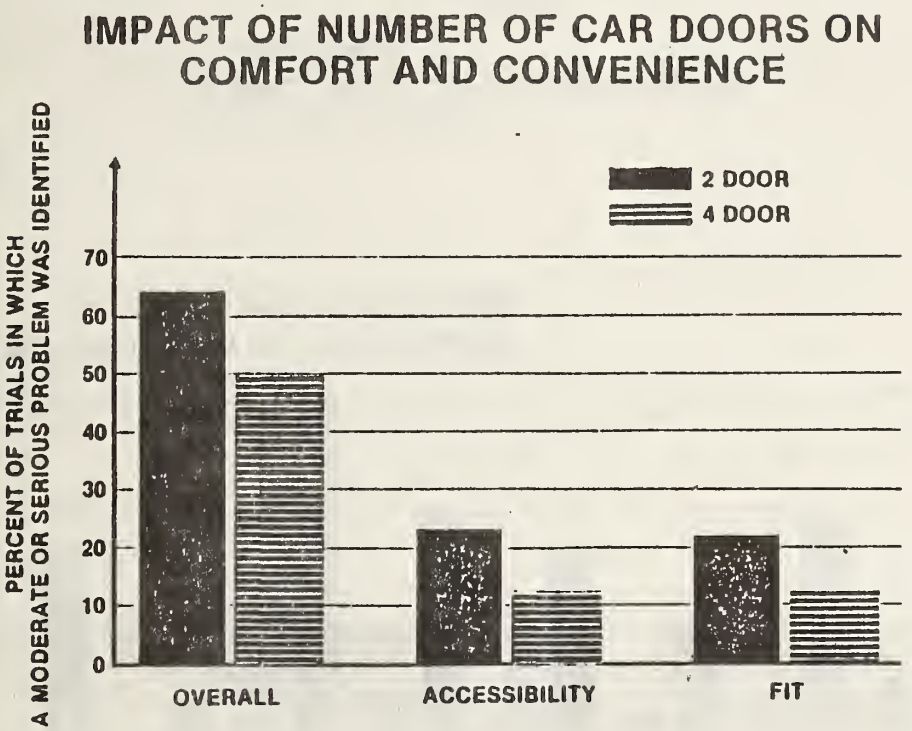
Figure 3



Another interesting result of the analysis is that 2-door cars had noticably more comfort and convenience problems than did 4-door cars. This observation can be made for all comfort and convenience aspects indivi-

dually, but is especially true for accessibility and fit. Figure 4 shows that for these two factors about 12 percent of the 4-door trials indicated a moderate to serious problemm, where double that percentage was indicated in 2-door trials. In other words, belt systems in 2-door cars are typically more difficult to reach and fit less well.

Figure 4

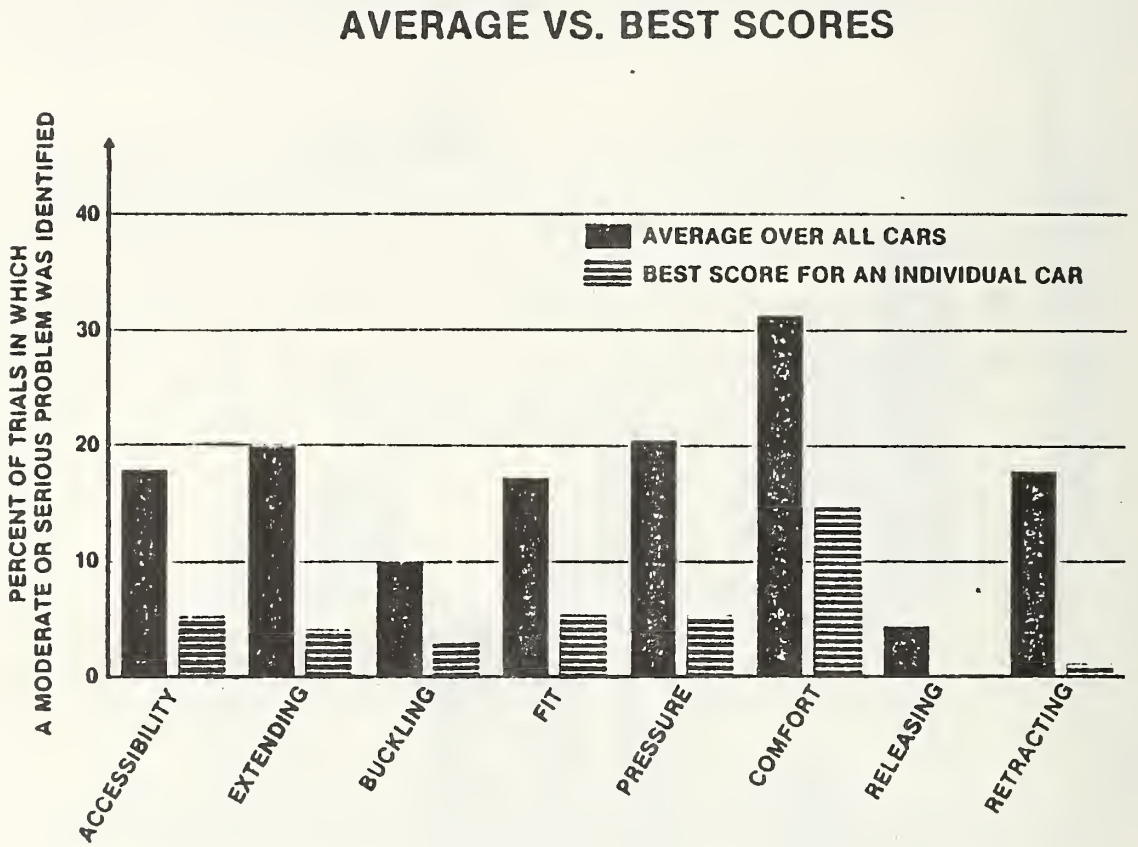


Other results of the analysis of the test data show that:

- Older user perceive fewer comfort and convenience problems than younger.
- The smaller cars have more accessibility problems than larger cars.
- Dual retractors have fewer retractor problems, while continuous loop systems have fewer comfort problems.
- Bucket seats have problems with safety belt accessibility, extending, buckling, releasing, and retracting, while bench seats have more fit, pressure, and comfort problems.
- User weight does not affect safety belt comfort and convenience.
- Usage rates do not affect safety belt comfort and convenience.

Returning to the various comfort and convenience aspects and to the cars included in the test sample, most of the cars had some good as well as bad aspects. Figure 5 compares the best score for each aspect with the average overall cars. This comparison shows that by combining the best features of cars used in this study, a safety belt system substantially better than the existing systems can be produced.

Figure 5



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INTRODUCTION

Recent surveys conducted for the National Highway Traffic Safety Safety Administration (NHTSA) have indicated that comfort and convenience problems have been one of the main reasons for not wearing safety belts. Earlier surveys have shown that of people who do not wear safety belts between 25 and 50 percent gave comfort and convenience problems as the reason. For example, 50 percent of the owners of 1974 model cars said they didn't wear safety belts for comfort and convenience reasons. Similarly, in a 1976 national survey, 35 percent of the adults sampled did not wear belts due to comfort and convenience problems.

PURPOSE OF THE STUDY

Since increasing safety belt usage has been a continuing concern of NHTSA, this study has two purposes. First, 1979 safety belt systems are to be evaluated to determine more specifically what are the comfort and convenience problem areas in new model cars. Second, the evaluations of the cars are to be analyzed to find those factors which influence comfort and convenience. The emphasis of this second goal is to test various hypotheses about the relationship between user and safety belt system characteristics, and comfort convenience. Some of the hypotheses to be tested are:

- Older users have more comfort and convenience problems than younger.
- Educational level and employment status have no influence on comfort and convenience perceptions.
- Tall and short users have more problems than those of average height.
- Female users perceive more comfort and convenience problems than males.
- Smaller cars have more comfort and convenience problems.
- Two-door cars have more problems than 4-door cars.

ORGANIZATION OF THIS REPORT

To accomplish these tasks a test design involving a sample of 120 drivers and thirty cars was developed. The following chapter discusses this test design in detail. Chapter 3 describes the car and driver samples used in the study, while the next chapter summarized the statistical results. Some conclusions are presented in the final chapter of this document.

2

TEST DESIGN

Because this study depends on how safety belt users perceive safety belt system comfort and convenience, the test design is based on a driver's evaluation of an individual car's safety belt system. This chapter discusses the overall design of the test which included 30 cars and 120 participants. The first section reviews the test intruments or questionnaires used to collect the appropriate data. A sample test day is described in the second section.

TEST INSTRUMENTS

Since the study is concerned with the realtionship of car and user characteristics to comfort and convenience in addition to comfort and convenience aspects of safety belt systems, a series of questionnaires about each participant and car in the test were completed. These included:

Participant Information Forms in which some socio-economic data about each driver in the test was recorded. Information such as the individual's safety belt usage rate and the number of years which he was a driver was asked in this form;

Physical Data Forms which recorded each participant's weight, height, sex, and other physical characteristics;

Car Checklists which provided descriptive information about each car in the test, such as the type of safety belt system, the number of doors, the location of the retractors, and the front seat configuration; and

Evaluation Forms on which the participant's reaction to each car was recorded. Each participant was asked questions about various system features during the evaluations. For example, "Did you have any difficulty in extending the webbing?" or "Does the safety belt restrict movement?" The responses to these questions were on a scale of zero to three, where zero is no problem, one is a slight problem, two is a moderate problem, and three is a serious problem.

Examples of these questionnaires are provided in Appendix A, Test Instruments.

Several additional details about the test instruments should be noted here. First, two evaluation forms were used, one for passive and one for active systems. This was necessary since their donning and doffing problems

differ. Second, special consultants completed not only the Car Checklists but also their own special evaluation forms. Since the test participants were evaluating only the driver's seat, the consultants were required to evaluate the rear seat belt systems. The complete consultant forms are provided in Appendix B, Consultant Evaluations.

SAMPLE TEST DAY

The data collection and evaluation procedure took four days. On each day, thirty of the test participants evaluated each of the test cars. Before the evaluation of the cars, each participant completed a Physical Data Form and a Participant Evaluation Form. The Car Checklists were completed before the tests began.

After completing the information forms, the test participants were briefed about the purpose of the test, the test procedures, and the use of safety belt systems. Special emphasis was placed on use of passive safety belt systems and of windowshade devices in belt retractors. Finally, each test participant was assigned an experimenter to guide him through the evaluation process.

The experimentors were responsible for three items during each test day. First, they recorded the participant responses to the evaluation questions. Second, they guided the participants from one car to the next to insure that the predetermined random order was maintained. Finally, the experimenters observed unusual safety belt system problems such as belt twisting, excessive belt slack, and incomplete belt retraction during each trial.

After the orientation and preliminary data collection were completed, the trials began. Each test day consisted of 30 trials of 5 minutes each. After the tenth and the twentieth trials there was a break. During a test day each participant evaluated each of the thirty test cars. Each trial consisted of a participant entering a test car, donning the safety belt, reaching for the glove box and turning to look out the rear window while wearing the belt system, removing the safety belt, and exiting the car. While the participant was executing these maneuvers, he was asked if he had any problems with various comfort and convenience aspects of the system, and if so, to what extent.

To reduce the possible effects of order on the test results, each participant evaluated the 30 cars in a different sequence. These sequences were designed so that each car was tested during each trial and so that no two participants tested the same car during the same trial.

Figure 2-1 shows the process used to develop the random orders with 5 cars, 5 trials, and 5 participants. The first step is to create a latin square in which each row and each column contain each participant once and only once. Step 2 assigned cars and trial numbers to each row and column, respectively. Finally, each participant sequence is determined by reformulating the results of step 2. For example, for Participant A, the fifth trial is with car number 3, as indicated in the upper-left corner of step 2.

Figure 2-1

ORDERING TECHNIQUE

STEP 1
Latin Square

Car Number	Trial Number 1	2	3	4	5
?	A	B	C	D	E
?	E	A	B	C	D
?	D	E	A	B	C
?	C	D	E	A	B
?	B	C	D	E	A

STEP 2
Random Ordering of Trial and Car Numbers

Car Number	Trial Number 5	1	3	4	2
3	A	B	C	D	E
1	E	A	B	C	D
5	D	E	A	B	C
4	C	D	E	A	B
2	B	C	D	E	A

STEP 3
Participant Sequence

Participant	Trial Number 1	2	3	4	5
A	1	2	3	4	5
B	3	4	1	5	2
C	2	5	3	1	4
D	4	1	2	3	5
E	5	3	4	2	1

After the evaluation procedure was determined, the sample of participants and test cars were selected. A description of both samples is provided in the next chapter.

3

DESCRIPTION OF SAMPLE

As in any test design, budget, space, and time constraints limit the size of a test sample. Consequently, these factors combine with the purpose of a test to determine the form of a sample and its selection criteria. This chapter describes the selection criteria for both the participant and the car samples. Additionally, some characteristics of the final samples are provided. The car sample is discussed in the first section, after which the participant sample is described.

CAR SAMPLE

Both of this study's goals influenced the selection criteria for the cars. One goal of the test was to determine what aspects of safety belt usage create the most comfort and convenience problems in 1979 models. Consequently, the car sample had to include models representing as large a percentage of expected 1979 sales as possible. At the same time, since the impact of car characteristics on comfort and convenience was being examined, the sample had to include cars of various sizes, manufacturers, seat configurations, and numbers of doors.

To facilitate the car selection, the auto manufacturers were polled to determine their expected sales for 1979. These forecasts were provided by model with subcategories for 4-door bucket seats, 4-door bench seats, 2-door bucket seats, and 2-door bench seats. In addition, the models were grouped according to body type so that cars with essentially identical safety belt systems could be evaluated as a group. As shown on Figure 3-1, for example, since the Cadillac Coupe de Ville is similar to the Cadillac Fleetwood, the Buick Electra, and the Buick Park Avenue, their expected sales were aggregated.

Based on these aggregated expected sales, the door-seat combination with the largest expected sales for each body type for each manufacturer was selected. The specific model with the highest expected sales within each selected group was chosen as a test car. This procedure provided a car sample which included a range of car sizes for all domestic manufacturers.

The selection criteria for imported models was slightly different. For these manufacturers, the top ten makes were selected. From these, the model with the largest expected 1979 sales was chosen to represent that manufacturer.

Figure 3-1

CARS SIMILAR TO DOMESTIC STUDY CARS*

STUDY CAR	SIMILAR CAR(s)
Cadillac Coupe de Ville	Cadillac Fleetwood Buick Electra Buick Park Avenue
Ford Fairmont	Mercury Zephr
Ford Granada	Mercury Monarch
Chevrolet Impala	Chevrolet Caprice Pontiac Catalina Pontiac Bonneville Oldsmobile Delta 88 Buick LeSabre
Plymouth Volare	Dodge Aspen
Ford LTD	Mercury Marquis
Chrysler Cordoba	Dodge Magnum XE
Dodge St. Regis	Chrysler Newport Chrysler New Yorker
AMC Pacer	None
Ford Mustang	Mercury Capri
Ford Pinto	Mercury Bobcat
Chevrolet Camaro	Pontiac Firebird
Chevrolet Chevette	None
Dodge Omni	Plymouth Horizon
Ford LTD II	Ford Thunderbird Mercury Cougar
AMC Concord	None
Oldsmobile Cutlass	Chevrolet Malibu Chevrolet Monte Carlo Pontiac Grand LeMans/Grand AM Pontiac Grand Prix Buick Century Regal

This Figure shows the other 1979 model cars similar in design to those included in the test. These domestic cars together with the evaluated imports include more than 80 percent of anticipated sales for the 1979 model year.

* Except Chevrolet Impala 1975

Finally, five special cars were included in the sample. The 1975 Chevrolet Impala was included since this model was used in other comfort and convenience tests and was rated highly. Similarly, two Volkswagen Rabbits and two Chevrolet Chevettes were selected. Since these two models offer

both an active and a passive safety belt system, they were chosen so that the comfort and convenience of the active systems could be compared to that of the passive systems.

This selection procedure provided a sample of 30 cars which represented more than 80 percent of anticipated sales for the 1979 model year. The sample included cars of different sizes, with different front seat configurations, with different safety belt systems, and with different numbers of doors. Figure 3-2 summarizes the characteristics of the car sample.

Figure 3-2

MAJOR CAR CHARACTERISTICS

	CHARACTERISTIC	NUMBER OF CARS
CAR SIZE	Subcompact	17
	Compact	3
	Midsize	7
	Fullsize	3
SAFETY BELT TYPES	Continuous Loop	24
	Dual Retractor	6
NUMBER OF DOORS	2-door	16
	4-door	14
FRONT SEAT CONFIGURATION	Bucket	21
	Bench	9
MANUFACTURER	General Motors	7
	Ford	6
	Chrysler	4
	American Motors	2
	Imports	11
WINDOWSHADE DEVICE	With	13
	Without	17

PARTICIPANT SAMPLE

The selection of the size of the participant sample depended largely on the number of test cars and the number of test days available. Since 30 cars were selected, each day was limited to accommodating 30 participants. Allowing more than 30 participants each day would have required that two test sessions be conducted each day. Given this limit of 30 participants per test day and four test days, the maximum number in the participant sample was 120.

Once the number of participants was determined, the characteristics selection criteria were defined. These criteria were based on the user characteristics being tested. For example, since one hypothesis was that both tall and short users have more comfort and convenience problem than users of average height, the selection criteria had to specify that tall and short people be recruited for the test. Similarly, since sex was another user characteristic being tested, the number of males and females in the test was another criteria.

Figure 3-3 provides a list of the requirements for the participant sample. This list was given to a recruiting agency based in Detroit, Michigan; Market Services, Inc. A detailed description of the participants taking part in the evaluation is shown on Figure 3-4. Note that because some of the selected participants did not participate in the tests the final sample size was 114.

Figure 3-3

CRITERIA FOR PARTICIPANT SAMPLE SELECTION

Total Number = 120

Number of Males = 60, Females = 60

Age Range = 19 to 70

Residence in Detroit City = 60

Between 60 and 70 years old = 8-16

26 of the women must be between 56 and 60 inches tall

26 of the men must be between 72 and 76 inches tall

14 of the women must be between 67 and 69 inches tall

14 of the men must be between 60 and 65 inches tall

20 of the women must be between 61 and 66 inches tall

20 of the men must be between 66 and 71 inches tall

At least 10 women must be more than 40 pounds overweight for their height

At least 10 men must be more than 40 pounds overweight for their height

This group of safety belt users along with the sample of test cars described earlier provided about 3420 evaluations. These were analyzed statistically to determine both comfort and convenience problem areas for each safety belt system and also user and car characteristics which impact on comfort and convenience. The results of that analysis are presented in the next chapter.

Figure 3-4

MAJOR PARTICIPANT CHARACTERISTICS

CATEGORIES	NUMBER OF PARTICIPANTS
A. Weight	
Overweight	18
Not Overweight	96
B. Height	
Less than 61 inches	19
61-72 inches	77
Greater than 72 inches	18
C. Age	
19-31 years old	44
32-56 years old	51
Greater than 56 years old	19
D. Sex	
Male	53
Female	61

4

STATISTICAL RESULTS

This chapter discusses in detail the procedures used to analyze the data collected during the test procedure and presents the results of that analysis. The emphasis of the statistical analysis is to identify both the major comfort and convenience problem areas for each car in the test sample and the participant and car characteristics which tend to cause more comfort and convenience problems.

To perform both these analyses, the questions on the evaluation form are grouped into various safety belt comfort and convenience aspects. The first section of this chapter describes the aspects evaluated. The indices used to measure the comfort and convenience of those aspects are discussed in the second section. The results of the analysis for individual cars are reviewed next, while the final section presents the relationship of specific car and participant characteristics to safety belt comfort and convenience.

COMFORT AND CONVENIENCE ASPECTS

The operation and comfort of a safety belt system can be summarized into a set of eight tasks or aspects. These aspects are:

Accessibility relates to reaching for and grasping the safety belt latch plate.

Extending pertains to moving the latch plate over to the buckle.

Buckling involves inserting the latch plate into the buckle.

Fit describes how the system fits the wearer.

Comfort pertains to how the system responds to upper torso movement; i.e., when the wearer reaches for the glove box or looks out the rear window.

Releasing involves releasing the latch plate from the buckle.

Retracting relates to how conveniently the system retracts out of the user's way.

The specific evaluation form questions associated with each of these aspects are listed in Figure 4-1. For example, questions 1 and 2 pertain to the accessibility aspect of safety belt usage.

Figure 4-1

GROUPINGS OF RESPONSES FROM THE EVALUATION FORM

COMFORT AND CONVENIENCE ASPECT	ASSOCIATED QUESTION NUMBERS[1]
Accessibility[2]	1,2
Extending[2]	3,4
Buckling[2]	5,6
Fit	7,8
Pressure	10 or 12
Comfort	14,15,16,17
Unbuckling[2]	18,19
Retracting[2]	20

[1]For specific questions, please refer to Appendix A, Test Instruments.

