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Behavioural Evaluation of Child Restraint System (CRS) Label/Warning Effectiveness

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1. ABSTRACT

Transport Canada is in the process of updating its standard for the adhesion properties of child restraint system (CRS) labels and warnings. At the same time, the U.S. National Highway Traffic Safety Administration (NHTSA) has proposed changes intended to make CRS labels and instructions clearer and simpler to understand. Transport Canada is very supportive of this objective, and is also considering amending its label requirements. Based on a passive evaluation of CRS labels, NHTSA made a number of proposed changes to their existing label requirements. To complement these passive evaluations, the present study compared the effectiveness of four different CRS label conditions on actual users' CRS installation behaviour. The four label conditions included: 1) no labels, 2) the manufacturer labels ('Consumer'; these labels conform to the current requirements for labeling of the Canadian Motor Vehicle Safety Standards (CMVSS), which are very similar to the current U.S. Federal Motor Vehicle Safety Standards (FMVSS) requirements), 3) labels designed according to a combination of the NHTSA current regulations and their proposed changes ('NHTSA'), and 4) labels based on a behavioural task analysis that were designed according to human factors principles and guidelines ('Optimal').

Results demonstrated that, overall, the Optimal labels resulted in higher usability ratings and better task performance. This indicates that labels designed using human factors principles and hierarchical task analyses that identify critical task information requirements for label features will result in increased user compliance with instructions, higher usability, and improved task performance. Results from the study also demonstrate that label design can decrease task performance, and that the actual design of a CRS may be more critical than label content in the choices it affords the user.

Results of the study suggest that implementation of the recommended changes to the U.S. FMVSS concerning CRS labeling would likely not result in increased performance or usability compared to existing consumer labels that follow the current FMVSS guidelines. In order to achieve significantly better ease-of-use and task performance, it would be necessary to implement features of the Optimal label condition.

2. INTRODUCTION

Transport Canada has investigated some of the factors that contribute to the misuse/non-use of child restraint systems (CRS). Based on these investigations, a CRS universal anchorage system was developed that improves ease-of-use and correct installation of a CRS in a vehicle (Pedder et al., 1994). These investigations have been supplemented by additional research on the correct placement of a child in the CRS and the type of harness used (Rudin-Brown et al., in press). Within this program of research an unexplored issue is the comprehensibility and effectiveness of warnings and labels that are directly affixed to a CRS. These labels/warnings can provide information to the user about (a) the correct installation of the CRS into a vehicle and (b) the correct installation of the child in a CRS.

Transport Canada is currently in the process of updating its standard pertaining to the physical characteristics of CRS labels and warnings. As part of that effort, the present study focused on the impact of label content and design on the behaviour of CRS users.

3. PURPOSE AND SCOPE OF THE STUDY

The purpose of the study was to evaluate and compare how well users install a CRS into a vehicle, and a child into a CRS, when four different types of labels/warnings, each differing in content, were affixed to the CRS.

4. GENERAL METHOD

4.1 RESEARCH DESIGN

A 2 (forward- *vs*. rear-facing; within-subjects) x 4 (label condition; between-subjects) mixed design was used to assess the effect of label content on CRS installation performance.

4.2 PARTICIPANTS

A total of 48 people participated in the study (12 per label condition). Fifty per cent of participants were female, and age was balanced across two age groups (20 to 39 *vs*. 40+ years). The ratio of experienced to inexperienced users was 2:1, reflecting the ratio of other-than-firstborn to firstborn births in Canada. An individual was considered an experienced CRS user if s/he had installed a CRS into a vehicle **and** a child into a CRS, both within the past two years. An individual was considered to be an inexperienced CRS user if s/he had **never** installed a CRS into a vehicle or a child into a CRS. Individuals who were professionally affiliated with any organization involved with CRSs or individuals with previous experience using the specific CRS used in the study were excluded. Participants were also required to specify whether they had normal or corrected-to-normal vision, and whether they had difficulties seeing colour; this was recorded for information purposes only and was not used as participant exclusion criteria.

Participants were recruited from a variety of sources, including newspaper advertisements, direct requests by phone and e-mail, flyers posted at the recreation complex where the study was performed, and flyers distributed to daycare centres around Ottawa. Participants were paid $30.00 for their time and received a video on CRS safety.

4.3 EQUIPMENT

The test CRS was a commercially available, convertible, 5-point harness design. It was inspected prior to the start of the study to ensure that all functions, straps, and harnesses were in proper working order. This specific CRS was selected because, in a previous study comparing four CRS harness designs (Rudin-Brown et al., in press), users perceived it as having the easiest harness to use, while it also resulted in the most installation errors. If alternative labels could be designed that improve performance, it was assumed that any improvement should be most apparent on a CRS that had previously shown high error frequency rates, such as this one.

An infant (6-month; 8 kg/17.6 lbs) and a child (18-month, 11kg/25 lbs) crash test dummy were used for the experimental trials. Both crash test dummies were equipped with an age and weight identifier label. The dummies were dressed in diapers and lightweight clothing.

The test rig within which the participants were required to install the CRS was the back seat of a 1998 Pontiac Grand Prix that did not have any doors or a roof (Figure 1). It was inspected prior to the study to ensure that the safety belts were working properly, and that a tether strap anchor was installed on the rear window shelf.

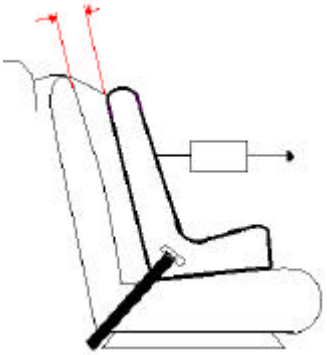
Figure 1. Vehicle test rig.

Each participant completed the study using one of the four label conditions. In the No labels condition, the Consumer labels were masked by black construction paper. In the Optimal and NHTSA conditions, the labels were affixed to their appropriate location with Velcro. Velcro was used so the labels could be easily and quickly attached to, and removed from, the CRS. The Optimal and NHTSA labels were printed in colour on white paper and were laminated to increase durability. The content and locations of the Consumer, NHTSA, and Optimal labels on the CRS are illustrated in Appendix A.

A variety of measuring devices were used to obtain CRS error measurements. Harness slack was measured using wooden dowels (1.59 cm or 5/8" dowel=1 finger, 3.2 cm or 1 ¼" dowel=2 fingers, 4.8 cm or 1 7/8"=3 fingers, 6.35 cm or 2 ½" dowel for four fingers or more). Vehicle seatbelt slack, tether slack and the space between the CRS base and the vehicle cushion (for rear-facing CRS installation) were measured using 2.54 cm (1") through 15.24 cm (6") wooden spacers. A spring-type fish scale (Figure 2) was used to assist in determining vehicle seatbelt slack; 5.5 kg (12 lbs) of force was used to pull the CRS forward, away from the vehicle seat, while a wooden spacer was used to measure the distance between the vehicle seat and the CRS (Figure 3).

Figure 2. Spring-type fish scale used to measure seat belt slack.

Figure 3. Method to measure seat belt slack.



The study took place at the Nepean Sportsplex, a recreation centre located in Ottawa. Barriers were placed around the testing site in order to minimize participant distraction. All experimental trials were videotaped.

4.4 PROCEDURE

Prior to the study, participants were briefed on the nature of the experiment and were informed of their right to withdraw from the experiment at any time. Participants completed two experimental trials: one using the infant (6-month) test dummy and one using the child (18-month) test dummy. For each trial, participants installed the CRS into the vehicle and then installed and secured the test dummy into the CRS. Twenty-four participants performed the first trial using the infant dummy and the other 24 participants completed the first trial using the child dummy. The label condition assigned to each participant was predetermined. Each experimental session lasted approximately 90 minutes.

Upon commencement of the trial, participants were instructed to become familiar with the CRS and the test dummy that they were presented with. Each participant was allowed to spend as much time as they felt necessary to become familiar with the CRS and make any necessary adjustments prior to the installation tasks. Participants informed the observer when they were ready to proceed.

Participants were instructed to install the CRS into the right seat of the vehicle mock-up. They were informed that the vehicle was a 1998 sedan. The model year was pointed out because the Optimal labels indicated that all 1994 model year vehicles and newer do not require the use of a locking clip on the vehicle seat belt because these vehicles are equipped with an Automatic Locking Retractor (ALR), while pre-1994 vehicles do require a locking clip. Instructions on how to use the ALR were included in the vehicle's owner manual, which was provided to all participants. Participants were instructed to install the CRS as effectively as possible, imagining that it was for their own child. Participants informed the observer when they were ready to proceed to the child (dummy) installation task.

Participants were then required to secure the infant or child dummy into the CRS. The participants were instructed to imagine that they were securing their own child into the restraint. Participants informed the observer when they had completed this task.

Upon completion of each trial, participants completed a *Subjective Questionnaire* that assessed how easy they found each task to complete and how confident they were that they had performed each task correctly. At the same time, an observer measured and recorded all CRS and child installation errors using an *Evaluation Checklist*. After both trials, participants completed two additional subjective questionnaires: one that related to overall label usability and another that pertained to user confidence in task performance. Once participants had completed both questionnaires, they were briefed in more detail regarding the purpose of the study and were permitted to ask any questions or voice concerns. If required, the observer also provided the participants with information concerning their own CRS and child installation errors. An example of a *Subjective Questionnaire* and an *Evaluation Checklist* are included in Appendix B.