[2]Not applicable for passive restraints.

The pressure aspect is a special case in which either question 10 or question 12 is applicable. For cars with windowshade devices, test participants were asked about webbing pressure both before and after the device was set. Since windowshade devices in retractor systems are designed to relieve webbing pressure for the wearer, it is expected that the participants would have on the average fewer pressure problems after the device is set than before. To test this hypothesis, two techniques were applied to analyze the responses to questions 10 and 12 for those cars with windowshade devices.

The first test is applied to the difference between question 10 and question 12 (DIFF = Q10 - Q12) for each valid trial. The a priori hypothesis is that on the average DIFF is greater than zero. The results of the statistical analysis of DIFF are shown in Figure 4-2(A). Since the T-statistic is greater than 2.32, the average difference between problems with pressure before and after the setting of windowshades is significantly greater than zero at a 99 percent confidence level. Consequently, the hypothesis is accepted.

The second test compares the frequency of moderate to serious pressure problems before and after setting the windowshade device. Figure 4-2(B) shows that a statistical comparison of these frequencies yields a t-statistic of 4.92. Since this value is greater than 2.32, at a 99 percent confidence level, the frequency of moderate-to-serious problems is significantly greater before setting the windowshade than after. Because both tests show that pressure problems are significantly less after setting the windowshade device, question 12 was substituted for question 10 for all cars with windowshade devices.

Figure 4-2

ANALYSIS OF PRESSURE PROBLEMS
BEFORE AND AFTER SETTING
THE WINDOWSHADE DEVICES

A. Test on the Difference Between Questions 10 and 12

Valid Observations	- 1440
Mean DIFF	- 0.270
Standard Deviation DIFF	- 0.933
Standard Error of the Mean	- 0.025

$$t = \frac{\text{Mean}}{\text{Standard Error}} = \frac{0.270}{0.025} = 10.8$$

B. Test on the Percent of Trials reporting Moderate-Serious Problems

QUESTION	VALID OBSERVATION	PERCENT OF TRIALS REPORTING MODERATE-SERIOUS PROBLEMS
10(before)	1467 (n_1)	14.52 (P_1)
12(after)	1447 (n_2)	8.71 (P_2)

$$t = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} = 4.92$$

COMFORT AND CONVENIENCE INDICES

To determine levels of comfort and convenience problems, an index for each of the eight aspects had to be developed. The two most direct rating systems are what the study calls "summated" ratings and "moderate-serious" ratings. This section of the report discusses the characteristics of these indices. For each index the method of calculation and the theoritical implications of the rating system are reviewed. Additionally, for both indices the average score over all trials for each aspect are presented.

Summated Index

The summated rating system is the average of all the responses to all evaluation questions pertaining to a particular comfort and convenience aspect. For example, questions 1 and 2 pertain to the accessibility aspect of safety belt systems. For each trial, the responses to these two questions are averaged to obtain an "accessibility score" for that trial. That summated rating score is used in all analyses of the accessibility aspect. The range of possible scores for each aspect is zero to three, where the higher score indicates more discomfort and inconvenience.

Use of the summated rating implies that each question asked about a particular aspect has an equal weight in a participant's measurement of that aspect's comfort and convenience. This means that a moderate problem response (2) on one question can be balanced by a no problem response (0) on the other question to obtain an overall response of minor problem (1) for that trial.

Moderate-Serious Index

The moderate-serious rating scheme is based on the percentage of trials which have at least one moderate or serious problem response to the questions relevant to each particular aspect. Figure 4-3 exemplifies the calculation of this index.

Figure 4-3

EXAMPLE OF MODERATE-SERIOUS INDEXING SCHEME

TRIAL NUMBER	RESPONSES*		MODERATE-SERIOUS ACCESSIBILITY PROBLEM
	QUESTION 1	QUESTION 2	
1	0	1	0
2	2	2	1
3	0	0	0
4	1	1	0
5	0	3	1
6	2	1	1
7	0	0	0
8	0	1	0
9	1	0	0
10	0	0	0

3 out of 10 or 30 percent of these trials had a moderate-serious problem with accessibility.

*Responses: 0 - No Problem
1 - Slight Problem
2 - Moderate Problem
3 - Serious Problem

In this sample of 10 trials, trials 2, 5, and 6 have at least one moderate (2) or serious (3) problem with accessibility, while the other trials have no responses indicating more than a slight problem. The moderate-serious accessibility index for these trials then is 30 percent. The higher this index the more comfort and convenience problems are indicated.

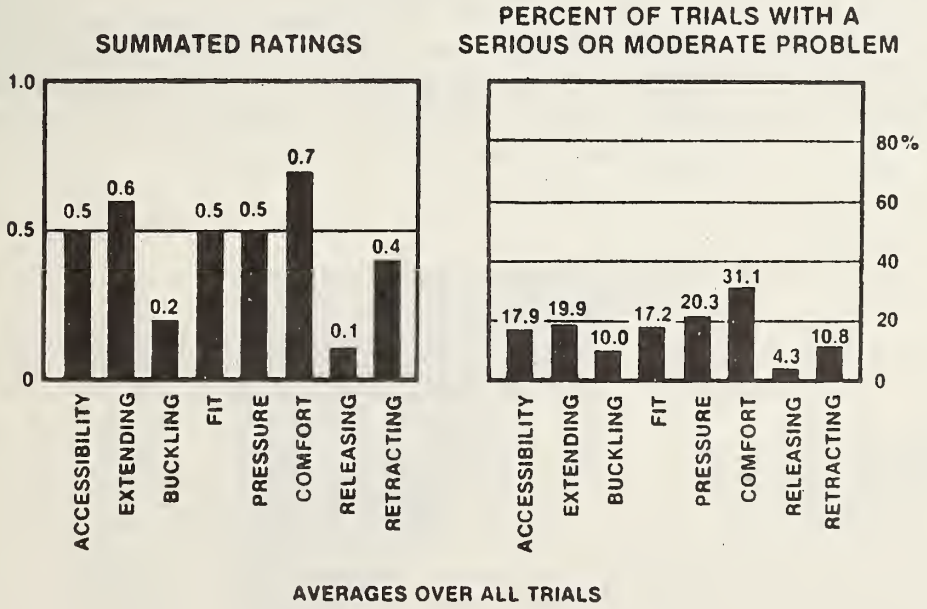
Use of this index is based on the assumption that good safety belt system features do not necessarily offset bad features. No matter how easy a latch plate is to locate, for example, it is still considered inaccessible, if a potential user cannot grasp it.

Average Scores

Figure 4-4 shows the average aspect scores for both indices over all trials.

Figure 4-4

COMPARISON OF
SUMMATED RATING TO MODERATE-SERIOUS RATING



Since subsequent analytical results present both scoring techniques, these averages provide one set of reference points. For example, by comparing the moderate-serious "accessibility" score for a particular car with the corresponding average over all trials, it can be determined if that car has a greater than or less than average problem with the accessibility aspect of comfort and convenience.

RESULTS BY CAR

A primary purpose of this study is to determine the comfort and convenience problem areas of each safety belt system. The results of this analysis are presented in this section. The first part of this section describes the procedures for calculating the aspect scores and the format for presenting them. Two summaries of the individual safety belt system results are shown in the second part of this section.

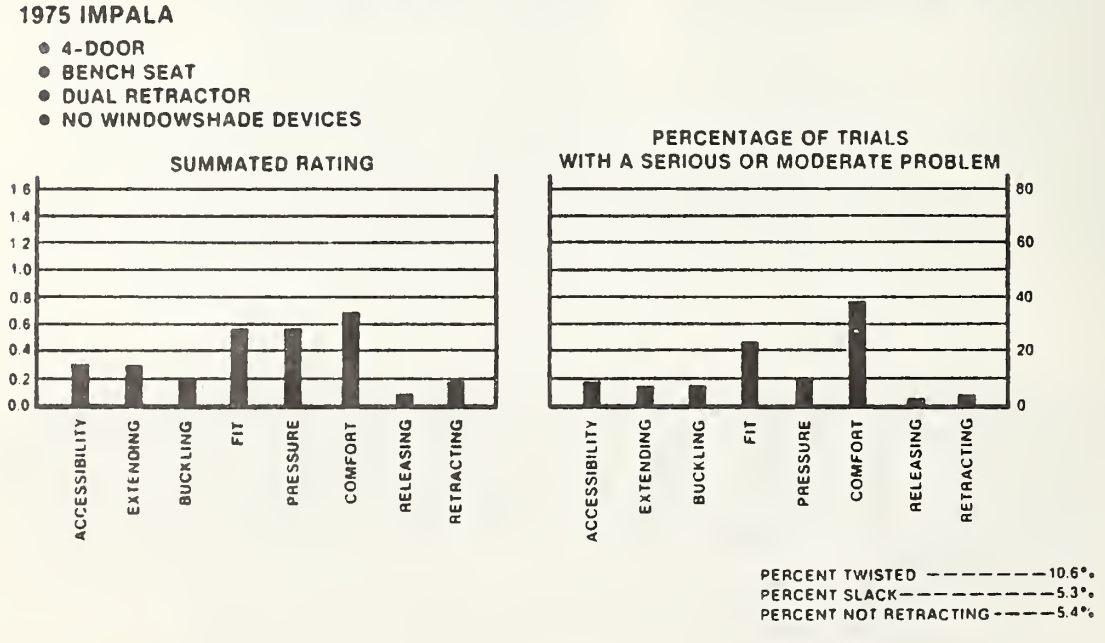
Individual Car Scores

To obtain the comfort and convenience aspect scores for each of the test cars, the results of the trials are first grouped by test car. These groupings include the evaluations of all 114 participants. Both the summated and moderate-serious ratings are calculated using the procedures described in an earlier section in this chapter.

The results of these calculations are presented by car in Appendix C, Results by Car. Figure 4-5 showing the results for the 1975 Chevrolet Impala is an example of the reporting format. Some descriptive information about the car used in the test are given first. The characteristics described are number of car doors, type of front seat configuration, type of safety belt system, and whether or not a windowshade device is used in the rectractor system. Similarly, in the lower right-hand corner the percentage of shoulder belt twisting, of excessive slack, and of incomplete retraction are shown for each car. Finally, both the summated and the moderate-serious rating scores are presented for each of the eight comfort and convenience aspects.

Figure 4-5

SAMPLE OF RESULTS FOR INDIVIDUAL CARS



For the 1975 Impala, the most severe comfort and convenience problem is indicated while reaching for the glove box and turning to look out the rear window, i.e., the comfort aspect. This is indicated because the comfort score for both indices is highest when compared to the other scores. Conversely, both indexing schemes indicate that releasing the buckle causes the fewest comfort and convenience problems. Interestingly, comparing the two indices shows similar relative results. That is, when the summated rating score is relatively high, the moderate-serious score is also, high.

Where the relative results are not similar, another interpretation is required. The 1975 Impala's pressure aspect, for example, shows a relatively high summated score, but a relatively low moderate-serious score. This difference occurs because a relatively large percentage of the participants reported a slight pressure problem, increasing the summated rating score, while not increasing the other index.

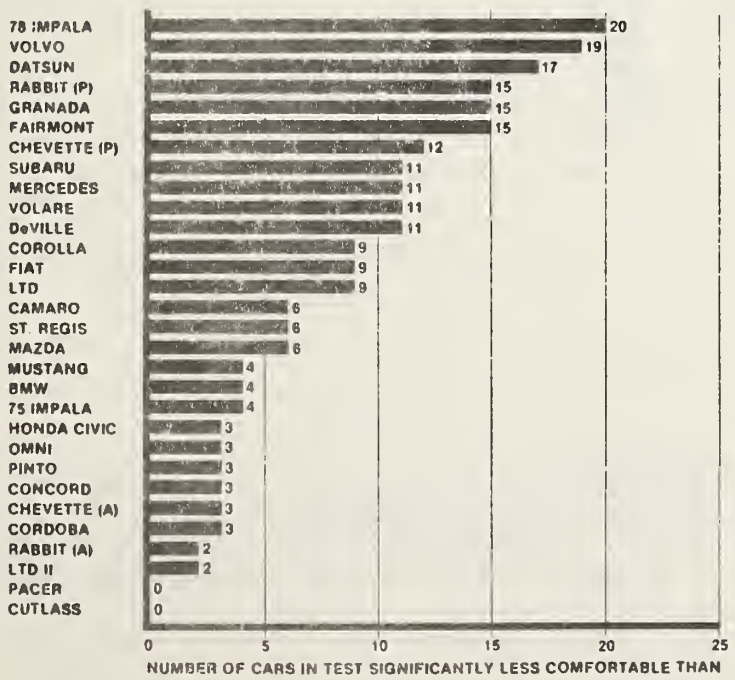
Summary of Car Scores

To summarize the results of the test, the scores for the eight aspects were aggregated into a comfort group and a convenience group. These aggregations are presented in Figures 4-6 and 4-7.

For Figure 4-6, the fit, pressure, and comfort aspects were combined into an overall comfort score.

Figure 4-6

SUMMARY OF SUMMATED COMFORT SCORES

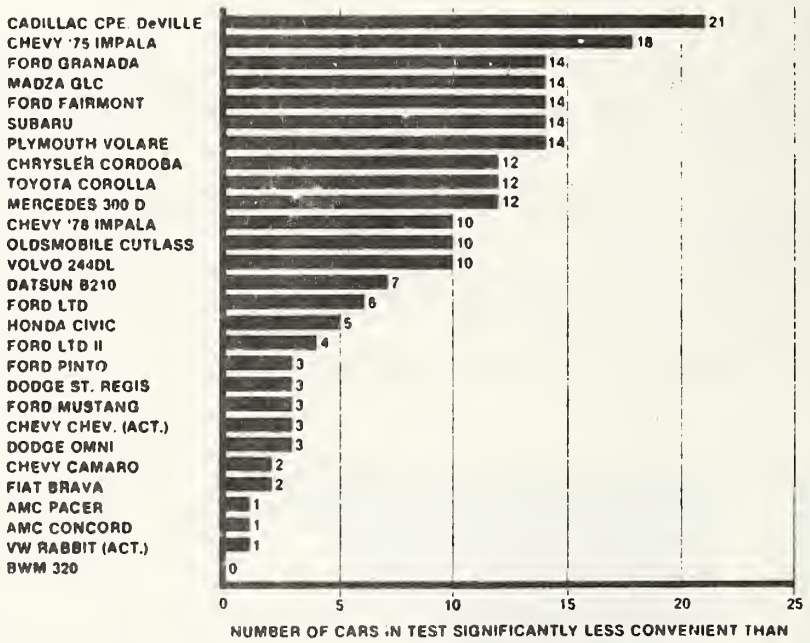


To facilitate evaluation of these scores, tests for statistical significance were used. This chart orders the cars by level of significance. This means, for example, that the 1978 Impala is significantly more comfortable than 20 other cars in the test. The Rabbit with a passive restraint, the Granada, and the Fairmont were not significantly different than each other, but were all rated significantly higher than 15 other test cars.

Similar results for the convenience aspects are shown by Figure 4-7. The aspects included are accessibility, extending, buckling, releasing, and retracting.

Figure 4-7

SUMMARY OF SUMMATED CONVENIENCE SCORES



The significance test used for both figures is a Student's t-test between the average comfort scores or convenience scores of two test cars. For each pair of test cars, the hypothesis tested is that the cars have equivalent scores at a 95 percent level of confidence. The test equation used is:

$$t_{AB} = \frac{|I_A - I_B|}{\sqrt{\frac{S^2_A}{N_A} + \frac{S^2_B}{N_B}}}$$

where I_B and I_B are the means of the index for the group of responses relating to cars A and B, respectively, where N_A and N_B are the number of valid responses evaluating the cars, and where S^2_A and S^2_B are the variance of the indices in the two populations.

This t-value is compared to a critical value representing the degree of confidence desired. If the t-value is less than this predefined critical value, the hypothesis that the indices are the same can be accepted. The hypothesis is not accepted if the t-value is greater than the critical value.

Figure 4-8, for example, compares the convenience indices for Car A with of Car B.

Figure 4-8

EXAMPLE OF SIGNIFICANCE TEST

AVERAGE CONVENIENCE INDEX	CAR A	CAR B
Average Convenience Index	$I_A = 2.68$	$I_B = 3.30$
Variance of the Comfort Index	$S^2_A = 12.43$	$S^2_B = 18.03$
Sample Size	$N_A = 114$	$N_B = 114$

$t_{.95} = 1.96$

$$t_{AB} = \frac{|I_A - I_B|}{\sqrt{\frac{S^2_A}{N_A} + \frac{S^2_B}{N_B}}} = \frac{|2.68 - 3.30|}{\sqrt{\frac{12.43}{114} + \frac{18.03}{114}}} = \frac{0.62}{0.51} = 1.21$$

RESULTS BY OTHER FACTORS

In addition to determining comfort and convenience problem areas for each of the safety belt systems tested, characteristics of both the cars and the participants are examined to determine their influence on safety belt comfort and convenience. User characteristics such as height, age, sex, race, and income are analyzed. Similarly, the analysis of test car characteristics such as number of doors, front seat configuration, and safety belt type is shown.

This section of Chapter 4 discusses the analyzed characteristics individually. In this discussion the groupings of trials are defined, the average summated and moderate-serious scores for each aspect are presented, and some conclusions are drawn. Additionally, a discussion about windowshade devices is presented.

Age of Participant

The hypothesis to be tested in this analysis is that older users have more comfort and convenience problems with safety belts than younger users. For this test, the trials are divided into three groups by age of participant. The groups and the results are shown in Figures 4-9 and 4-10. Interestingly, for both rating schemes and for all aspects the oldest age group shows fewer problems than the younger groups. Moreover, there is almost no difference between the scores for the two younger groups.

Figure 4-9

RESULTS BY AGE OF PARTICIPANT GROUPINGS

Moderate - Serious Ratings

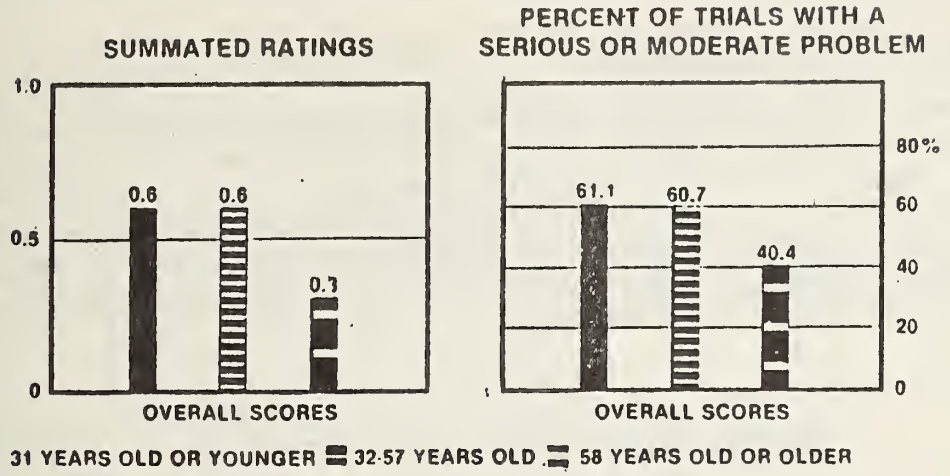
Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
31 years old or less	1229	19.8	23.6	9.4	18.4	22.9	34.7	4.1	14.2
Between 32 and 56 years old	1427	21.1	22.0	11.8	21.4	22.7	36.0	5.3	11.3
57 years old or more	532	10.7	12.2	9.6	8.7	14.5	19.6	3.8	4.7

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
31 years old or less	1226	0.6	0.6	0.2	0.5	0.5	0.7	0.1	0.5
Between 32 and 56 years old	1389	0.3	0.3	0.3	0.5	0.5	0.7	0.1	0.4
57 years old or more	529	0.4	0.4	0.2	0.3	0.3	0.4	0.1	0.2

Figure 4-10

RELATIONSHIP OF AGE OF PARTICIPANT TO
COMFORT AND CONVENIENCE



Educational Level of Participant

The a priori hypothesis tested in this analysis is that educational level does not influence the user' perception of safety belt comfort and convenience. The trials were grouped into four educational categories shown by Figure 4-11.

Figure 4-11

RESULTS BY EDUCATIONAL LEVEL GROUPINGS

Moderate - Serious Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
No High School Diploma	224	18.3	17.9	8.5	13.4	16.1	29.5	3.1	4.0
High School Diploma	1147	16.8	18.7	10.3	18.3	22.1	33.8	5.2	10.5
Some College Education	1202	19.3	20.7	10.2	17.0	19.1	30.2	4.0	10.8
College Degree	587	23.0	28.1	13.0	22.8	27.6	36.1	5.1	17.4

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
No High School Diploma	224	0.4	0.5	0.2	0.3	0.3	0.3	0.1	0.2
High School Diploma	1135	0.5	0.5	0.2	0.5	0.5	0.7	0.2	0.3
Some College Education	1167	0.6	0.6	0.2	0.4	0.4	0.6	0.1	0.4
College Degree	589	0.6	0.7	0.3	0.6	0.6	0.7	0.1	0.6

These results indicate that of the participants included in this study those with more formal education tended to be more critical, to have more comfort and convenience problems. As with the age categories, both indexing schemes reflect this tendency.

Employment Status of Participant

That employment status would not influence the magnitude of safety belt comfort and convenience problems experienced by the user is tested in this analysis. Figure 4-12 shows the average results of the index calculations for those working full time and for those not working full time. These results do show no major differences between the scores for the employment categories, supporting the hypothesis that employment status has no influence on comfort and convenience.

Figure 4-12

RESULTS BY EMPLOYMENT STATUS GROUPINGS

Moderate - Serious Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Employed Full-Time	1287	20.0	21.6	11.4	17.0	19.3	30.5	4.5	10.8
Not Employed Full-Time	1845	18.2	20.5	9.8	19.2	22.9	34.8	4.8	11.9

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Employed Full-Time	1266	0.5	0.6	0.3	0.4	0.4	0.6	0.1	0.4
Not Employed Full-Time	1823	0.5	0.6	0.2	0.5	0.5	0.7	0.1	0.5

Height of Participant

The hypothesis being tested here is that both taller and shorter users have more comfort and convenience problems with safety belts than do users of average height. To test this hypothesis, the trials were grouped by participant height into three cagetories shown by Figures 4-13 and 4-14. The results shown by these figures indicate that contrary to expectations user height has little impact on the scores for accessibility, extending, buckling, pressure, and releasing. On the other hand, problems with fit, with comfort during movement of the upper body,

and with retraction seem to be related to user height. Shorter participants indicate more fit and comfort problems than taller participants, while the taller groups show more retraction problems than the 60 inches or shorter category.

Figure 4-13

RESULTS BY HEIGHT OF PARTICIPANT GROUPINGS

Moderate - Serious Ratings

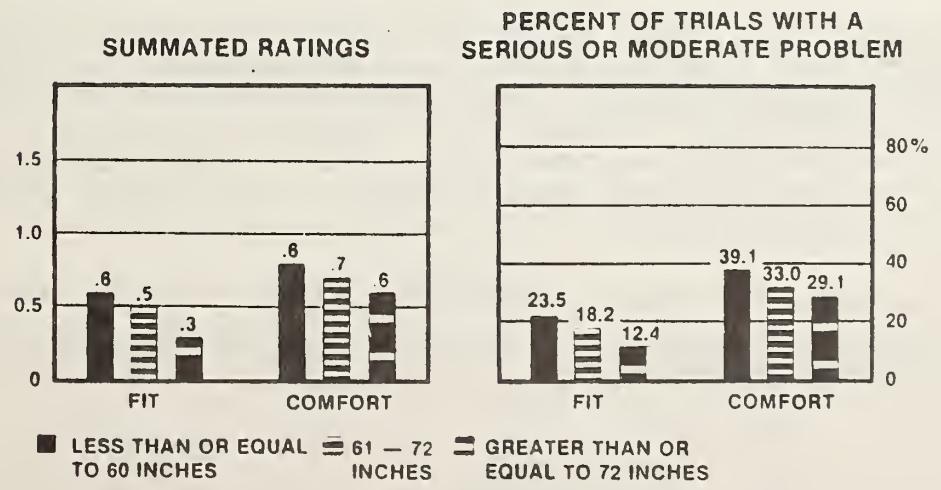
Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
60 inches tall or less	532	20.7	22.2	11.3	23.5	22.6	39.1	4.0	8.8
Between 61 and 72 inches tall	2096	18.8	20.5	9.8	18.2	21.6	33.0	4.5	12.4
73 inches tall or more	364	21.4	23.1	13.2	12.4	21.2	29.1	5.8	11.0

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
30 inches tall or less	531	0.5	0.6	0.2	0.3	0.5	0.8	0.1	0.3
Between 61 and 72 inches tall	2056	0.5	0.6	0.2	0.5	0.5	0.7	0.1	0.5
73 inches tall or more	364	0.6	0.6	0.3	0.3	0.5	0.6	0.2	0.5

Figure 4-14

RELATIONSHIP OF HEIGHT OF PARTICIPANT TO COMFORT AND CONVENIENCE



Weight of Participant

Another hypothesis tested is that overweight users have more comfort and convenience problems with safety belts than non-overweight users. For purposes of this study, overweight people are defined as those more than 40 pounds over the average weight for their sex, age, and height. The average index scores for the trials with overweight and non-overweight participants are shown in Figure 4-15. These data show that the overweight category does not generally report more comfort and convenience problems than the other group. The aspects reflecting the greatest difference are buckling and pressure. However, in general, the *a priori* hypothesis can be rejected.

Figure 4-15

RESULTS BY PARTICIPANT WEIGHT GROUPINGS

Moderate - Serious Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Not Overweight	2490	18.8	21.5	9.4	17.2	20.6	32.3	4.5	11.3
Overweight	698	19.1	19.3	14.6	21.6	24.2	34.5	4.9	11.3

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Not Overweight	2463	0.5	0.6	0.2	0.5	0.4	0.7	0.1	0.4
Overweight	681	0.5	0.5	0.3	0.5	0.5	0.6	0.1	0.4

Safety Belt Usage

The hypothesis to be tested in this analysis is that safety belt users have fewer comfort and convenience problems than non-users. For this test, the trials were divided by reported participant safety belts usage rates into the three groups shown by Figure 4-16. Analysis of the average index scores shows that generally all three groups experience the same level of comfort and convenience problems for all aspects. Consequently, the test hypothesis can be rejected.

Figure 4-16

RESULTS BY SAFETY BELT USAGE RATES GROUPINGS

Moderate - Serious Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
20% of the time or less	2153	17.5	20.2	10.7	17.8	21.6	32.8	4.9	12.3
30 - 60% of the time	503	22.7	21.5	9.9	14.7	19.7	32.8	5.4	9.3
70% of the time or more	532	20.9	23.9	10.2	22.7	22.4	32.9	2.4	9.4

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
20% of the time or less	2119	0.5	0.6	0.2	0.5	0.4	0.6	0.1	0.5
30 - 60% of the time	498	0.6	0.6	0.2	0.4	0.4	0.6	0.1	0.4
70% of the time	527	0.6	0.6	0.3	0.5	0.5	0.7	0.1	0.4

Sex of Participant

The a priori assumption tested in this study is that female safety belt users have more comfort and convenience problems than male users. Figures 4-17 and 4-18 present the average indices for the trials grouped according to sex.

Figure 4-17

RESULTS BY SEX OF PARTICIPANT GROUPINGS

Moderate - Serious Ratings

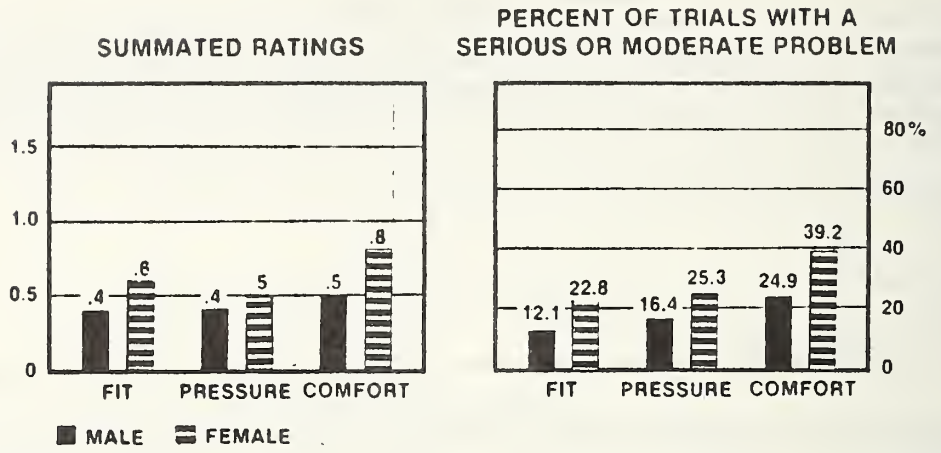
Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Male	1484	16.9	19.4	10.0	12.1	16.4	24.9	4.4	10.9
Female	1676	20.5	22.0	11.0	22.8	25.2	39.2	4.7	11.9

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Male	1461	0.5	0.5	0.2	0.4	0.4	0.5	0.1	0.4
Female	1655	0.6	0.6	0.2	0.6	0.5	0.8	0.1	0.4

Figure 4-18

RELATIONSHIP OF SEX OF PARTICIPANT TO
COMFORT AND CONVENIENCE



These data show that sex does not affect the problems encountered when buckling, releasing or retracting the safety belt system. On the other hand, the female participants perceived on the average more comfort and convenience problems with accessibility, extending, fit, pressure, and upper torso comfort than did the male participants. For these five aspects, therefore, the hypothesis is substantiated.

Size of Car

In addition to participant characteristics, characteristics of the cars may also affect safety belt comfort and convenience. One a priori hypothesis, for example, is that larger cars will on average have fewer comfort and convenience problems than smaller cars. To test this theory, the trials were divided into the four groups shown on Figure 4-19. These categories are defined by the wheelbase of the test cars as shown by Figure 4-20.

The averages scores presented by Figure 4-19 indicate that for most aspects there is no clear cut relationship between car size and comfort and convenience of the safety belt system. The scores for the accessibility aspect show the most consistent results. For this aspect, the subcompacts were reported to have more problems than the larger cars.

Figure 4-19

RESULTS BY SIZE OF CAR GROUPINGS

Moderate - Serious Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Sub-Compact	1497	26.4	25.0	11.8	17.0	18.8	33.3	5.2	9.2
Compact	570	11.2	17.2	11.8	11.8	21.9	21.9	6.0	11.4
Mid-Sized	798	12.9	16.5	6.9	25.9	24.2	37.7	2.6	16.3
Full-Sized	341	12.6	20.5	11.1	15.5	25.2	37.0	3.8	8.8

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Sub-Compact	1460	0.7	0.6	0.3	0.4	0.5	0.7	0.2	0.4
Compact	561	0.4	0.5	0.3	0.3	0.4	0.5	0.2	0.4
Mid-Sized	787	0.4	0.5	0.2	0.6	0.4	0.7	0.1	0.5
Full-Sized	336	0.4	0.6	0.2	0.4	0.4	0.7	0.1	0.3

Figure 4-20

CLASSIFICATION OF CAR SIZE

SIZE	WHEELBASE (in inches)
Sub-Compact	Less than or equal to 101
Compact	Between 102 and 111
Mid-Sized	Between 112 and 120
Full-Sized	Greater than 120

Number of Car Doors

Since positioning of the safety belt anchor points depends on the number of car doors, it is hypothesized that this number affects the comfort and convenience of safety belt systems. The a priori hypothesis tested here is that 2-door cars have more comfort and convenience problems than 4-door cars. The indices calculated from this grouping are presented in Figures 4-21 and 4-22.

Figure 4-21

RESULTS BY NUMBER OF CAR DOORS GROUPINGS

Moderate - Serious Ratings

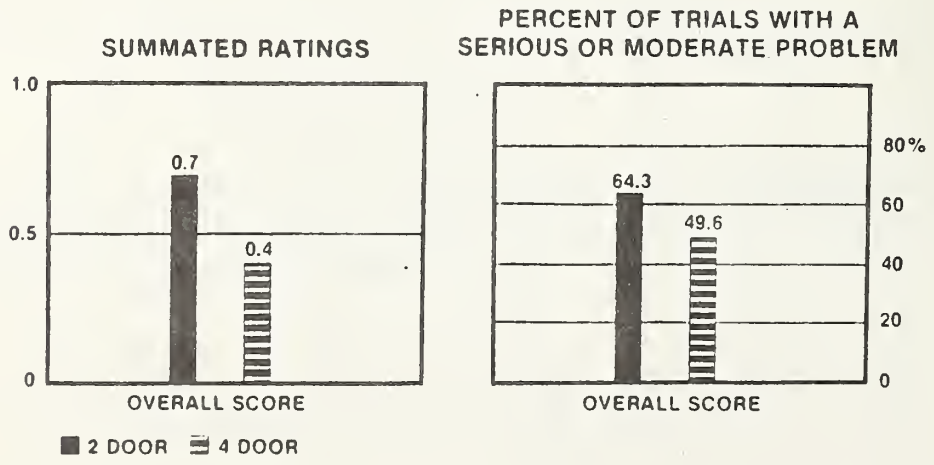
Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
2 - Door	1707	24.7	23.4	11.2	22.3	24.3	39.0	5.0	14.3
4 - Door	1481	12.2	18.2	9.7	13.4	18.1	25.6	4.0	7.9

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
2 - Door	1694	0.6	0.6	0.3	0.6	0.5	0.8	0.1	0.5
4 - Door	1450	0.4	0.5	0.2	0.3	0.4	0.5	0.1	0.4

Figure 4-22

RELATIONSHIP OF NUMBER OF DOORS TO COMFORT AND CONVENIENCE



Both the summated and the moderate-serious rating systems support the hypothesis. The greatest differences are shown by the accessibility, the fit, the upper body comfort, and the retracting aspects. Apparently, 2-door cars influence these comfort and convenience aspects most severely.

Type of Safety Belt System

Another hypothesis being examined is that the dual retractor safety belt system has fewer comfort and convenience problems than the continuous loop system. The average indices for these two groups are shown in Figures 4-23 and 4-24. These results do not in general substantiate the a priori hypothesis. However, the pressure comfort, and retracting aspects are affected by the type of system.

Figure 4-23

RESULTS BY TYPE OF SAFETY BELT SYSTEM GROUPINGS

Moderate - Serious Ratings

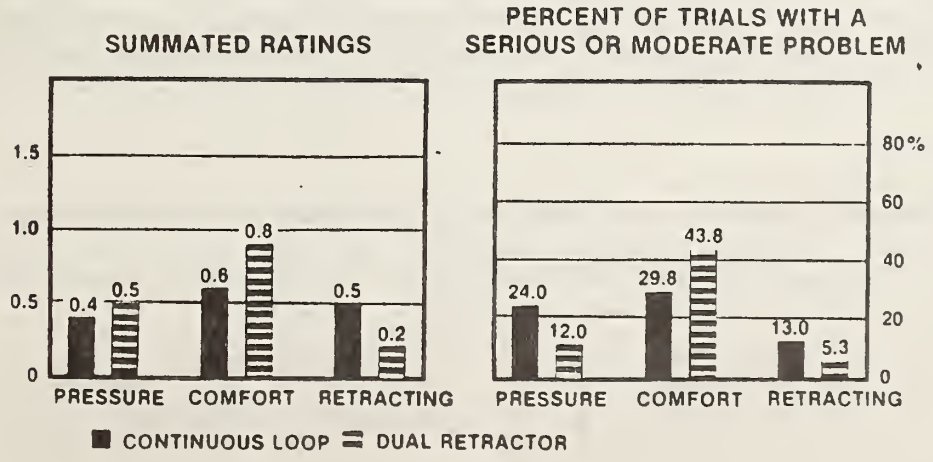
Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Continuous Loop	2505	18.7	21.5	10.2	18.2	24.0	29.8	5.3	13.0
Dual Retractor	683	19.5	19.0	11.7	18.0	12.0	43.8	2.3	5.3

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Continuous Loop	2483	0.5	0.6	0.5	0.5	0.4	0.6	0.1	0.5
Dual Retractor	661	0.5	0.6	0.6	0.5	0.5	0.8	0.1	0.2

Figure 4-24

RELATIONSHIP OF SAFETY BELT TYPE TO COMFORT AND CONVENIENCE



According to the data presented, dual retractor systems are clearly less comfortable when reaching for the glove box and turning to look out the rear window. However, dual retractors retract more satisfactorily. The results for the pressure aspect, however, are different for the two scoring methods. This difference occurs because a relatively large percentage of the trials with dual retractor systems reported slight pressure problems, increasing the summated rating score, while not increasing the serious-moderate score.

Seat Type

The final car characteristic analyzed in this report is the front seat configuration. The hypothesis being tested is that bucket seats create more comfort and convenience problems than bench seats. Figure 4-25 presents the average indices for trials grouped by seat type.

Figure 4-25

RESULTS BY FRONT SEAT CONFIGURATION GROUPINGS

Moderate - Serious Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Bucket	2163	22.1	22.8	11.8	17.6	21.5	31.4	5.7	11.9
Bench	1025	12.0	17.1	7.7	19.3	21.1	35.8	2.2	10.1

Summated Ratings

Category	N	Access	Extend	Buckle	Fit	Press	Comfort	Release	Retract
Bucket	2133	0.6	0.6	0.3	0.4	0.5	0.6	0.2	0.5
Bench	1011	0.4	0.5	0.2	0.5	0.4	0.7	0.1	0.4

The data shown in this figure indicates that fit, pressure, and comfort aspects, cars with bucket seats have fewer problems than those with bench seats. Conversely, for the aspects of accessibility, extending, buckling, releasing, and retracting, the *a priori* hypothesis can be accepted.

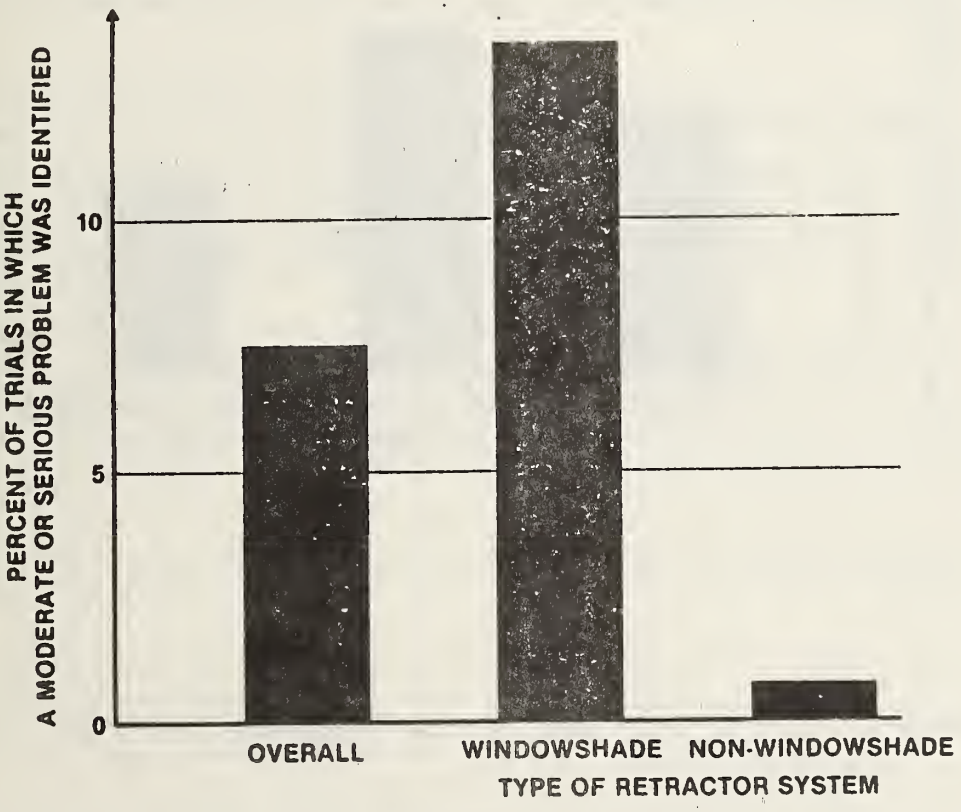
Windowshade Devices

This section of Chapter 4 concludes with the study's finding about windowshade devices in safety belt retractors. As outlined in the first section of this chapter, windowshade devices do relieve belt pressure on the shoulder and chest. Other problems are created, however.

For example, as shown by Figure 4-26, systems with windowshade devices have excessive slack more often than those without, despite the fact that the proper use of windowshade devices was demonstrated to all test participants. Since excessive slack reduces the protection to the wearer, a safety porblem is indicated.