4.5 SEVERITY SCORES

The severity of potential 'CRS-in-vehicle' and 'child-in-CRS' usability errors was adapted from Noy and Arnold (1995) and Rudin-Brown, Kumagai, Angel, and Iwasa-Madge (in press) using Czernakowski and Müller's (1991; 1993) MMEA procedure. Three subject matter experts with backgrounds in CRS forensics and usability were asked to rate, on a scale from 0 to 10, an error's probable effect on safety, with 10 indicating the most negative effect. Final severity scores for each potential error were determined by averaging the subjective, independent ratings of all experts. Severity scores of four or more are considered unacceptable, and will likely compromise the effectiveness of a CRS in the event of a collision (Czernakowski & Müller, 1993). The severity scores for the 'CRS-in-vehicle' and 'child-in-CRS' usability errors are shown in Table 1. Some 'CRS-in-vehicle' usability errors had not been previously associated with severity scores (tether strap twist, shoulder belt twist, lap belt twist, seatbelt routed incorrectly-forward facing condition), as well as one 'child-in-CRS' error (shoulder harness bar not locked), and so are not included in the Table.

Table 1. 'CRS-in-vehicle' and 'Child-in-CRS' severity scores.

CRS-in-Vehicle		
Error	**Forward Facing**	**Rear Facing**
Tether Strap Twist		
Tether Strap Slack 1"	1	
Tether Strap Slack 2"	3	
Tether Strap Slack 3"	3	
Tether Strap Slack 4"	3	
Tether Strap Slack 5.5" or greater	8	
Shoulder Belt Twist		
Lap Belt Twist		
Seatbelt Routed Incorrectly		9
Seatbelt not Buckled	6	7
Space Btw. Seat Back (FF) or Front (RF) and Vehicle Cushion 1"	2	1
Space Btw. Seat Back (FF) or Front (RF) and Vehicle Cushion 2"	4	3
Space Btw. Seat Back (FF) or Front (RF) and Vehicle Cushion 3"	5	4
Space Btw. Seat Back (FF) or Front (RF) and Vehicle Cushion 4"	6	5
Space Btw. Seat Back (FF) or Front (RF) and Vehicle Cushion 5"	6	6
Space Btw. Seat Back (FF) or Front (RF) and Vehicle Cushion 6"	6	7
Child-in-CRS		
Error	**Forward Facing**	**Rear Facing**
Recline Position Inappropriate	4.6	3
Five-Point Harness Buckle not Attached	10	10
Chest Clip not Attached	2	2.3
Chest Clip Level too High	2.5	2.5
Chest Clip Level too Low	1.5	2
Shoulder Harness Bar not Locked		
Shoulder Harness Level too High	1.7	6.3
Shoulder Harness Level too Low	2.3	2.3
Harness Tightness is Wrong (2 Fingers)	1.3	1.7
Harness Tightness Wrong (3 Fingers)	3.7	4.3
Harness Tightness Wrong (> 4 Fingers)	6.3	6.7
Shoulder Harness Strap Twist	1.3	2.7
Crotch Strap Twist	3.5	3.5

4.6 RISK PRIORITY NUMBER (RPN)

The RPN is a composite measure of a potential error's severity score and the frequency with which the error actually occurs during testing. Typically, this number is derived using a subjective scale similar to the severity score rating scale, with 0 representing 'no misuse' and 10 representing 'misuse almost inevitable' (ISO, 1999). In the present study, however, the RPN was based on an actual count of the number of participants demonstrating a particular error, and did not depend on a subjective rating. In order to be able to compare results to other studies, the number of participants was normalized to n=100. By doing this, an RPN value for each error could potentially range from 0 to a maximum of 1000, if 100% of participants committed an error of severity 10.

It is important to note that some 'CRS-in-vehicle', and one 'child-in-CRS', usability errors were not previously associated with severity scores (tether strap twist, shoulder belt twist, lap belt twist, seatbelt routed incorrectly-forward facing condition; shoulder harness bar not locked). Therefore, these errors are not reflected in the calculated RPN values. This is ultimately a limitation of the analysis of the CRS, however, these errors were considered through a general frequency analysis.

4.7 STATISTICAL ANALYSIS

Descriptive statistics were calculated for the purposes of a general usability analysis, as was the percentage of correct installations relating to the installation of the CRS in the vehicle, and of the child into the CRS. Although the study was designed so that each participant had an opportunity to install the infant dummy rear-facing and the child dummy forward-facing, a large number of participants did not correctly associate the infant test dummy with a rear-facing CRS configuration. This resulted in the rear-facing condition sample size being too small to conduct statistical analysis on some of the data.