Figure 4-26

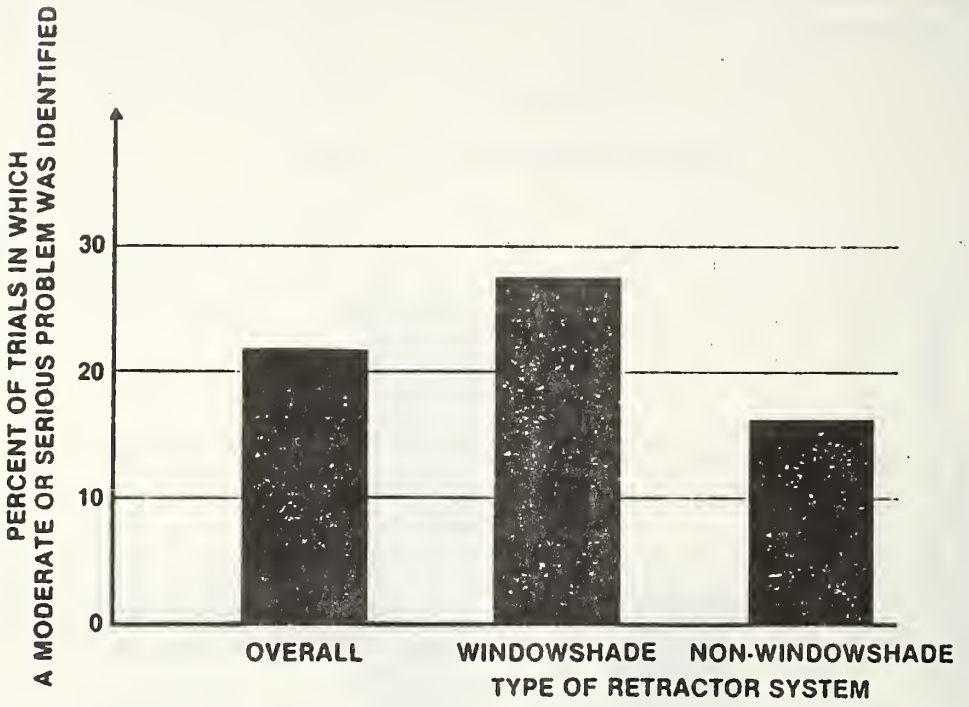
EXCESSIVE SHOULDER BELT SLACK



Another important factor affected by the windowshade device is belt retraction. When belts are released, they should return automatically to their rectractors. Figure 4-27 shows that those systems with windowshade devices had improper retraction in a greater percentage of the trials. Moreover, in over 20 percent of all trials, incomplete retraction was observed.

Figure 4-27

INCOMPLETE RETRACTION



5

CONCLUSIONS

This chapter summarizes the statistical results detailed in Chapter 4. The principle conclusions which can be derived from the statistical analysis are:

- Individual 1979 model cars have differing comfort and convenience problems. However, as a whole, the greatest comfort and convenience problems with 1979 model cars occur when the user is reaching for the glove box or turning to look out the rear window, with extending the latchplate over to the buckle, with fit, with belt pressure on the chest and choulder, and with latchplate accessibility.

- Older users perceive fewer comfort and convenience problems than younger.

- Shorter users perceive problems with the fit and comfort aspects of safety belt systems, while taller users experience problems with belt retraction.

- Comfort and convenience ratings are not affected by subject weight and belt usage.

- The smaller cars had more accessibility problems than larger cars.

- Two-door cars cause more problems with accessibility, fit, comfort, and retraction than do 4-door cars.

- Dual retractors create fewer retraction problems, while continuous loop systems cause fewer comfort problems.

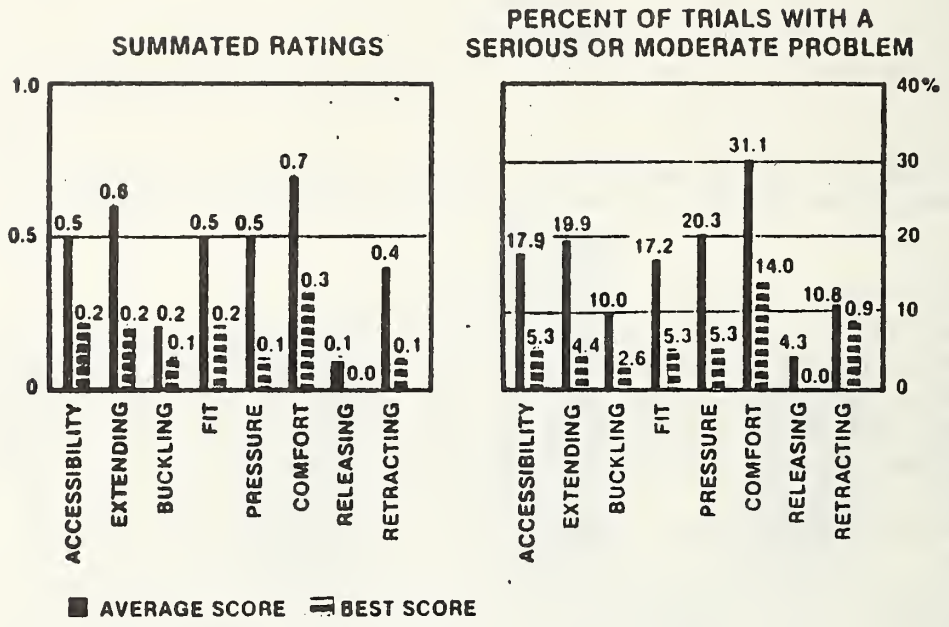
- Bucket seats create problems with safety belt accessibility, extending, buckling, releasing, and retracting, while bench seats caused more fit, pressure, and comfort problems.

- Windowshade devices relieve belt pressure on the shoulder and chest when used properly. However, they do create problems with excessive safety belt slack and incomplete retraction. Moreover, for all trials, over 20 percent of the trials had incomplete belt retraction.

Finally, examination of the study results show that most of the cars had some good as well as bad aspects. Figure 5-1 compares the best score for each aspect with the average over all cars. This comparison shows that by combining the best features of cars used in this study, a safety belt system substantially better than the existing systems can be produced.

Figure 5-1

COMPARISON OF AVERAGE AND BEST SCORES



APPENDIX A

TEST INSTRUMENTS

Copies of the Car Checklist, the Participant Information Form, the Physuical Data Form, and the Active and Passive Forms are provided in this Appendix.

CONSULTANT CHECKLIST FOR CARS
IN THE NHTSA SAFETY BELT TEST

1. Consultant's Name:	Woodson [1]	1
	Glenn [2]	
	Other (specify): [3]	
2. Date:	9 7 8	
3. Car Number:		
4. Make/Manufacturer	GMC [1]	11
(Name of Car)	Ford [2]	
(Color)	Chrysler [3]	
	AMC [4]	
	VW [5]	
	Other Foreign [6]	
5. Model:	Subcompact [1]	13
	Compact [2]	
	Luxury [3]	
	Specialty [4]	
6. Year of car:	▶	15 16
7. Number of Doors:	2 Door [1] 4 Door [2]	18
8. Hatch Back?	YES [1] NO [2]	20
9. Type of Seats:	Bucket [1] Bench [2]	22
10. Descriptor for safety belt system	Active [1] Passive [2]	24
11. Specific descriptors for safety belt system ▶ 1. Continuous loop (single retractor). 2. Continuous loop with tension reliever (windowshade) that deactivates when the door is opened. 3. Dual retractor. 4. Dual retractor with comfort clip and sling. 5. Dual retractor with comfort clip and webbing guide. 6. Dual retractor with tension reliever (windowshade) that deactivates when the door is opened with automatic locking retractor on lab belt. 7. Dual retractor with automatic locking retractor on lap belt.	Enter Choice:	26
12. Number of Retractors:	None [1] One [2] Two [3]	28
13. Location of shoulder guide:	None [1] Seat Back [2] Door Post [3]	30
14. D Ring?	YES [1] NO [2]	32
15. Where is buckle fastened to car?	Seat [1] Floor [2] Console [3]	34

16. Type of lap belt retractor:	None [1] Emergency Locking [2] Automatic Locking [3]	36
17. Type of shoulder belt retractor:	None [1] Vehicle Locking [2] Webbing Locking [3] Window-shade [4]	38
18. Outboard retractor location:	Floor [1] Rocker Panel [2] B-Pillar High [3] B-Pillar Low [4] Roof Rail [5] Door [6] Seat [7] Not applicable [8]	40
19. Inboard retractor location:	Floor [1] Tunnel [2] Console [3] Seat [4] N/A [5]	42
20. Outboard tongue-buckle attachment point:	Floor [1] B-Pillar High [2] B-Pillar Low [3] Door [1] Seat [2] N/A [3]	44
21. Inboard tongue-buckle attachment point:	Floor [1] Tunnel [2] Console [3] Seat [4] N/A [5]	46
22. Emergency Release (for belts):	Inboard [1] Outboard [2] Interlock [3] N/A [4]	48
23. Seat Belt Manufacturer:		
24. Type of steering wheel:	Tilt [1] Swing Away [2] Fixed [3]	50
25. Warning buzzer?	▶ YES [1] NO [2]	52
26. Warning lights?	▶ YES [1] NO [2]	54
27. Is latch plate movable or adjustable for different size occupants?	▶ YES [1] NO [2]	56
28. Arm rests?	Front Center [1] Back Center [2] Both [3] None [4]	58
29. Power seats?	YES [1] NO [2]	60

Comments: (other features describing system)

Specific Problems With Systems

Front outboard seats:

Center front seats:

Rear Seats:

PARTICIPANT INFORMATION FORM

Participant's Initials: _____ (first middle last)	Date: 1 2 3 4 — 0 9 (month day)	
		Participant's Number: 7 8 9
		Sex: Male [1] Female [2] — 11
		Age: 12 13
1. Mark the item that indicates the highest level of education you have completed. Mark only one:		No High School Diploma: [1]
		High School Diploma : [2]
		Some College: [3] — 16
		College or Advanced Degree: [4]
2. Do you work in the auto industry?		YES [1] NO [2] — 18
If your answer is YES, indicate what area?		Production: [1]
		Sales: [2] — 20
		Other (specify): [3]
3. Does any member of your family, who lives in your household, work in the auto industry?		YES [1] NO [2] — 22
If your answer is YES, what area?		Production: [1]
		Sales: [2] — 24
		Other (specify): [3]
4. At what age did you get your driver's license?		26 27
5. What race or ethnic group are you?		American Indian: [1]
		Black: [2]
		Hispanic: [3]
		Oriental: [4] — 29
		White: [5]
		Other: [6]
6. Mark the category that represents the total annual income for your family.		0 - $4,999 [1]
		$ 5,000 - $ 9,999 [2]
		$10,000 - $14,999 [3]
		$15,000 - $19,999 [4] — 31
		$20,000 - $24,999 [5]
		$25,000 - $29,9999 [6]
		$30,000 - or more [7]

PLEASE COMPLETE REVERSE SIDE

(Please do not write in shaded areas)

7. Of all the cars manufactured in the last 10 years, which one is your favorite?	Make:	3 4
	Model:	5 6
	Year:	11 12
8. It there any car you would not ever want to own or drive?	YES 1 / NO 2	14
If your answer is YES, what car?	Make:	16 17
	Model:	19 20
	Year:	22 23
Why?		

9. Please list the makes and models of cars currently owned by you or persons living in your household. MAKE MODEL YEAR		
A. _____ _____ _____		25 26 27 28 29 30
B. _____ _____ _____		32 33 34 35 36 37
C. _____ _____ _____		39 40 41 42 43 44
D. _____ _____ _____		46 47 48 49 50 51
10. Of the car(s) listed above, which do you drive most frequently? A, B, C, or D? Mark One:	A ▶ 1	53
	B ▶ 2	
	C ▶ 3	
	D ▶ 4	
11. Place a mark on this diagram that represents the amount of time you typically use a safety belt when riding in a car.	All the time: 100	
	Almost all the time: 90 / 80 / 70 / 60	
	About half the time: 50 / 40 / 30	
	Almost never: 20 / 10	
	Never: 0	
		55 56 57
12. Do you work full time for pay?	YES 1 / NO 2	59
If your answer is YES, what is your occupation:		61 62 63

PHYSICAL DATA FORM

Participant's Initials:

first _____ middle _____ last _____

1.	Experimenter Number:	___ ___ ___ (1 2 3)
2.	Participant's Number:	___ ___ ___ (5 6 7)
1.	Sex	Male [1] Female [2] (9)
2.	Age	___ ___ (11 12)
3.	Weight (In pounds)	___ ___ ___ (14 15 16)
4.	Height (In inches)	___ ___ (18 19)
5.	Seated Height (In inches)	___ ___ (21 22)
6.	Arm Length (In inches)	___ ___ (24 25)
7.	Chest (In inches)	___ ___ (27 28)
8.	Seated Waist (In inches) (circumference)	___ ___ (30 31)
9.	Leg Length (In inches)	___ ___ (33 34)
	SPECIAL NOTATIONS	
10.	Do you have Arthritis?	YES [1] NO [2] (36)
11.	Do you have Bursitis?	YES [1] NO [2] (38)
12.	Any mobility Problems?	YES [1] NO [2] (40)

If your answer to mobility problems is YES, please describe:

Comments:

SAFETY BELT SYSTEM EVALUATION - ACTIVE SYSTEMS

Experimenter Number: ___ (1 2 3)	Date: 6 6 7 6 — 0 9 — month day	Participant Number (10 11 12)	
KEY: 0 = No Problem 2 = Moderate Problem; 1 = Minor Problem 3 = Serious Problem		Car Number (14 15)	0 1
		Trial Number (17 18)	

I. ACCESSIBILITY AND SEAT BELT DONNING		CIRCLE ONE ANSWERS	
INSTRUCTIONS	**QUESTIONS**		
After the participant has entered the car, closed the door, adjusted the seat and the safety belt, READ the questions in I. and record responses.	1. Did you have any difficulty locating the latch plate?	0 1 2 3	20
	2. Did you have any difficulty in retrieving the latchplate?	0 1 2 3	22
	3. Did you have any difficulty in extending the webbing?	0 1 2 3	24
	4. Did you have any difficulty moving the latchplate over to the buckle?	0 1 2 3	26
	5. Did you have any difficulty finding the buckle?	0 1 2 3	28
	6. Did you have any difficulty inserting the latchplate into the buckle?	0 1 2 3	30
	7. EXPERIMENTER: Note if belt is twisted.	YES [1] NO [2]	32
II. SEAT BELT COMFORT			
Place both hands on the steering wheel as if you were driving. Keep them there.	8. Does the webbing come across or rub your face or neck?	0 1 2 3	34
	9. Does the shoulder belt fit across your chest comfortably?	0 1 2 3	36
	10. Do you experience webbing pressure on your chest or shoulder?	0 1 2 3	38
For cars with windowshade devices, say, "Set the windowshade." If none skip questions 10 and 11.	11. Did you experience difficulty in setting the windowshade?	0 1 2 3 [N/A 4]	40
	12. Do you experience webbing pressure on your chest or shoulder?	0 1 2 3 [N/A 4]	42
Keep your left hand on the wheel and lean as far forward as you can toward the glove box.	13. EXPERIMENTER - Note if excessive slack in shoulder belt upon sitting back.	YES [1] NO [2]	44
	14. Any restriction of movement from safety belt?	0 1 2 3	46
	15. Any uncomfortable tension or rubbing on the shoulder?	0 1 2 3	48
For cars with windowshade say "Readjust the windowshade." - For all cars then say "Keeping your left hand on the wheel, look over your right shoulder through the back window as if you were going to change lanes."	16. Does the safety belt restrict movement?	0 1 2 3	50
	17. Does it produce uncomfortable tension or rubbing on your shoulder?	0 1 2 3	52
III. SEAT BELT DOFFING AND CAR EXIT			
Unlatch the safety belt and exit the car.	18. Did you have any difficulty in locating the buckle release?	0 1 2 3	54
	19. Did you have difficulty operating the buckle release?	0 1 2 3	56
	20. Did the safety belt system retract out of your way?	0 1 2 3	58
	21. EXPERIMENTER: Note if belt went back into retractor as designed.	YES [1] NO [2]	60

Comments: (write item number first, then comment.)

(1) Check form for completeness.
(2) Insert in "Completed" envelope.
(3) Leave car in test condition.
(4) Wait for timekeeper's signal.

SAFETY BELT SYSTEM EVALUATION - PASSIVE SYSTEMS

Experimenter Number: ___ (1 2 3)	Date: 0 9 (month) ___ (day) (1 2 3 4)	Participant Number	10 11 12
		Car Number	14 0 13 4
KEY: 0 = No Problem 2 = Moderate Problem; 1 = Minor Problem 3 = Serious Problem		Trial Number	17 18

INSTRUCTIONS	QUESTIONS	CIRCLE ONE ANSWERS	
I. ACCESSIBILITY AND SEAT BELT DONNING			
Open the car door, get into the drivers seat, close the door. Adjust the seat so you are comfortable.	1. Did you have any confusion about how you were supposed to get into the car when you first saw the safety belt system?	0 1 2 3	20
	2. Did you have to enter the car in a special way because of the safety belt system?	0 1 2 3	22
	3. Did the belt interfere with your closing the car door?	0 1 2 3	24
	4. Did the webbing entrap your hand or arm inadvertently when the door was closing?	0 1 2 3	26
	5. EXPERIMENTER: Note if belt is twisted.	YES [1] NO [2]	32
II. SEAT BELT COMFORT			
Place both hands on the steering wheel as if you were driving, and keep them there	6. Does the webbing come accross or rub your face or neck?	0 1 2 3	34
	7. Does the shoulder belt fit across your chest comfortably?	0 1 2 3	36
	8. Do you experience webbing pressure on your chest or shoulder?	0 1 2 3	38
For cars with windowshade devices say "Set the windowshade." If none, skip questions 9 and 10.	9. Did you experience difficulty in setting the windowshade?	0 1 2 3 N/A [4]	40
	10. Do you experience webbing pressure on your chest or shoulder?	0 1 2 3 N/A [4]	42
Keep left hand on the wheel and lean as far forward as you can toward the glove box.	11. EXPERIMENTER - Note if excessive slack in shoulder belt upon sitting back.	YES [1] NO [2]	44
	12. Any restriction of movement from safety belt?	0 1 2 3	46
	13. Any uncomfortable tension or rubbing on the shoulder?	0 1 2 3	48
For cars with windowshade say "Readjust the windowshade." - For all cars then say "Keeping your left hand on the wheel, look over your right shoulder through the back window as if you were going to change lanes."	14. Does the safety belt restrict movement?	0 1 2 3	50
	15. Does it produce uncomfortable tension or rubbing on your shoulder?	0 1 2 3	52
III. SEAT BELT DOFFING AND CAR EXIT			
~~Unfasten safety belt and~~ exit car.	16. Did you have difficulty in getting hold of the door or door handle to open the door?	0 1 2 3	54
	17. Did the safety belt system retract out of your way?	0 1 2 3	56

Comments: (write item number first, then comment.)

(1) Check form for completeness.
(2) Insert in "Completed" envelope.
(3) Leave car in test condition.
(4) Wait for timekeeper's signal.

APPENDIX B

CONSULTANT EVALUATIONS

The results of the consultant evaluations of the front passenger and rear safety belt systems are provided in this appendix. The consultants providing this information were Wesley Woodson and Thomas Glenn.

Concord

Specific Problems With System
Front outboard seats: Non-rigid buckles Belt did not retract full after exit Seat adjustment required after donning because of latch plate adjuster
Center front seats: None
Rear seats: No comment.

Pacer

Specific Problems With System
Front outboard seats: O. K.
Center front seats: None
Rear seats: Buckles can be forced down between seat and back Short, soft connected

Cordoba

Specific Problems With System
Front outboard seats: Bad-occupant must tug on belt to make it retract before opening door. Comfort clip is on headrest causing neck rubbing when head rest is in the proper position.
Center front seats: Soft buckle attachment. Soft latchplate attachment
Rear seats: Soft, short buckle arrangmenet which will disappear into seat in time.

Omni

Specific Problems With System
Front outboard seats: Belt will roll through and double over in latchplate
Center front seats: None
Rear seats: None

St. Regis

Specific Problems With System
Front outboard seats: Difficult to set windowshade Retraction slightly sluggish Latchplate has excessive friction when moving along belt Shoulder belt too high for small occupants.
Center front seats: No Comment
Rear seats: Buckles Twisted Semi-soft buckle attachments will disappear behind seat.

Volare

Specific Problems With System
Front outboard seats: Seat adjustment required after donning the belt
Center front seats: No Comment
Rear seats: No Comment

Fairmont

Specific Problems With System
Front outboard seats: Latchplate slips down too far on webbing . Plastic latchplate cover resists movement. Belt hooks arm when retracting .
Center front seats: Restraint system not provided.
Rear seats: Short soft buckles will disappear behind seat. Auto lock will lockout belt unless fully extended.

Granada

Specific Problems With System
Front outboard seats: Windowshade difficult to set. Belt hooks arm when retracting.
Center front seats: Restraint system not provided.
Rear seats: Auto lock will lockout belt unless fully extended.

LTD

Specific Problems With System
Front outboard seats: Slightly stiff in movement across to buckle. Belt hooks arm on retraction.
Center front seats: No Comment.
Rear seats: Latchplates in center; buckles out board.

LTD II

Specific Problems With System
Front outboard seats: Webbing guide to low for smaller occupants. Hooked arm when retracting.
Center front seats: No Comment.
Rear seats: Autolock will lockout belt if not fully extended. Soft buckle attachments will go behind seat in time.

Mustang

Specific Problems With System
Front outboard seats: Retraction is sluggish unless belt is tugged when doffing. Swinging lap belt anchor point located too far out for easy location.
Center front seats: None
Rear seats: Autolock retractor will lockout belt unless fully extended. Soft buckle attachments will disappear behind seat.

Pinto

Specific Problems With System
Front outboard seats: Retraction sluggish. Belt hooked arm when retracting.
Center front seats: None
Rear seats: Soft buckle attachments will go behind seat.

Camaro

Specific Problems With System
Front outboard seats: Shoulder belt guide on seat back too far inboard. Will create problems for small occupants.
Center front seats: None.
Rear seats: Lap belt lockout unless fully extended.

Chevette (Active)

Specific Problems With System
Front outboard seats: Belt must be tugged smartly before retraction.
Center front seats: None
Rear seats: Belt lockout will occur unless fully extended.

Chevette (Passive)

Specific Problems With System
Front outboard seats: No Comment.
Center front seats: None
Rear seats: Lockout unless belt is fully extended.

Coupe de Ville

Specific Problems With System
Front outboard seats: Webbing guide on head rest causes belt to rub neck when head rest is in proper position. Shoulder belt hooks arm on retraction.
Center front seats: No Comment.
Rear seats: Soft buckle attachments will allow buckles to go behind seat or armrest. Autolock will lockout belt unless it is fully extended.

Cutlass

Specific Problems With System
Front outboard seats: No Comment.
Center front seats: No Comment.
Rear seats: No Comment.

Impala

Specific Problems With System
Front outboard seats: Shoulder belt retracts improperly.
Center front seats: No Comment.
Rear seats: Autolock will lockout belt unless it is fully extended.

Rabbit (Active)

Specific Problems With System
Front outboard seats: Belt hooks arm when retracting. Belt will twist through latchplate.
Center front seats: None
Rear seats: Soft buckle attachments will allow buckles to disappear behind the seat. Lock out of belt will occur unless belt is fully extended.

Rabbit (Passive)

Specific Problems With System
Front outboard seats: Belt caught on pens in pocket; exit impeded slightly.
Center front seats: None
Rear seats: No Comment.

BMW 3201

Specific Problems With System
Front outboard seats: Latchplate difficult to retrieve. Latchplate difficult to extend. Improper retraction.
Center front seats: None
Rear seats: Sluggish retraction.

Datsun B210

Specific Problems With System
Front outboard seats: Sluggish retraction. Plastic cover on latchplate resists movement of belt.
Center front seats: None
Rear seats: Very poor retraction. Latchplates located inboard; buckles outboard.

Fiat Brava

Specific Problems With System
Front outboard seats: Belt hooked on left arm when retracting.
Center front seats: None
Rear seats: None

Honda Civic

Specific Problems With System
Front outboard seats: O. K.
Center front seats: None
Rear seats: Webbing spool and retractor on latchplate; impedes easy operation. Improper retraction.

Mazda GLC

Specific Problems With System
Front outboard seats: Sluggish retraction. Incomplete retraction.
Center front seats: None
Rear seats: Webbing spool and retractor on latchplate; impedes easy operation.

Mercedes 300D

Specific Problems With System
Front outboard seats: Shoulder belt hooks arm when retracting.
Center front seats: None
Rear seats: Belt hooks arm when retracting.

Subaru

Specific Problems With System
Front outboard seats: Difficult to extend webbing over to buckle.
Center front seats: None
Rear seats: Sluggist retraction

Toyota Corolla

Specific Problems With System
Front outboard seats: Latchplate difficult to grasp. Lapbelt slips through comfort clip.
Center front seats: None
Rear seats: Webbing lockout when extended too rapidly. Stowed belts impede exit.

APPENDIX C

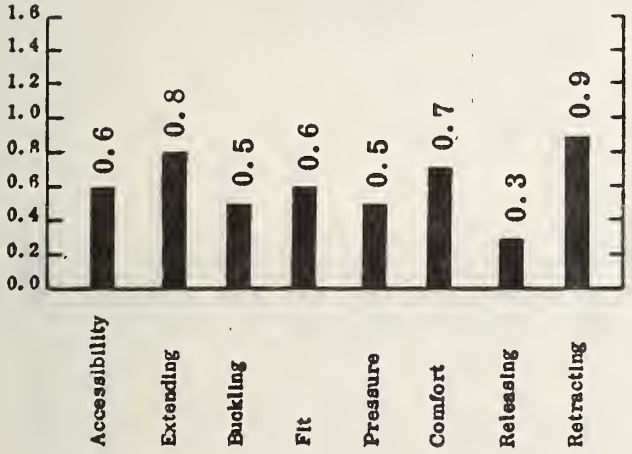
RESULTS BY CAR

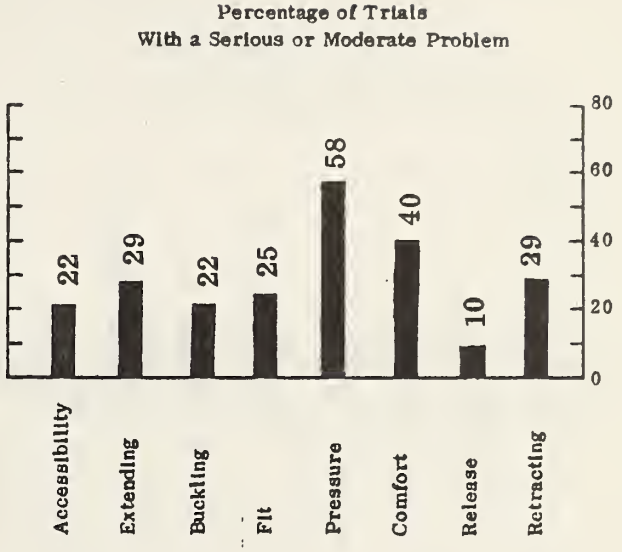
A summary of the summated ratings and the moderate-serious ratings for each of the cars included in the test are provided in this appendix. The cars are presented alphabetically by manufacturer and model.

AMERICAN MOTORS CORPORATION

CONCORD

- 2-Door
- Bucket Seat
- Continuous Loop
- Windowshade

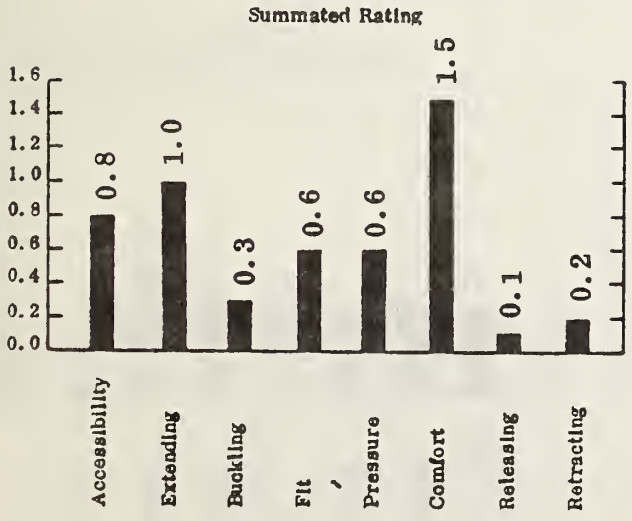


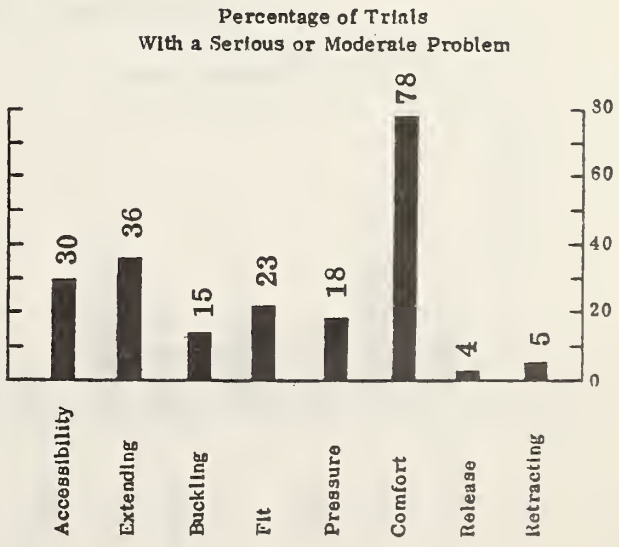


Percent Twisted ------- 22%
Percent Slack ---------- 6%
Percent Not
Fully Retracting ------- 51%

PACER

- 2-Door
- Bucket Seat
- Dual Retractor
- No Windowshade Device

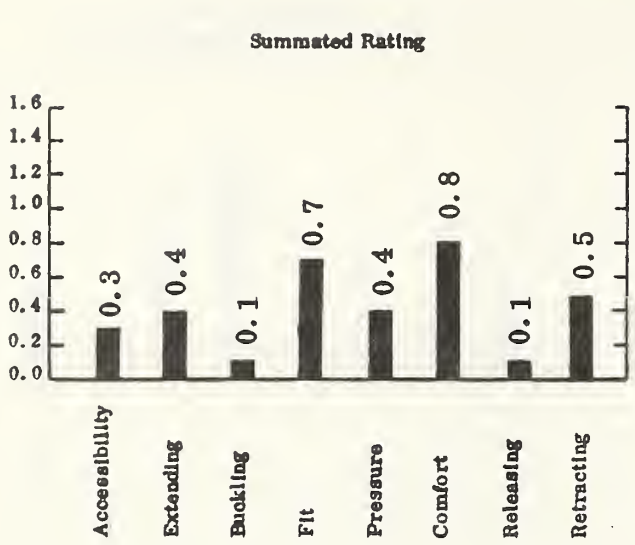


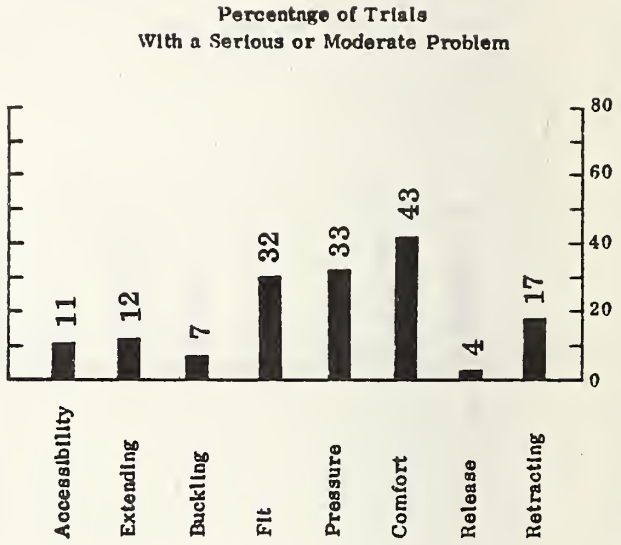


Percent Twisted ------- 31%
Percent Slack --------- 10%
Percent Not
Fully Retracting ------- 17%

CORDOBA

- 2-Door
- Bucket Seat
- Continuous Loop
- Windowshade Device

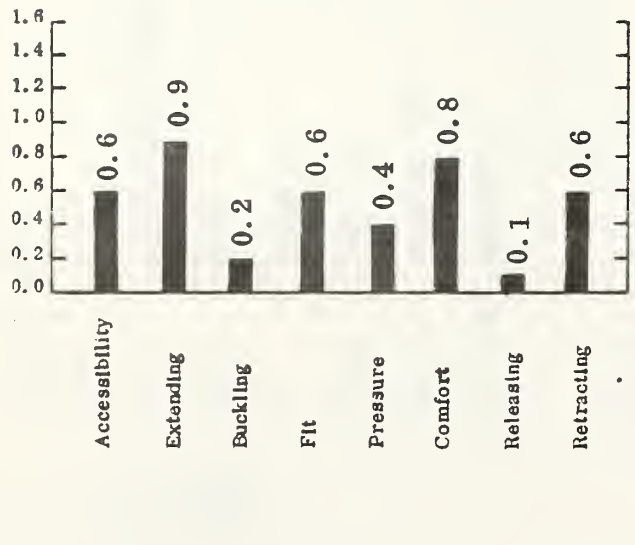


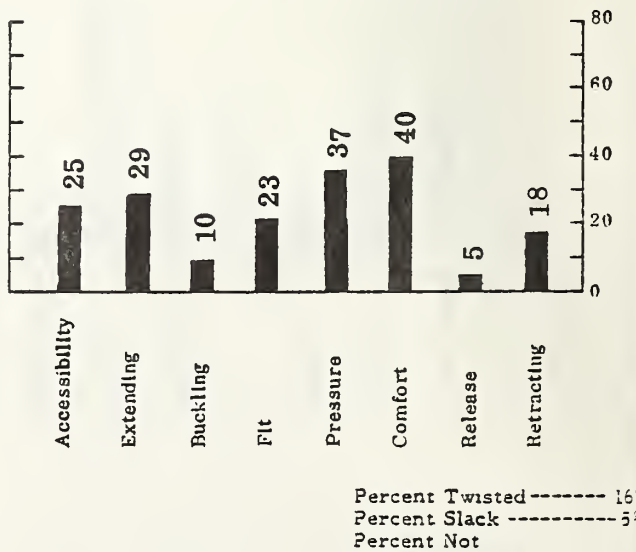


Percent Twisted -------13%
Percent Slack ----------2%
Percent Not
Fully Retracting -------29%

OMNI

- 4-Door
- Bucket Seat
- Continuous Loop
- Windowshade Device

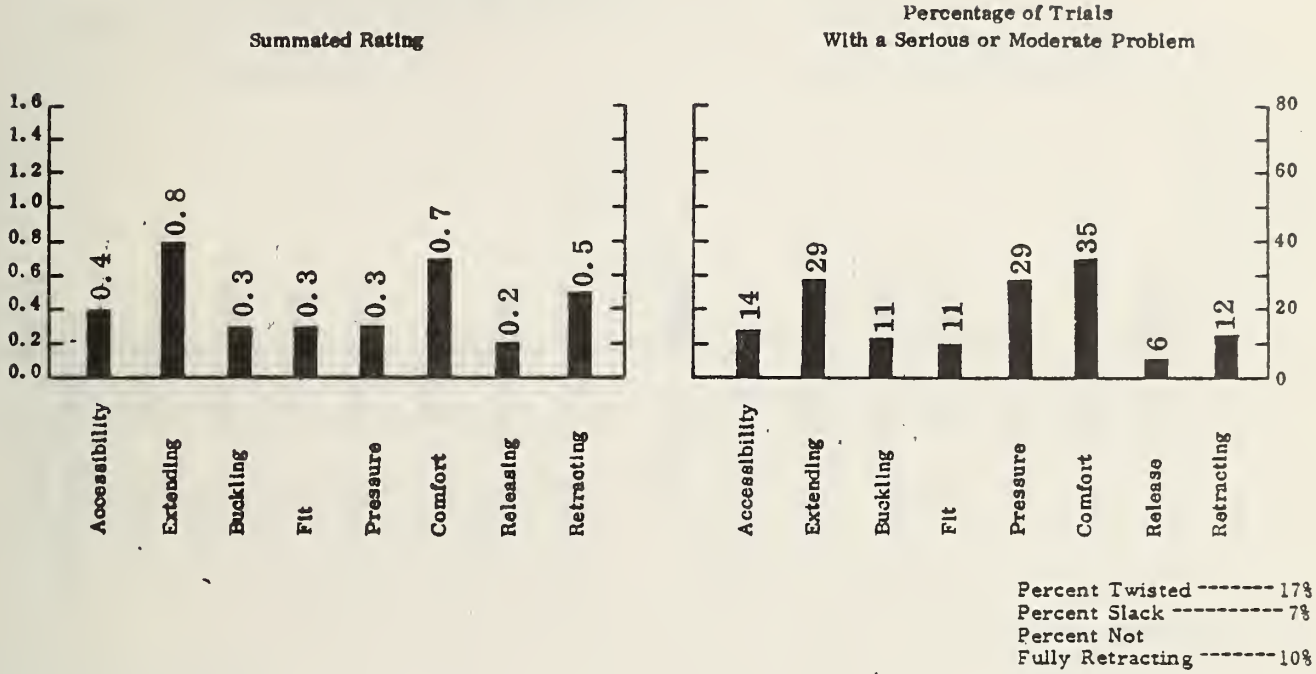




Percent Twisted ------- 16%
Percent Slack ----------5%
Percent Not
Fully Retracting -------22%

ST. REGIS

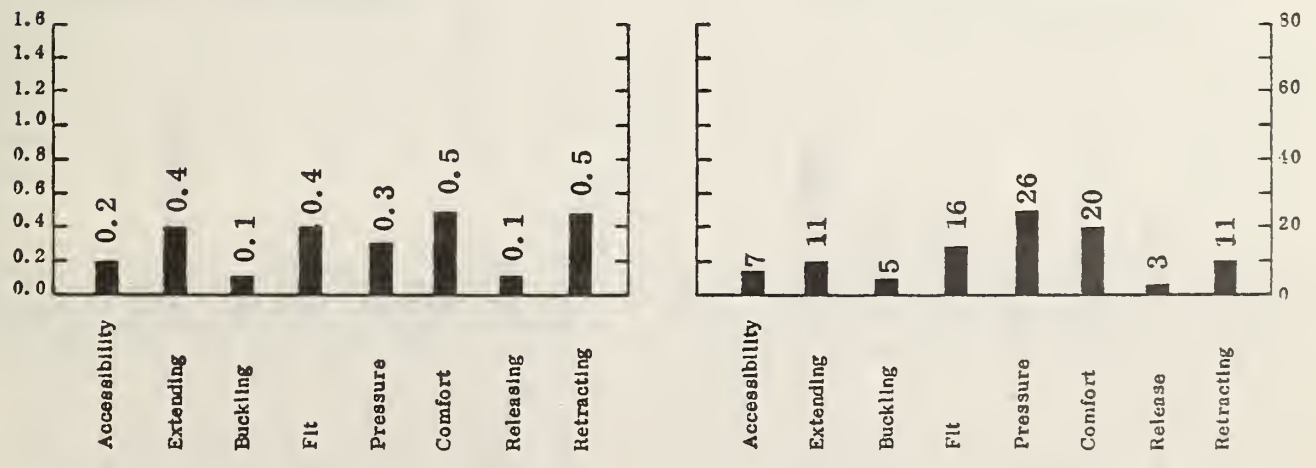
- 4-Door
- Bench Seat
- Continuous Loop
- Windowshade Device



Percent Twisted ------- 17%
Percent Slack ---------- 7%
Percent Not
Fully Retracting ------- 10%

VOLARE

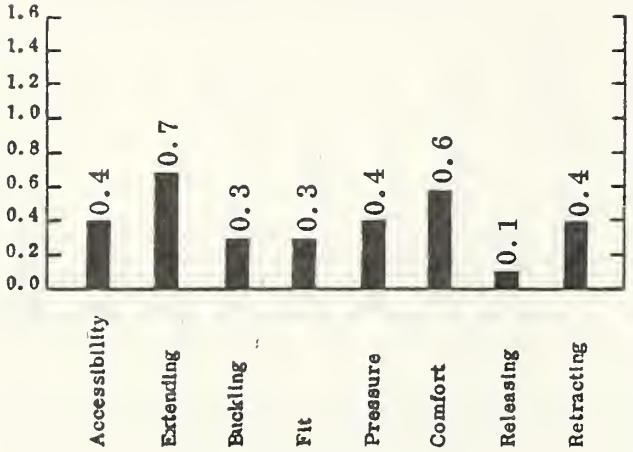
- 4-Door
- Bucket Seat
- Continuous Loop
- Windowshade Device



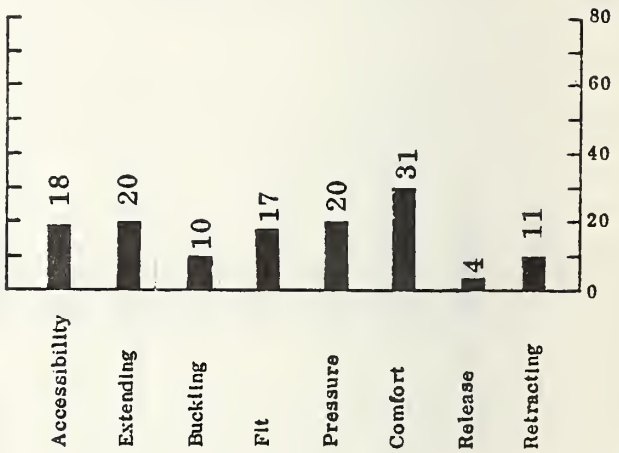
Percent Twisted ------ 30%
Percent Slack ---------- 9%
Percent Not
Fully Retracting ------- 15%