Where appropriate, individual one-way analyses of variance (ANOVAs) were performed on the data. An alpha level of .05 was used to determine statistical significance.

5. RESULTS AND DISCUSSION

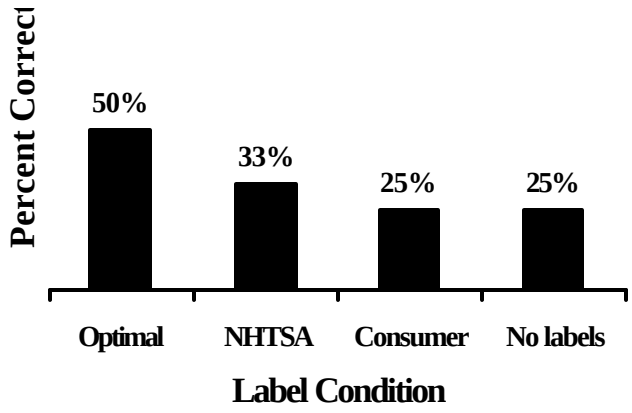
5.1 TASK PERFORMANCE

5.1.1 Decision to Install CRS Forward- vs. Rear-Facing

The participants' first key decision during the experimental trial was to determine whether the CRS was to be installed forward- or rear-facing, depending on the test dummy presented. The CRS for the 6-month dummy should have been installed rear-facing while the CRS for the 18-month dummy should have been installed forward-facing.

There was a strong tendency for participants to install the CRS into the car in the forward-facing direction for both the infant and the child (Figure 4), even though all labels clearly indicated that child size determines the direction of installation. In the No label condition, participants did not receive any visual feedback to aid their decision, however, the Consumer, NHTSA, and Optimal labels all specified that infants were to be installed rear-facing, and children, forward-facing.

Figure 4. Percentage of participants who correctly chose to install the 6-month infant test dummy rear-facing.



As each of the three label conditions contained information that specified CRS orientation for an infant (rear-facing) and a child (forward-facing), it is interesting to note such a low level of correct performance. To investigate this further, a literature review was conducted that focused on consumer product label compliance, including research on whether consumers read product labels, and what factors influence whether a product label will be read. The literature review revealed that the likelihood a user will read warnings decreases as a user's familiarity with a product increases; as familiarity reduces a user's perceived hazard associated with product use (Ortiz, Redneck, and Kingston 2000; Braun, Holt, and Sliver 1995; Godfrey and Laugher 1984; Godfrey, Allender, Laughery, and Smith 1983). Since CRS experience in the current study was controlled with a 2:1 experienced to inexperienced ratio, this may have played a role in not following the rear-facing label instructions. In addition, several of the experienced participants indicated that they had previously used a designated infant restraint system when their children were infants, and subsequently placed them into a forward-facing CRS when they outgrew it. Thus, several participants did not have previous experience with a convertible CRS, resulting in them viewing the CRS as one that is used only in the forward-facing direction.

The label compliance literature also addressed the effects of label colour. One study determined that orange was perceived as a greater hazard than blue (Cheatham and Wogalter, 1999), while another indicated that red was interpreted by readers as indicating the greatest level of perceived hazard, followed by orange, black, green, and blue (Shaver and Braun, 2000). The Optimal labels used orange for the forward-facing condition (NHTSA used red) and blue as the rear-facing condition (as per the proposed NHTSA guideline changes), which may have influenced participants to focus more attention on the forward-facing instructions, rather than on those specified for the rear-facing configuration.

DeJoy (1989) assessed the effectiveness of consumer product warnings, and found that many people who notice warnings do not actually read them. Further, if people do read product warnings, they often fail to take the recommended precautions. The data from the literature review was summarized according to the percentage of participants who noticed, read, and complied with warnings, and is repeated here in Table 2.

Table 2. Consumer product label compliance (from DeJoy 1989).

	Notice Warning	**Read**	**Complied**
Friedmann, 1988	88%	46%	27%
Otubso, 1988	64%	39%	26%
Strawbridge, 1986	91%	77%	37%
Average	**81%**	**54%**	**30%**

Comparing the data in Table 2 with the current findings, the Consumer and NHTSA label conditions resulted in what appears to be typical compliance levels (25% and 33%). The Optimal condition increased compliance above typical levels to 50% indicating that, with this label design, half of the participants correctly made the key decision regarding the orientation of the CRS in relation to child age and weight. The Optimal label that specifies CRS orientation used a pictogram along with text to convey this message instead of simple text alone (as in the NHTSA and Consumer conditions). As well, the rear- and forward-facing orientation labels were located on the front of the CRS to increase the probability of detection.

5.1.2 Percentage of Correct Installations

One measure of CRS usability is the percentage of installations ('CRS-in-vehicle' and 'child-in-CRS') that are performed correctly. To derive this measure for each label condition and seat direction, the severity scores for all of the usability errors that occurred during each participant's installation were evaluated. A CRS was considered correctly installed if there were no errors having a severity score of four or more. An 85% criterion value was chosen to represent acceptable label performance, based on the requirements of ISO test procedure 13215-2 (Requirements and Test Procedures for Correct Installation; 1999), wherein a CRS is considered acceptable if at least 85% of the installations are performed correctly.

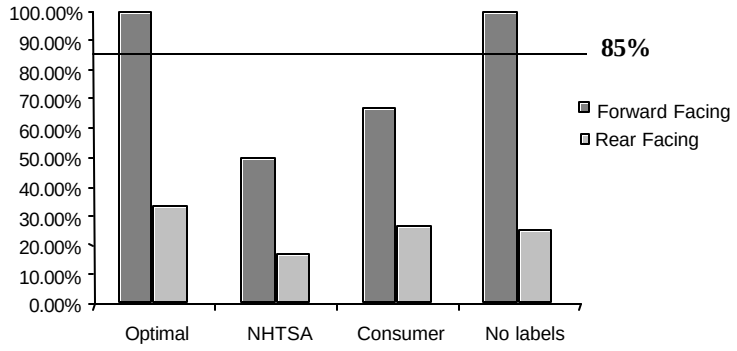
5.1.2.1 CRS-in-Vehicle

The percentage of correct installations of the CRS in the vehicle was computed per label condition for both forward- and rear-facing conditions (Figure 5). The No labels and Optimal conditions demonstrated the best performance in the forward-facing mode, and were the only two conditions that met the 85% criterion. The Optimal condition resulted in the best performance rear-facing, but with only 33% of installations being performed correctly.

These results indicate the following three important findings:

1. Optimal label design resulted in higher levels of performance than the other conditions.
2. Because of the visual clues provided by certain features of the CRS (such as where the seat belt is to be routed), CRS design appears to be a critical influence on task performance (as the No labels condition demonstrated good performance)
3. Label design can interfere with task performance, as illustrated by lower performance levels in the NHTSA and Consumer conditions compared to the No labels condition.

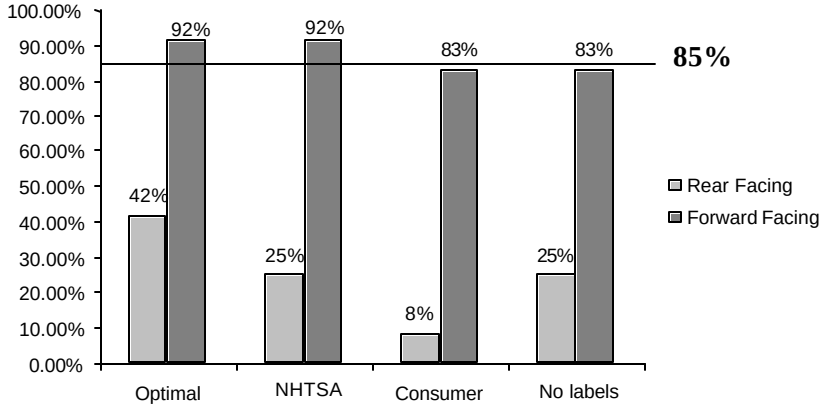
Figure 5. Percentage of correct installations (CRS-in-vehicle)



5.1.2.2 Child-in-CRS

The percentage of correct child (dummy) installations was computed per label condition for both forward- and rear-facing conditions. These data are presented in Figure 6, illustrating that all four label conditions approached or exceeded the criteria of 85% correct for forward-facing, while none met the threshold for rear-facing.

Figure 6. Percentage of correct installations (child-in-CRS).



It is noteworthy that the Consumer label condition resulted in 83% correct installations forward-facing and 8% correct installations rear-facing, compared to 85% and 11%, respectively, for the same CRS and labels in a previous study (Kumagai et al., 2000; Rudin-Brown et al., in press). In the current study, the NHTSA and Optimal labels improved performance beyond the Consumer condition to a 92% correct installation level for the forward-facing condition, and the Optimal labels increased rear-facing performance to a 42% correct installation level.