LTD
- 4-Door
- Bench Seat
- Continuous Loop
- Windowshade Device

Summated Rating



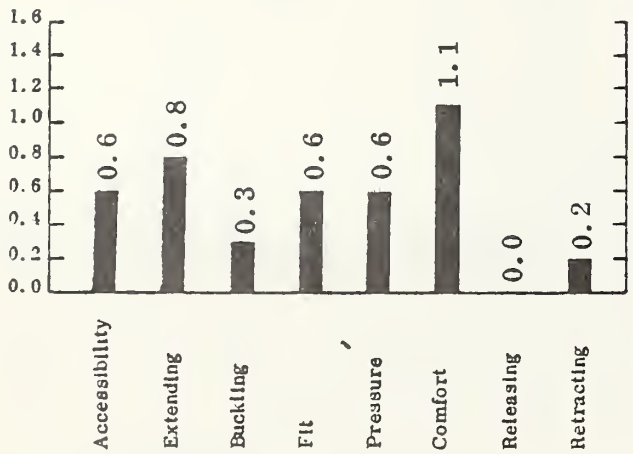
Percentage of Trials
With a Serious or Moderate Problem



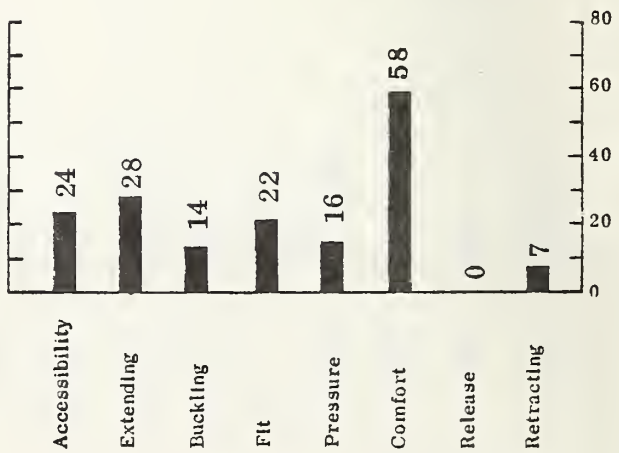
Percent Twisted ------- 20%
Percent Slack --------- 13%
Percent Not
Fully Retracting ------- 17%

LTD II
- 2-Door
- Bench Seat
- Dual Retractor
- No Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

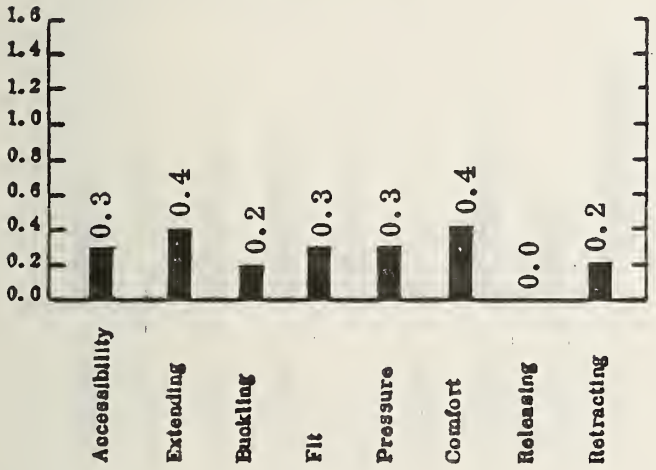


Percent Twisted ------- 18%
Percent Slack ---------- 3%
Percent Not
Fully Retracting -------- 3%

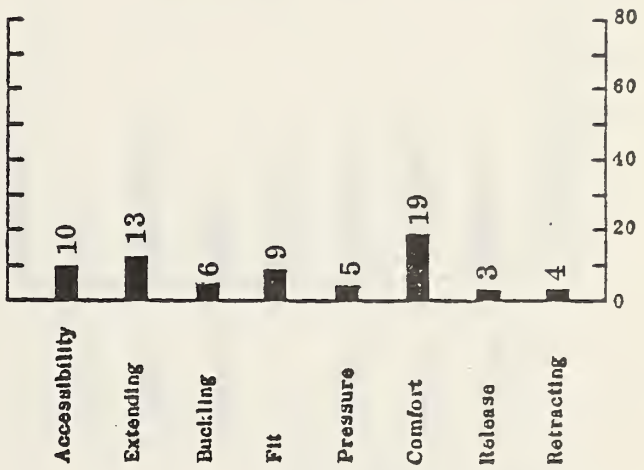
FAIRMONT

- 4-Door
- Bench Seat
- Continuous Loop
- No Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

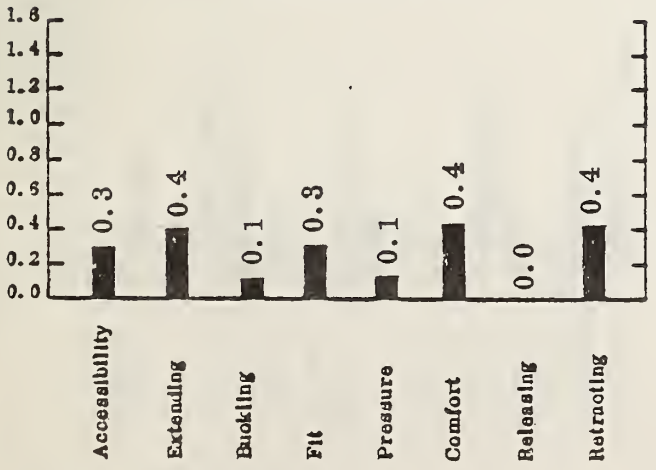


Percent Twisted ——— 18%
Percent Slack ——— 1%
Percent Not
Fully Retracting 5%

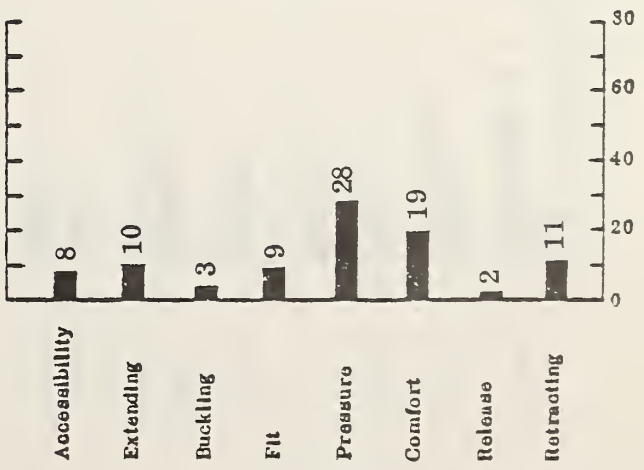
GRANADA

- 4-Door
- Bench Seat
- Continuous Loop
- Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

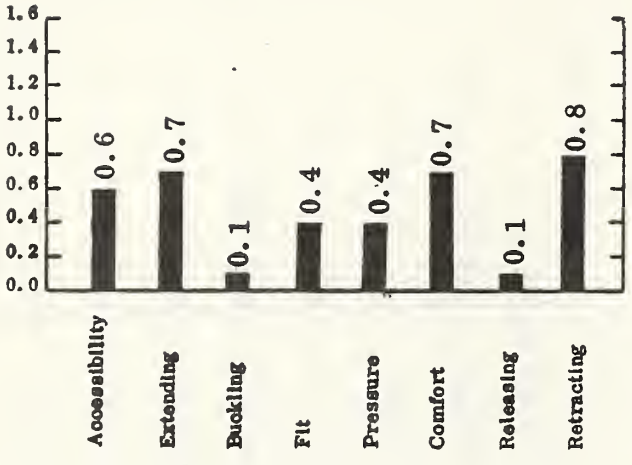


Percent Twisted ——— 12%
Percent Slack ——— 10%
Percent Not
Fully Retracting ——— 17%

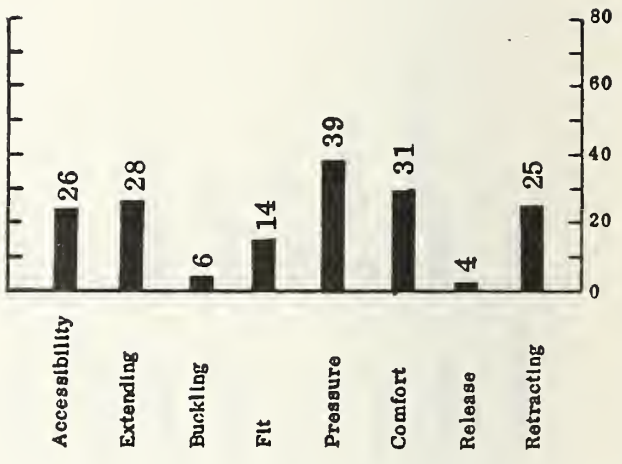
MUSTANG

- 2-Door
- Bucket Seats
- Continuous Loop
- Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

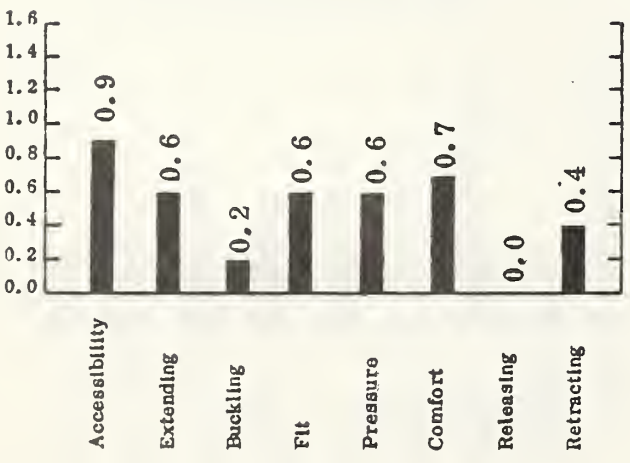


Percent Twisted -------- 21%
Percent Slack ---------- 18%
Percent Not
Fully Retracting -------- 49%

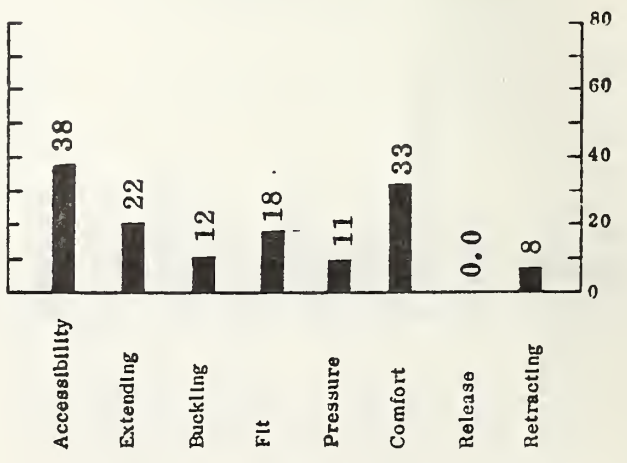
PINTO

- 2-Door
- Bucket Seats
- Continuous Loop
- No Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem



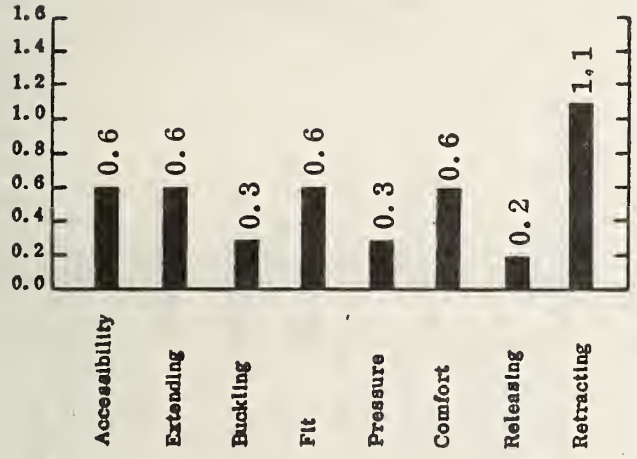
Percent Twisted -------- 31%
Percent Slack ---------- 3%
Percent Not
Fully Retracting ------ 26%

GENERAL MOTORS CORPORATION

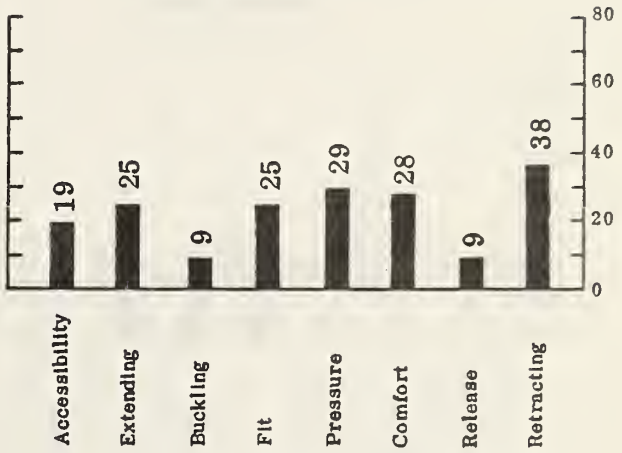
CAMARO

- 2-Door
- Bucket Seat
- Continuous Loop
- Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

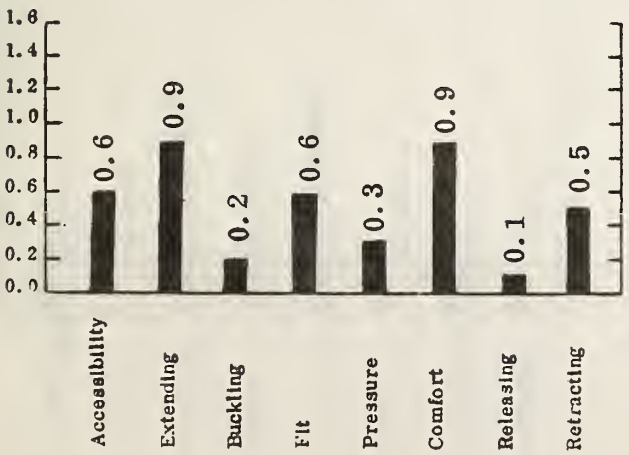


Percent Twisted--------32%
Percent Slack ---------- 9%
Percent Not
Fully Retracting -------57%

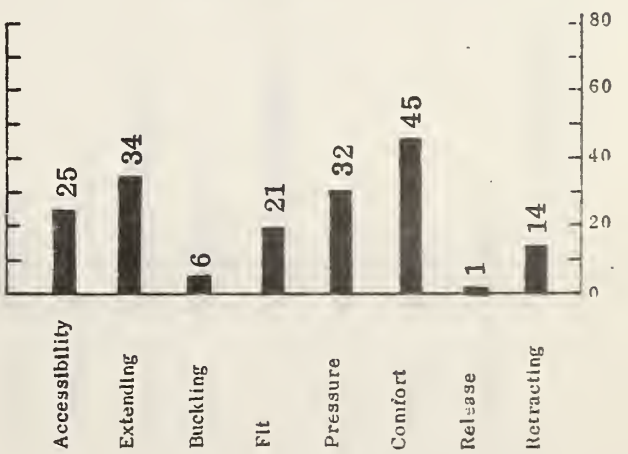
CHEVETTE (Active)

- 2-Door
- Bucket Seat
- Continuous Loop
- Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

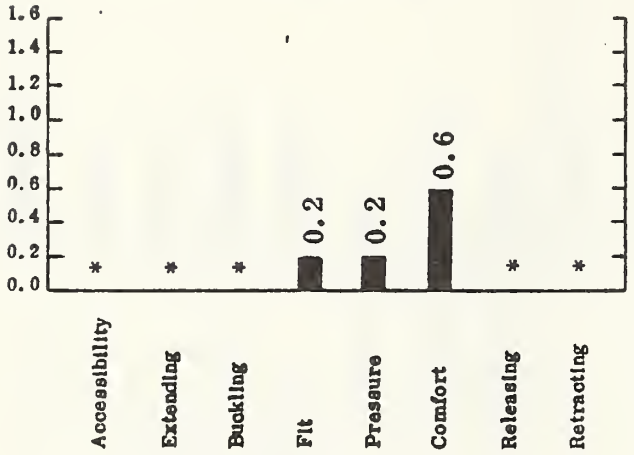


Percent Twisted---------- 20.0%
Percent Slack---------- 6.3%
Percent Not
Retracting---------- 23.4%

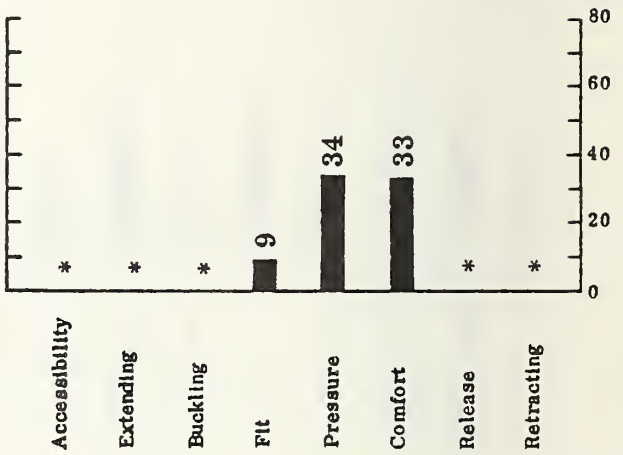
CHEVETTE (Passive)

- 2-Door
- Bucket Seat
- Continuous Loop
- Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem



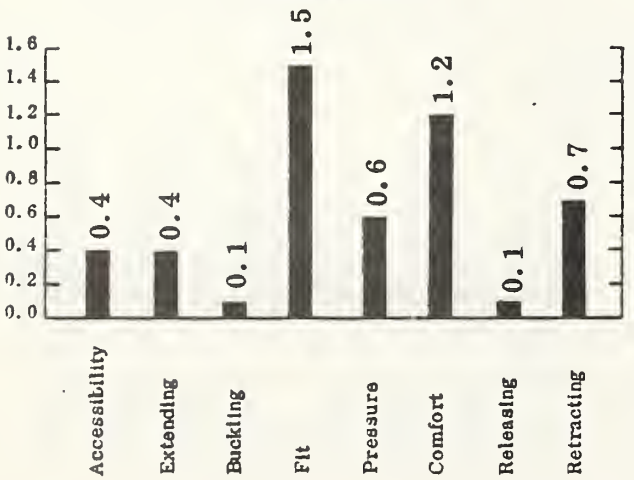
Percent Twisted------- 10%
Percent Slack ---------- 6%
Percent Not
Fully Retracting*

*Not applicable for Passive Systems

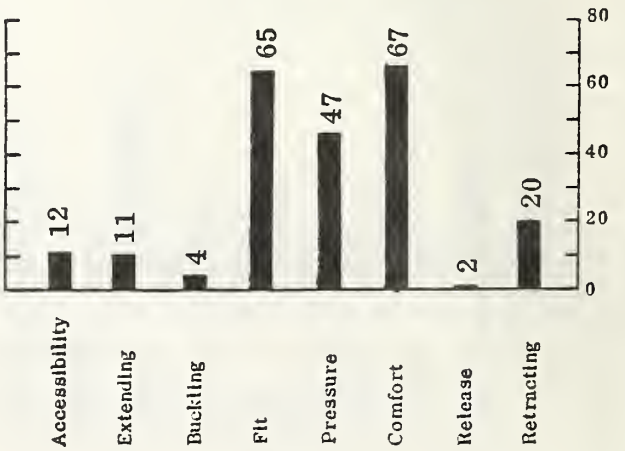
CUTLASS

- 2-Door
- Bench Seat
- Continuous Loop
- Windowshade Device

Summated Rating



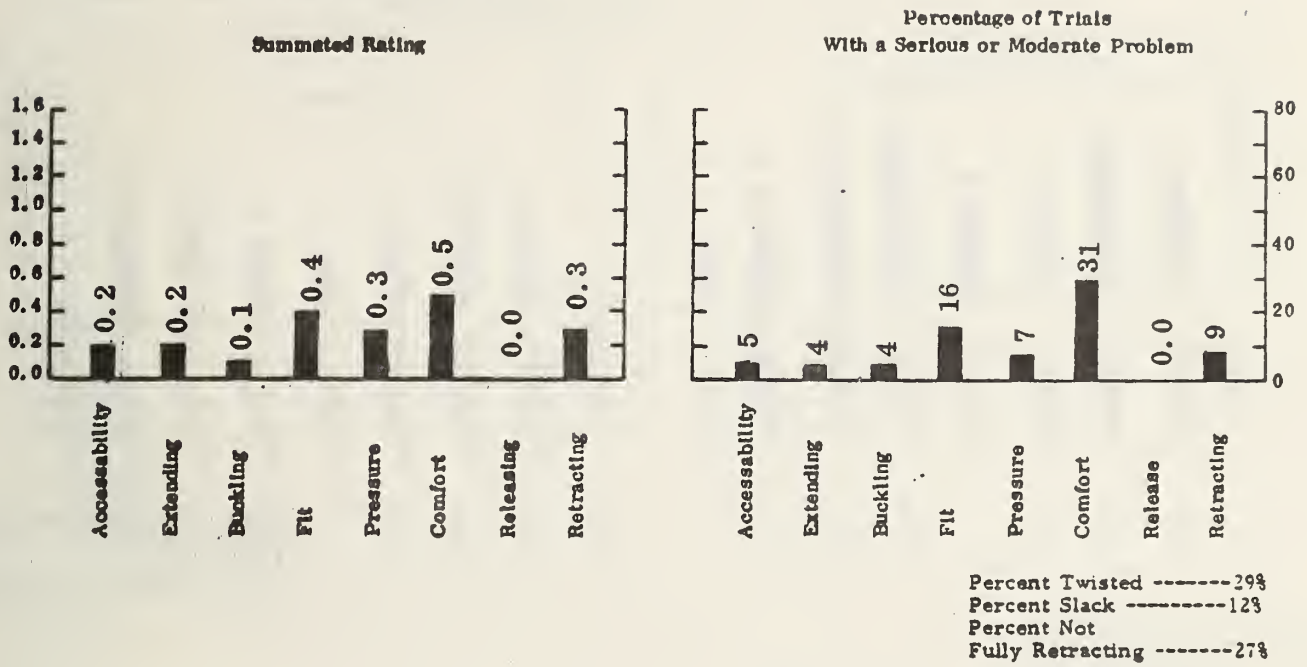
Percentage of Trials
With a Serious or Moderate Problem