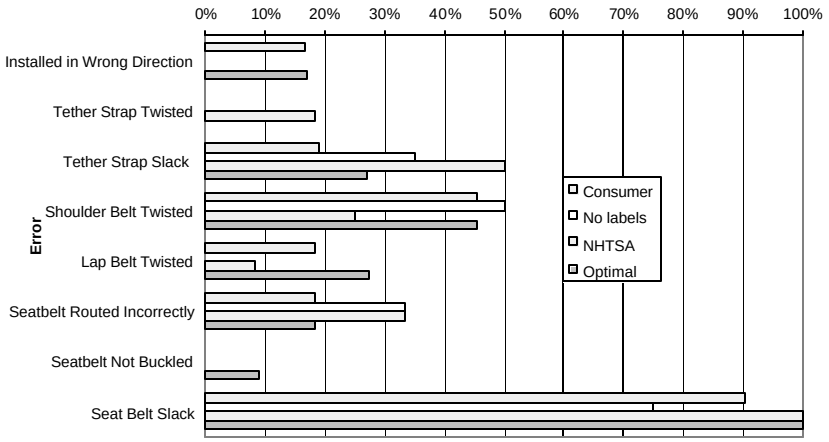
It is equally noteworthy that having no labels affixed to the CRS resulted in an increase in performance over the Consumer label condition for rear-facing, and equal performance when forward-facing. This finding reinforces the suggestion that CRS design is critical and that label design can degrade task performance.

5.1.3 Error Frequencies

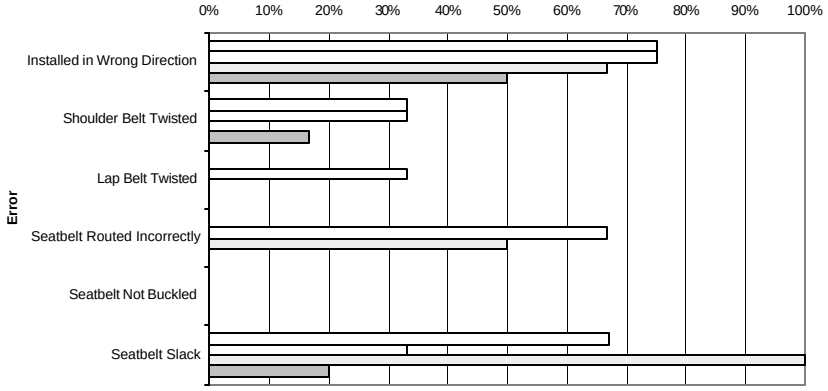
Figure 7 outlines 'CRS-in-vehicle' error frequencies for forward- (a) and rear-facing (b) configurations. The two errors in which the Optimal labels resulted in similar, instead of reduced, error frequencies when compared to the other three label conditions forward-facing are shoulder belt/lap belt twist and vehicle belt slack. The removal of seatbelt twist (shoulder and lap) was not illustrated on the Optimal labels; it was left to the judgment of the participants whether twist in the vehicle belt compromises CRS safety. During the experimental trials, some participants stated that they were aware of the twist in the vehicle belt, however, they felt that a twist in the vehicle belt was of no concern as long as the vehicle belt was buckled. On the same note, participants indicated that twist in the vehicle belt would likely affect a child's comfort level, however, it is possible that there was no effort to fix the error since a crash test dummy and not a real child was used during the trial.

Figure 7. Error Frequency: CRS-in-vehicle (a) forward-facing; (b) rear-facing.

(a)



(b)



The Optimal labels resulted in 100% error for 'seat belt slack' in the forward-facing configuration, which is the same as the NHTSA condition and slightly higher than the Consumer and No labels conditions. Although the use of a locking clip or the vehicle's ALR to remove belt slack was identified on the Optimal labels, participants continuously failed to perform the function properly. Upon discussing this error with the participants, several indicated that they knew the CRS was not properly secured, but they did not know how to tighten the slack, even though they were aware of the slack removal directions on the label. Participants indicated that they were not familiar with the locking clip and had never used a clip before. Participants also mentioned that they were confused with the ALR terminology (on the labels and in the vehicle's user

manual), and several participants did not notice the vehicle user manual that was provided to them (which specified how to use the ALR). The observers noted that some participants initially used the ALR properly, but then unbuckled the vehicle belt to perform other tasks and consequently forgot to re-engage the ALR when re-securing the CRS.

It is important to note that the Optimal labels resulted in better performance (>10%) than the No labels and NHTSA conditions for proper routing of the vehicle seat belt. This error is viewed as safety critical, as an improper routing can result in the CRS rotating, extending and swaying a fair distance from the vehicle seat. Improved performance in the Optimal condition likely resulted from the seatbelt routing arrow indicators that were affixed to the CRS; several participants indicated on the label usability questionnaire that the arrow indicators were easy to understand and aided task performance.