Percent Twisted-------- 9%
Percent Slack---------- 7%
Percent Not
Fully Retracting------- 20%

DE VILLE

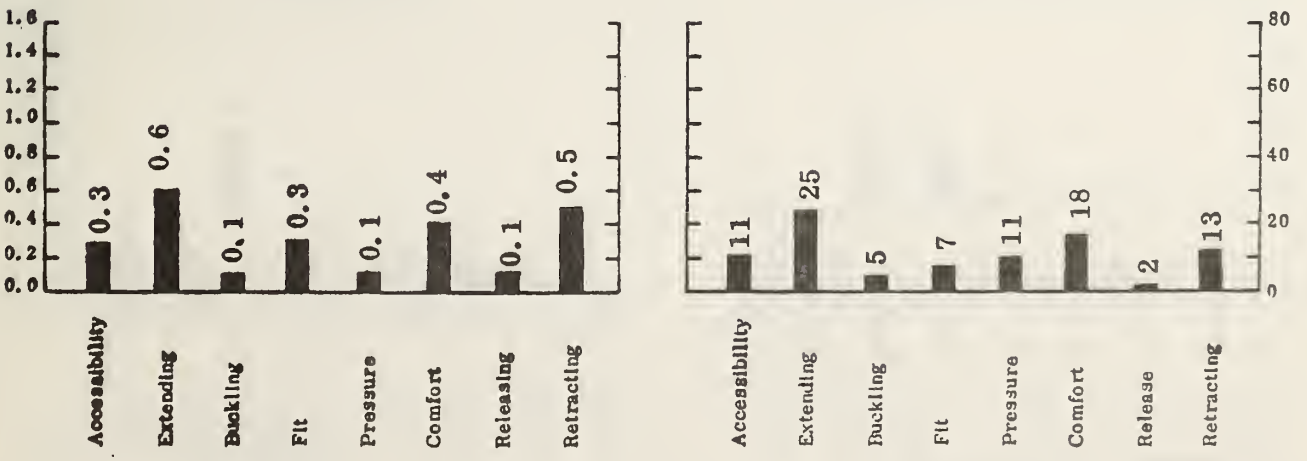
- 2-Door
- Bench Seat
- Dual Retractor
- Windowshade Device



Percent Twisted -------29%
Percent Slack ---------12%
Percent Not
Fully Retracting -------27%

IMPALA (1978)

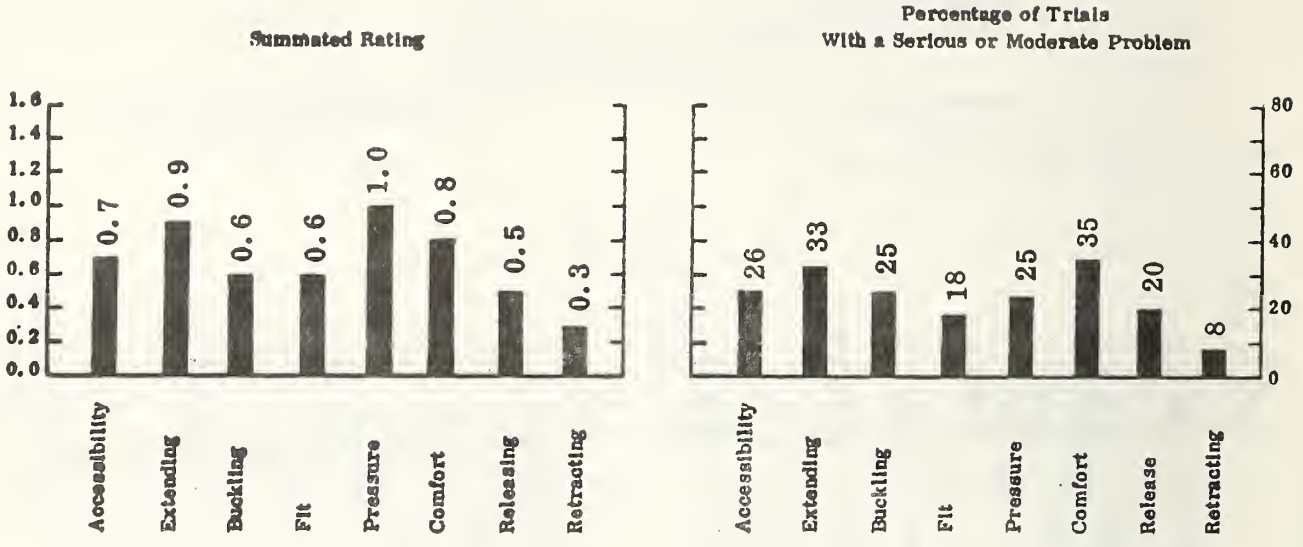
- 4-Door
- Bench Seat
- Continuous Loop
- Windowshade Device



Percent Twisted -------21%
Percent Slack ----------10%
Percent Not
Fully Retracting -------19%

RABBIT (Active)

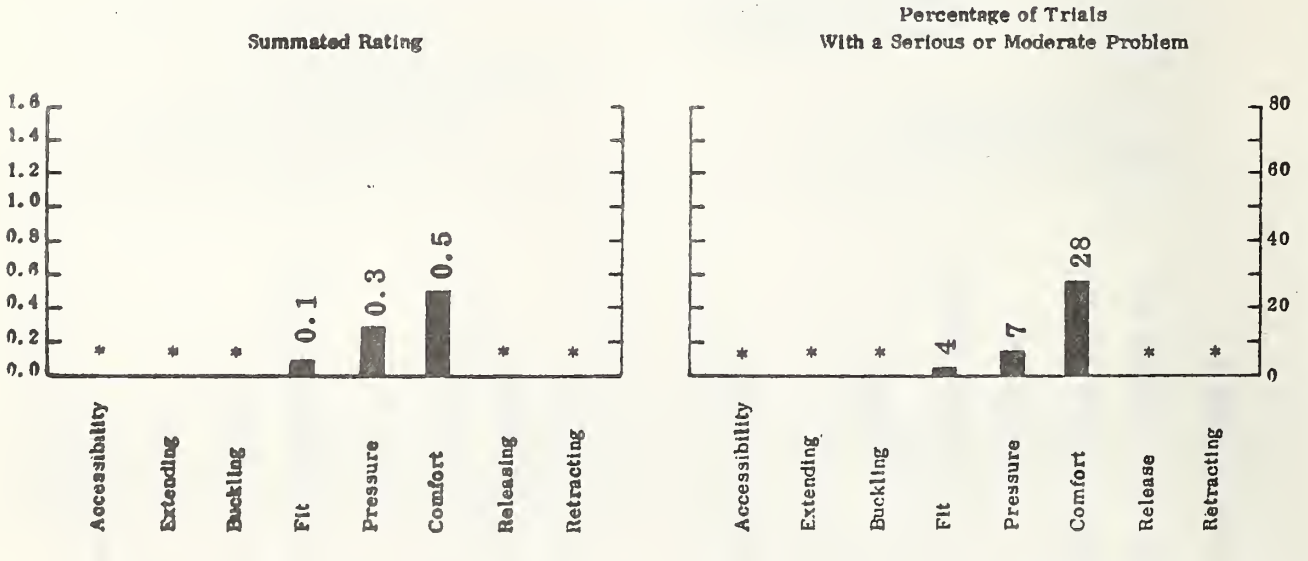
- 2-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device



Percent Twisted --------8%
Percent Slack ----------1%
Percent Not
Fully Retracting--------16%

RABBIT (Passive)

- 4-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device



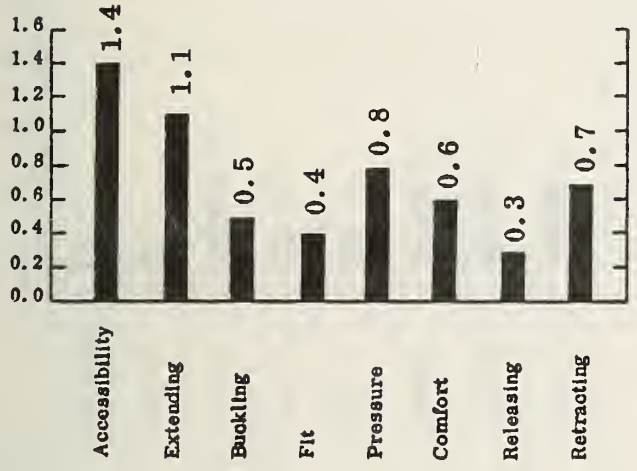
Percent Twisted -------16%
Percent Slack ----------3%
Percent Not
Fully Retracting *

*Not applicable for Passive Systems

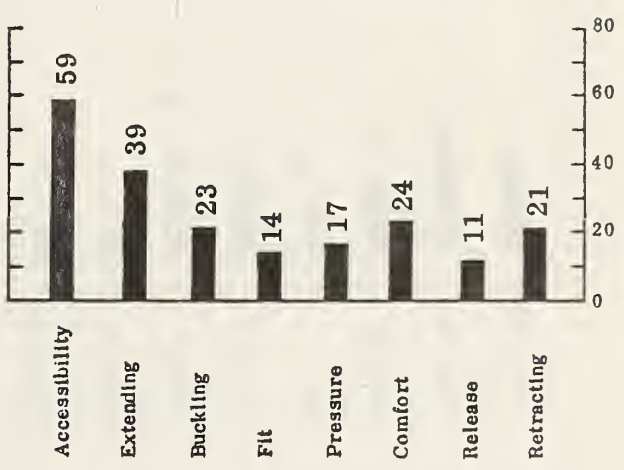
BMW 320i

- 2-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

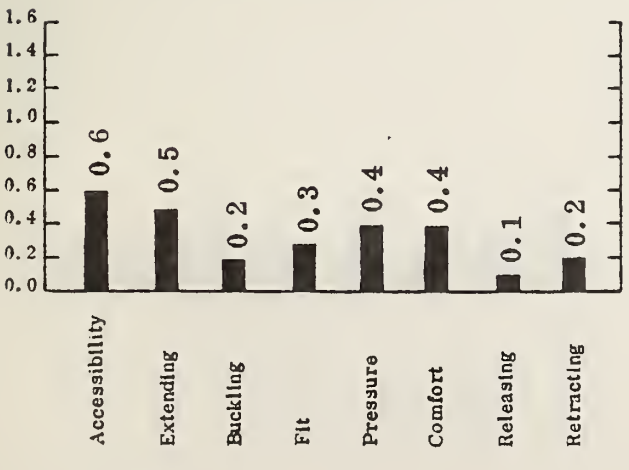


Percent Twisted ------- 20%
Percent Slack ---------- 2%
Percent Not
Fully Retracting -------47%

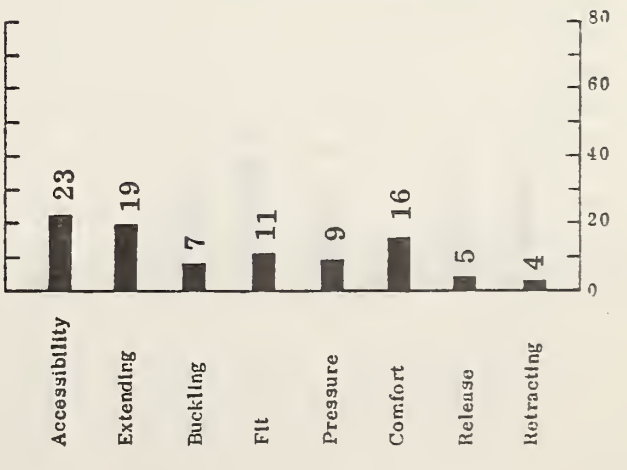
DATSUN B210

- 2-Door
- Bucket Seat
- Continuous Loop
- No Windowshade

Summated Rating



Percentage of Trials
With a Serious or Moderate Problem

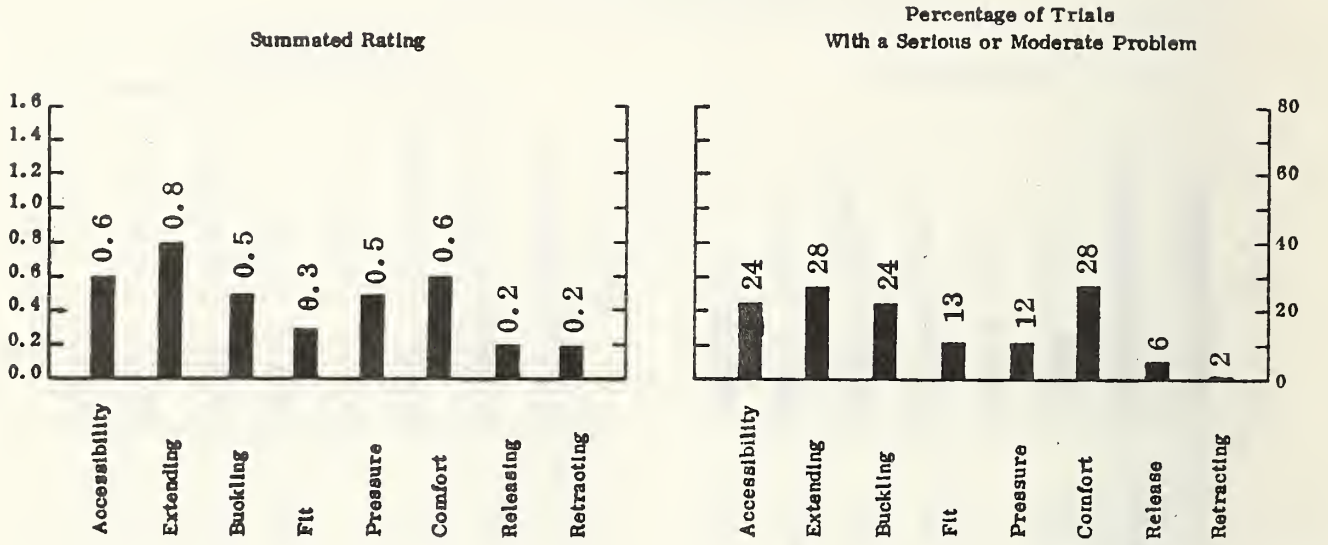


Percent Twisted ------- 10%
Percent Slack ---------- 1%
Percent Not
Fully Retracting ------ 25%

OTHER IMPORTED MODELS

FIAT BRAVA

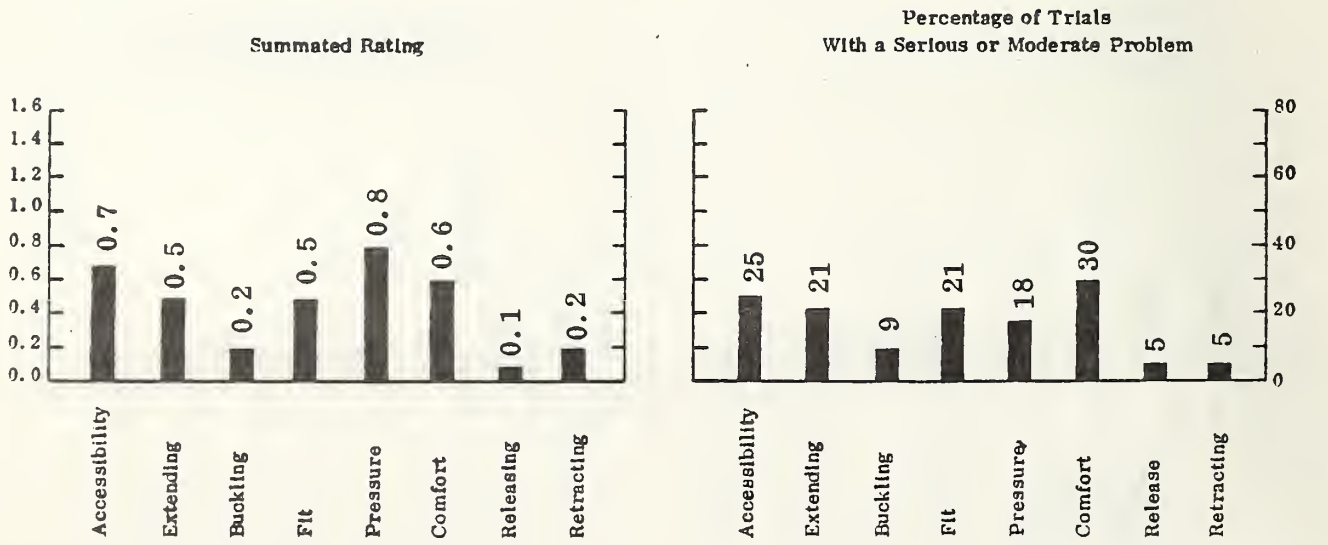
- 4-Door
- Bucket Seat
- Dual Retractor
- No Windowshade Device



Percent Twisted ------ 18%
Percent Slack ---------- 2%
Percent Not
Fully Retracting -------- 3%

HONDA CIVIC

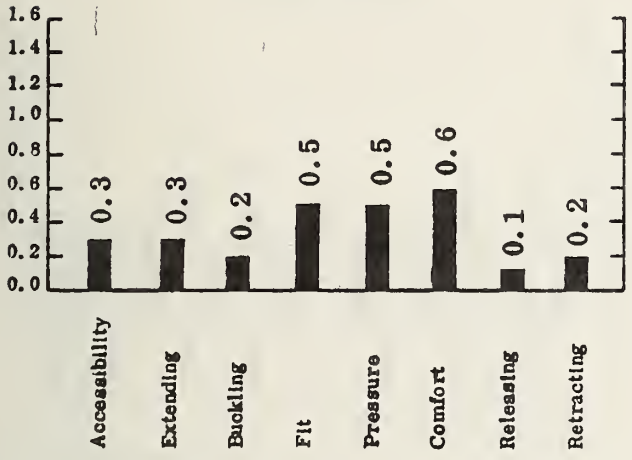
- 2-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device



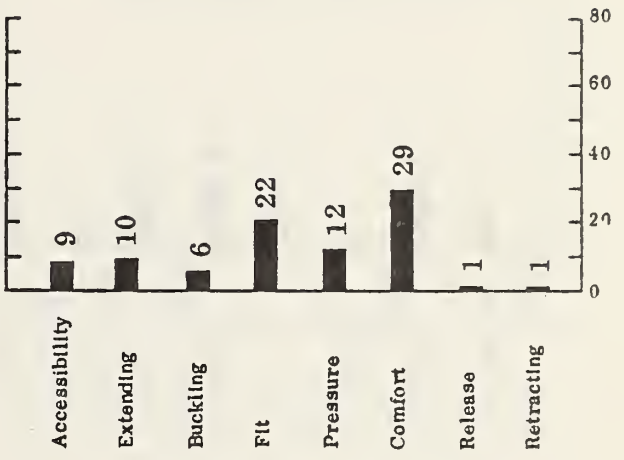
Percent Twisted -------15%
Percent Slack ---------- 3%
Percent Not
Fully Retracting -------10%

MAZDA GLC
- 4-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device

Summated Rating



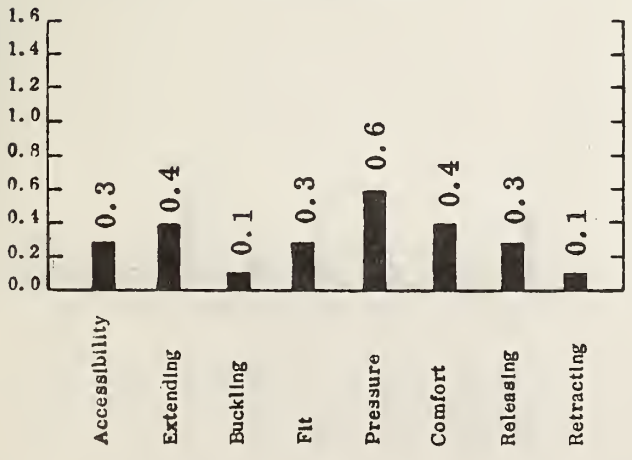
Percentage of Trials
With a Serious or Moderate Problem