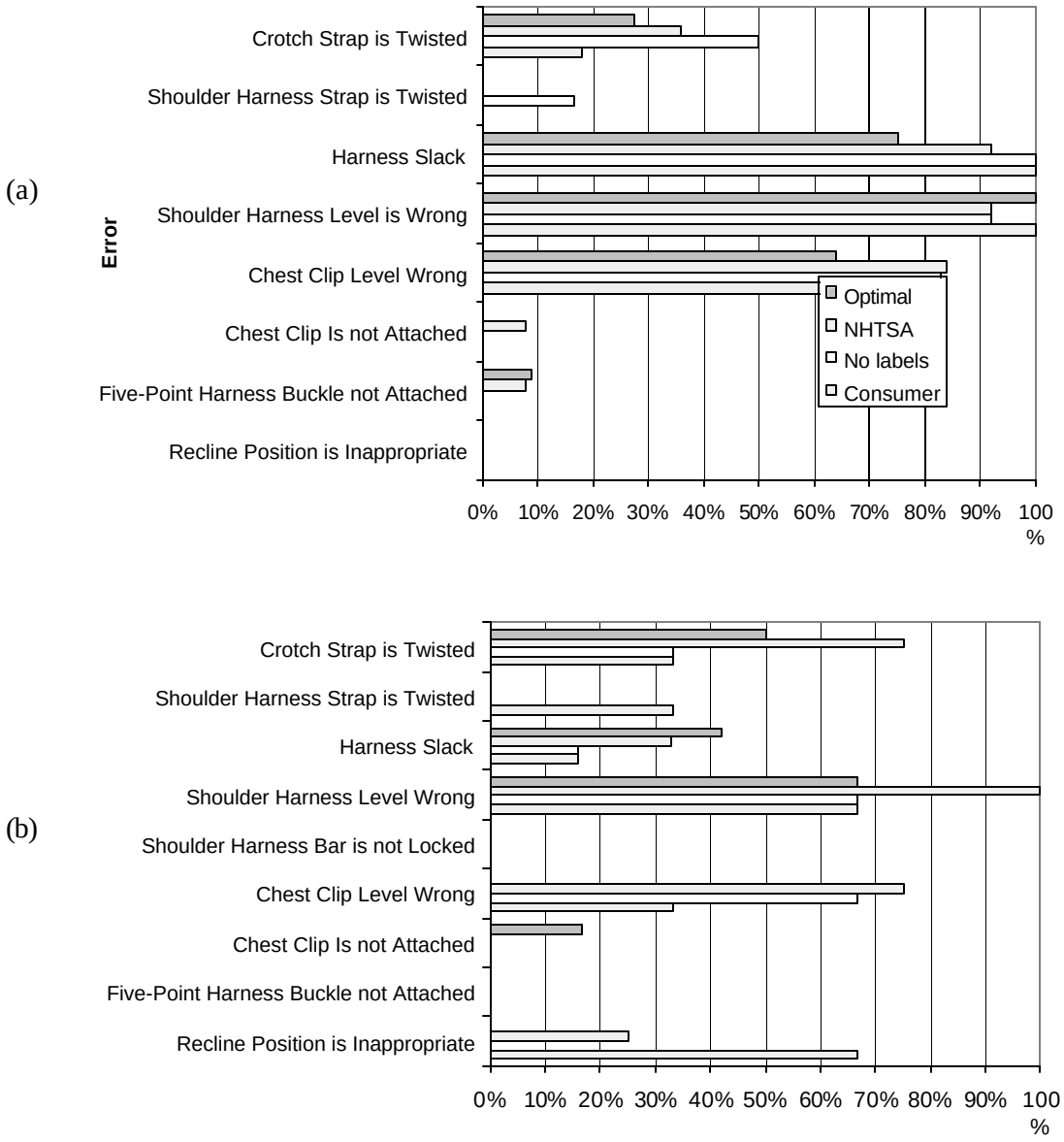
Tether strap slack in the forward-facing configuration was more common in the No labels and NHTSA conditions than the Optimal condition (>20% for the NHTSA condition). The correct attachment of the tether strap is critical to the safety effectiveness of the CRS; therefore, the percentage of participants that performed this error in the Optimal condition (27%) is still considerable. During the experimental trials, several participants indicated that the tether strap was not secured properly during their installation, and they could not determine how to remove the slack based on the poor design of the tether strap re-threading buckle. The Optimal labels, therefore, did prompt participants to remove the slack; however, it was the design of the tether itself that made this function difficult to perform. It is recommended that simpler tether strap tightening mechanisms be implemented on CRSs.

CRS-in-vehicle errors for the rear-facing configuration related mostly to the seat belt being routed incorrectly and seat belt slack. The Optimal label condition showed the greatest improvement in performance, compared to the other three conditions, in these areas.