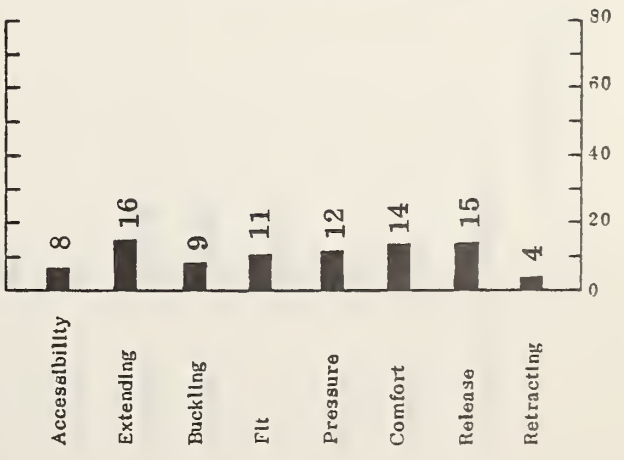
Percent Twisted -------16%
Percent Slack ----------2%
Percent Not
Fully Retracting-------10%

MERCEDES 300D
- 4-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device

Summated Rating

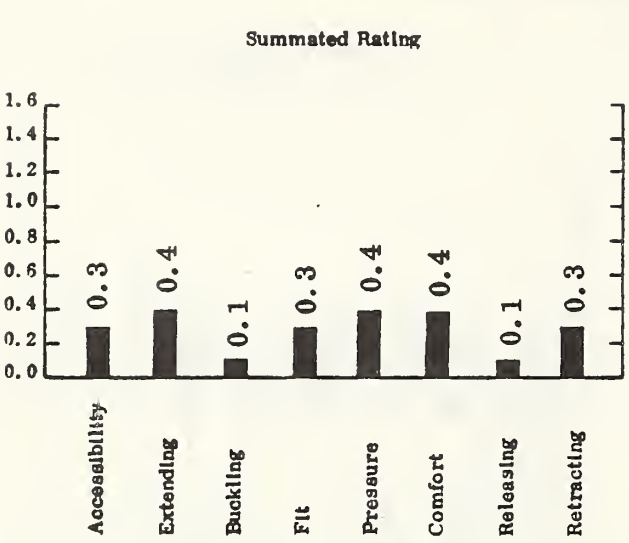


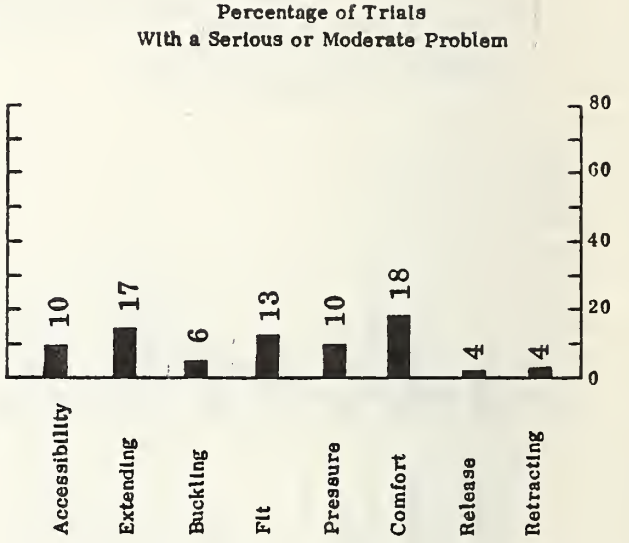
Percentage of Trials
With a Serious or Moderate Problem



Percent Twisted-------15%
Percent Slack----------1%
Percent Not
Fully Retracting -------20%

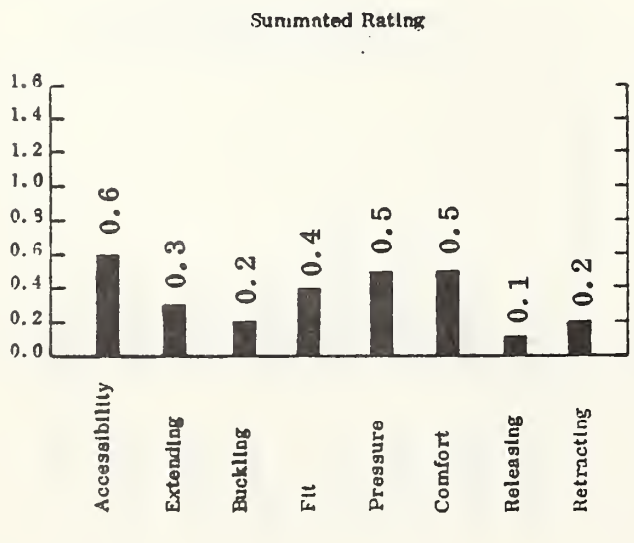
SUBARU
- 4-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device

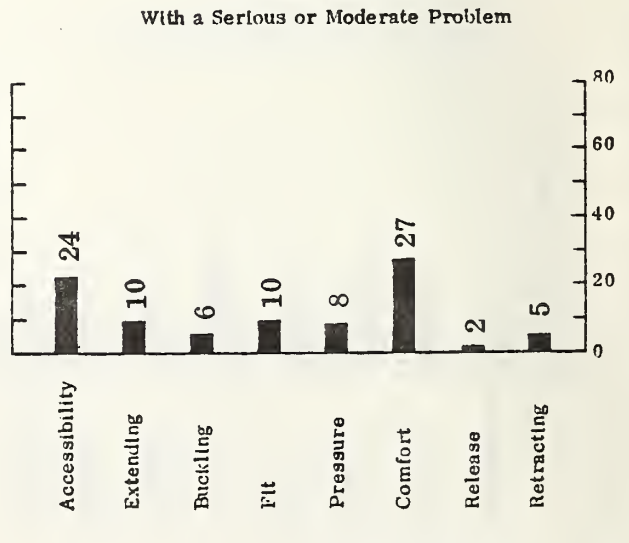




Percent Twisted -------13%
Percent Slack ---------- 2%
Percent Not
Fully Retracting ------- 5%

TOYOTA COROLLA
- 2-Door
- Bucket Seat
- Dual Retractor
- No Windowshade Device

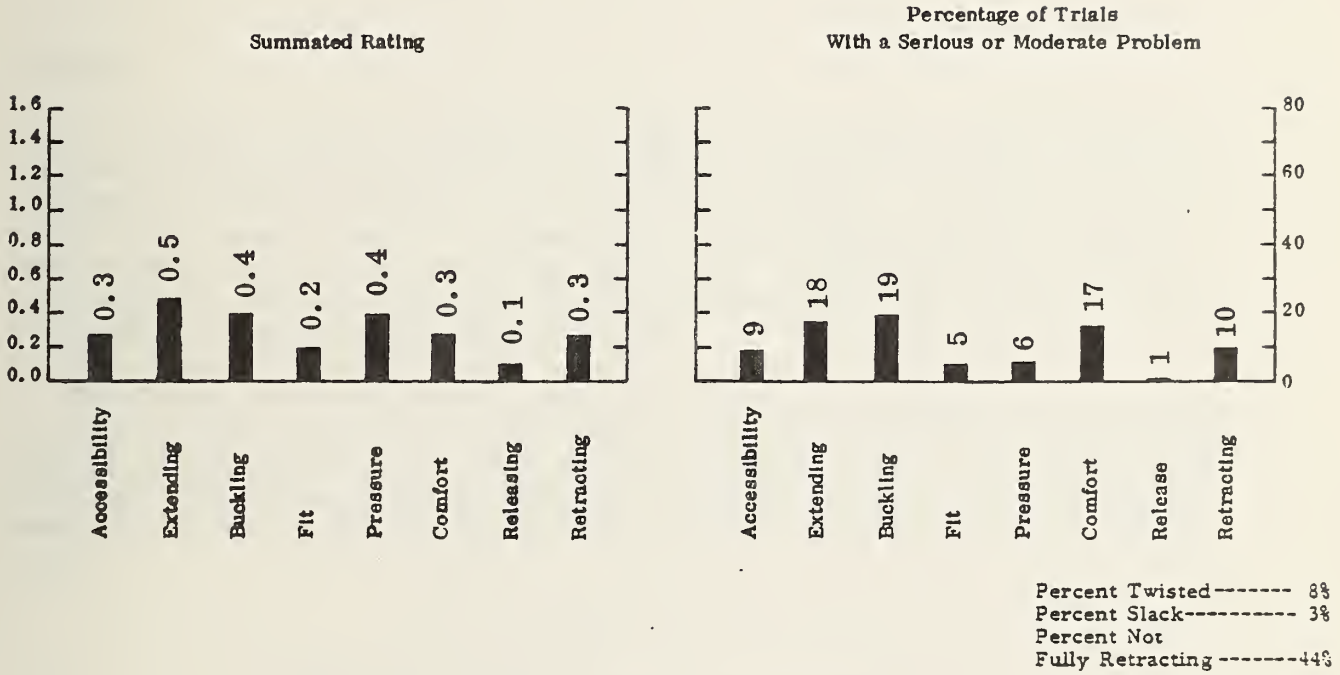




Percent Twisted 3%
Percent Slack 3%
Percent Not
Fully Retracting 4%

VOLVO 244DL

- 4-Door
- Bucket Seat
- Continuous Loop
- No Windowshade Device



Percent Twisted------- 8%
Percent Slack---------- 3%
Percent Not
Fully Retracting -------44%

APPENDIX D

FOCUS PANEL REPORT

OVERVIEW

It is sometimes useful to conduct intensive research among small groups of persons to get in-depth responses to issues or questions. This approach is called focus group research or in-depth interviewing. The goal of a focus group is to obtain answers to questions in an atmosphere that is spontaneous, non-evaluative and non-threatening. There are usually 8-12 participants and a trained moderator to ask the questions. The session usually lasts about 2 hours and is tape recorded.

To obtain some qualitative information about the comfort and convenience of safety belts, two focus groups were conducted at the conclusion of four days of in-car testing with 19 volunteers from the pool of 114 participants. Figure D-1 describes the participants in each of the two sessions. This Appendix discusses some of the main findings in those focus panel discussions.

Figure D-1

FOCUS PANEL PARTICIPANT CHARACTERISTICS

PANEL A	PANEL B
10-12 AM	2-4 PM
8 women	5 women
2 men	4 men
Age range 28-70	Age range 20-60
3 were average height	2 short women
5 were short	4 tall men
2 were tall	3 tall women

General Comment about the Test

Remarks about the test in general were varied. Most were surprised at the variety of safety belt systems in the thirty cars they tested. Participants indicated that they were enlightened and had "learned a lot" about safety belts; particularly about how to recognize and operate belts with a window shade device and about the passive restraint system which they found especially appealing and interesting. Several participants said they would look at safety belt comfort and convenience aspects when they shop for a new car.

Comments about Safety Belts

Many comments were made about the passive systems. Although, as one participant put it, the system "can be intimidating" at first glance, the group as a whole liked the system. The concept of the passive system in general was praised since several participants insisted that they would not wear a system that they themselves had to buckle. In other words, passive systems were received favorably. Criticism centered on the system's "intimidating" appearance, on the inability to adjust the belt to a higher or lower position, and on the advisability of the passive systems for small children. When asked "What was your favorite safety belt in the test," many cited "the passive system" for these reasons:

- Most comfortable
- Didn't press or bind on the body
- Didn't feel confined
- Didn't have claustrophobic feeling

Other problems with safety belt systems that were mentioned included:

(1) In some cars the latch plate mounting location resulted in reach problems for people with a shorter arm length. With the seat moved forward the problem was even more severe.

(2) Some of the most appealing cars had the most uncomfortable belts. For example, tall, average and short people in the focus panels reported discomforts with the belt system in the Cutlass.

(3) Buckling is difficult in cars with bench seats. Even with the middle seat passenger eliminated, the buckle is difficult to locate.

(4) In larger cars with two doors, short people had difficulty finding the latch plate. The problem was less for 4-door cars.

(5) Comments about passive systems led to a discussion about "scooting out" from under the safety belt in a crash. Participants, apparently unfamiliar with the knee pad aspect of crash protection, felt that lap belts should be included to give better protection.

Best and Worst Safety Belt Systems

When asked which system they thought was the worst or the best and why, the answers were as follows:

WORST	WHY
Fiat	Difficulty reaching latch plate. Had to get out of car to grasp it (5'9" female)
Camero	Difficulty in locating latch plate (6' male)
Cutlass	People representing a variety of anthropometric sizes had difficulty with the webbing curting across the neck. It was jokingly referred to as the "choker."
Pacer	Couldn't reach glove box with belt on
BMW	Uncomfortable seats and measurement seat belts

BEST	WHY
Passive Systems	The system would not require the wearer to remember to don it.
Volvo	Comfortable, easy
75 Impala	Most comfortable - most familiar

Windowshade Devices

In talking about the windowshade device the consensus was that both panels like it because it could be "adjusted to your comfort" in order to remove the excess pressure against the chest. Participants admitted that they had not previously known what the device was and how to use it. Once they learned how to operate the windowshade, they thought it was one of the best devices on the safety belt systems. Several older people commented that they didn't like shoulder belts, windowshade device or not.

Emergency Locking of the Belt Retractor

Participants did not understand how the belt could restrain them in a collision since they could pull on the webbing and it would not lock. Only one of the participants understood that sudden stops activate the safety system.

Suggestions for Improving Safety Belt Systems

The panel participants made the following suggestions for improving the system:

(1) Location of the buckle interfers with reaching across the car. The protruding design is not convenient. Buckles should be located to the side of the passenger versus center abdomen location.

(2) Allow one hand fastening of the latch plate into the buckle.

(3) The panel participants felt that thicker webbing would not twist and tangle as easily as the current thinner design.

(4) Safety belt systems should be made comfortable, better fit and less pressure. Belts should be made comfortable for different sized people.

(5) More cars should be equiped with passive systems.

General Comments

Other general comments included that "sturdier cars like back in the 50's" would be an improvement. However, safety features are not priority items to consider in purchasing a new car.

Interestingly, people admitted that they did not increase their usage of safety belts although they thought about wearing them.

When asked why only 18 percent of the U.S. population wear safety belts, the panel candidly responded with the following answers:

(1) Safety belts are uncomfortable.

(2) They are inconvenient.

(3) Many people haven't developed the habit of wearing them.

(4) People are too lazy to buckle up.

(5) It isn't a compulsory law.

APPENDIX E

DETAILED SUMMARY OF RESPONSES

This appendix contains a detailed summary of the responses to each question in the evaluation forms. The data contained in the table are numerical averages of all valid responses for each question for each test car. A list of the questions can be found in Appendix A, Test Instruments.

QUESTION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CONCORD	0.57	0.69	0.80	0.81	0.54	0.47	1.78	0.58	0.67	0.59	1.48	0.54	1.94	0.58	0.89	0.61	0.91	0.33	0.23	0.90	1.51
CHEVETTE(A)	0.48	0.77	0.95	0.91	0.14	0.19	1.79	0.58	0.61	0.59	0.63	0.34	1.94	0.90	1.10	0.65	0.89	0.10	0.07	0.48	1.24
OMNI	0.40	0.72	0.92	0.83	0.21	0.18	1.84	0.43	0.60	0.92	0.64	0.39	1.95	0.78	0.91	0.60	0.71	0.14	0.13	0.55	1.22
CHEVETTE(F)	0.71	0.68	0.19	0.18			1.90	0.19	0.25	0.25	1.03	0.19	1.94	0.71	0.68	0.32	0.53	0.28		0.78	
VOLARE	0.18	0.27	0.40	0.38	0.15	0.12	1.80	0.41	0.42	0.51	0.55	0.28	1.91	0.50	0.57	0.39	0.47	0.15	0.09	0.45	1.15
CAMARO	0.54	0.56	0.66	0.64	0.22	0.32	1.68	0.65	0.50	0.55	0.63	0.27	1.91	0.40	0.82	0.35	0.64	0.35	0.13	1.09	1.57
RABBIT(F)	1.09	0.96	0.32	0.33			1.82	0.05	0.22	0.29			1.95	0.45	0.62	0.33	0.45	0.39		0.77	
VOLVO 244DL	0.20	0.32	0.46	0.48	0.54	0.35	1.92	0.10	0.27	0.35			1.97	0.24	0.32	0.33	0.45	0.07	0.04	0.31	1.44
TOYOTA COROLLA	0.72	0.47	0.31	0.31	0.15	0.17	1.92	0.30	0.45	0.50			1.97	0.50	0.69	0.32	0.64	0.08	0.03	0.21	1.04
MAZDA GLC	0.24	0.30	0.36	0.34	0.14	0.30	1.84	0.50	0.50	0.52			1.98	0.50	0.65	0.45	0.81	0.09	0.09	0.20	1.10
HONDA CIVIC	0.70	0.75	0.55	0.52	0.20	0.21	1.85	0.42	0.59	0.82			1.97	0.46	0.70	0.54	0.89	0.16	0.12	0.23	1.10
FIAT BRAVA	0.63	0.65	0.82	0.77	0.34	0.66	1.82	0.21	0.47	0.54			1.98	0.70	0.62	0.41	0.52	0.22	0.21	0.15	1.03
MERCEDES 300D	0.26	0.27	0.50	0.39	0.08	0.19	1.85	0.13	0.49	0.56			1.99	0.35	0.52	0.34	0.58	0.51	0.06	0.14	1.20
IMPALA 78	0.23	0.39	0.62	0.61	0.09	0.15	1.79	0.26	0.24	0.27	0.30	0.14	1.90	0.37	0.39	0.28	0.41	0.04	0.07	0.47	1.19
CORDOBA	0.32	0.35	0.42	0.42	0.12	0.15	1.87	0.86	0.63	0.73	0.65	0.42	1.96	0.69	1.09	0.53	0.78	0.11	0.09	0.50	1.29
CUTLASS	0.35	0.39	0.46	0.43	0.09	0.13	1.91	1.91	1.18	1.07	0.48	0.58	1.93	1.05	1.70	0.77	1.24	0.11	0.08	0.70	1.20
PACER	0.76	0.82	0.99	0.95	0.21	0.47	1.69	0.64	0.50	0.59			1.90	2.28	1.57	0.93	1.09	0.10	0.07	0.21	1.17
RABBIT(A)	0.74	0.75	0.96	0.78	0.45	0.70	1.92	0.35	0.81	1.03			1.99	0.75	0.92	0.66	0.96	0.71	0.32	0.28	1.15
SUBARU	0.30	0.29	0.50	0.39	0.07	0.20	1.87	0.20	0.40	0.45			1.98	0.34	0.50	0.36	0.54	0.10	0.06	0.25	1.05
BMW 320I	1.53	1.37	1.11	1.01	0.46	0.58	1.80	0.21	0.65	0.78			1.98	0.52	0.69	0.49	0.74	0.31	0.26	0.73	1.47
PINTO	0.92	0.83	0.62	0.54	0.21	0.18	1.69	0.59	0.56	0.59			1.97	0.68	0.78	0.56	0.95	0.03	0.04	0.37	1.25
DATSUN B210	0.56	0.58	0.54	0.50	0.15	0.20	1.90	0.23	0.38	0.42			1.99	0.29	0.38	0.28	0.45	0.18	0.12	0.25	1.25
LTD II	0.54	0.62	0.82	0.68	0.16	0.45	1.82	0.59	0.57	0.53			1.98	1.33	1.30	0.78	1.16	0.02	0.04	0.25	1.08
MUSTANG	0.55	0.69	0.77	0.61	0.11	0.12	1.79	0.29	0.54	0.55	0.94	0.36	1.82	0.68	0.79	0.54	0.65	0.13	0.12	0.80	1.49
FAIRMONT	0.30	0.39	0.39	0.39	0.13	0.27	1.82	0.22	0.31	0.35			1.99	0.39	0.45	0.33	0.53	0.07	0.04	0.18	1.05
COUPE DE VILLE	0.25	0.14	0.21	0.15	0.05	0.11	1.71	0.55	0.30	0.34	0.37	0.17	1.87	0.37	0.67	0.40	0.62	0.03	0.04	0.32	1.29
ST REGIS	0.35	0.54	0.82	0.74	0.24	0.35	1.83	0.17	0.47	0.50	0.73	0.29	1.93	0.88	0.79	0.54	0.64	0.19	0.15	0.47	1.10
IMPALA 75	0.32	0.26	0.32	0.26	0.17	0.13	1.89	0.72	0.54	0.55			1.94	0.95	0.84	0.40	0.68	0.07	0.05	0.16	1.05
GRANADA	0.23	0.32	0.47	0.42	0.07	0.07	1.88	0.14	0.40	0.44	0.75	0.15	1.90	0.52	0.46	0.33	0.45	0.04	0.04	0.45	1.17
LTD	0.31	0.49	0.74	0.66	0.28	0.31	1.80	0.23	0.38	0.54	0.87	0.42	1.87	0.83	0.72	0.40	0.47	0.07	0.08	0.37	1.17