Figure 8 outlines 'child-in-CRS' error frequencies for forward- (a) and rear-facing (b) configurations. Forward-facing, the Optimal label condition resulted in a reduction in harness slack and fewer incorrect chest clip height errors than the other label conditions. This may have resulted from the pictorials used on the labels, along with the placement of these labels on the harness shoulder straps of the CRS, ensuring that they were clearly visible to participants during the child installation task. However, it should be noted that the Optimal condition still resulted in considerable error frequencies (harness slack= 75%; chest clip level=64%). Harness slack is directly related to the height of the shoulder harness slots; if the shoulder harness is not lowered to the appropriate level for the child, it is virtually impossible to remove harness slack. As illustrated in Figure 8, the Optimal condition resulted in 100% error for 'wrong shoulder harness levels', thus maintaining a high error frequency for harness slack.

Every label condition (both forward- and rear-facing) resulted in a high frequency of incorrect shoulder harness levels. During the experimental trials, participants raised concerns regarding the height of the shoulder harness for the child and infant. At the same time, participants mentioned that they could not determine how to lower the height of the harness to the appropriate location. Upon discussing this with the participants further, it was noted that the participants were accustomed to restraint systems that have several harness slots that require re-threading—the Alpha Omega has one harness slot on an adjustable backrest. The participants believed that the one harness slot was stationary.

Figure 8. Error frequency: child-in-CRS (a) forward-facing; (b) rear-facing.



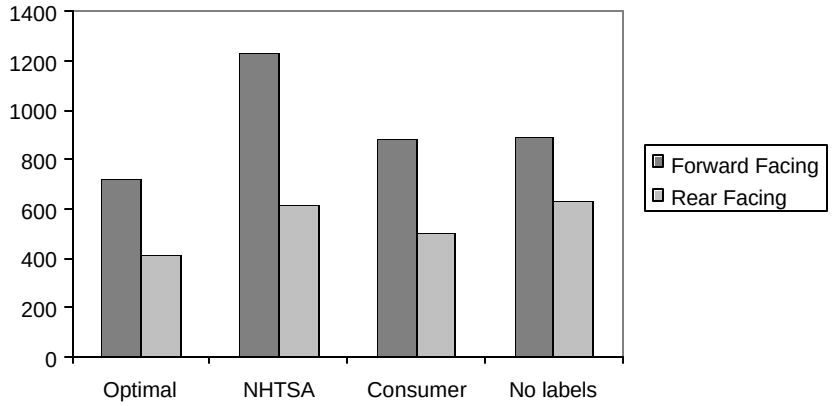
5.1.4 Risk Priority Numbers (RPNs)

Severity scores, frequencies and RPN values for each 'CRS-in-vehicle' and 'child-in-CRS' error in each label condition in the forward- and rear-facing seat orientation are presented in Appendix C. Total RPN values for each label condition are also provided. For each label condition, the frequency of each error (normalized to n=100) was computed. The error frequencies were then multiplied by the predetermined severity score to provide a RPN value for each error. Each individual error RPN value for a label condition was summed to provide a total RPN value for the label condition.

5.1.4.1 CRS-in-Vehicle

The total RPN value associated with installing the CRS into the vehicle for each label condition is presented in Figure 9, and indicates that, forward- and rear-facing, the greatest overall error levels occurred in the NHTSA and No labels condition.

Figure 9. CRS-in-vehicle total RPNs

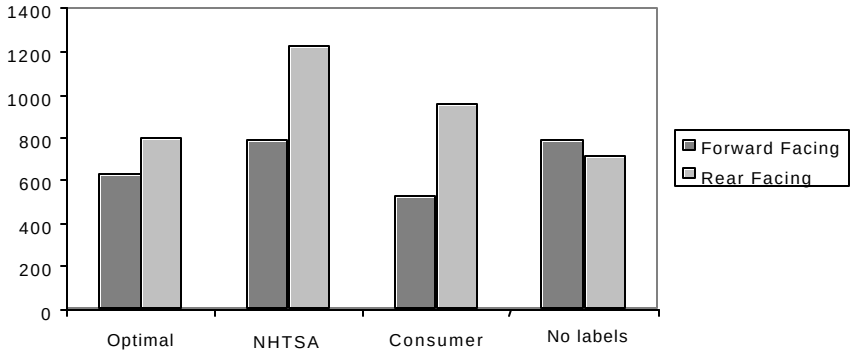


RPN values were calculated individually for each participant, resulting in each participant receiving an overall error score representing their forward- and rear-facing task performance. A t-test was performed to examine the effects of participant experience on error scores. A significant effect of experience was found, $t=3.49$, $p<.001$, revealing that experienced participants had significantly lower individual errors scores than inexperienced participants(4.367 *vs.* 9.625) for the task of installing the CRS in a vehicle.

5.1.4.2 Child-into-CRS

The total RPN value associated with installing the child into the CRS for each label condition is presented in Figure 10, and indicates that the greatest overall error levels occurred in the NHTSA and Consumer label conditions when installed rear-facing, while the Optimal and No labels condition had the lowest overall error level.

Figure 10. Child-in-CRS total RPNs



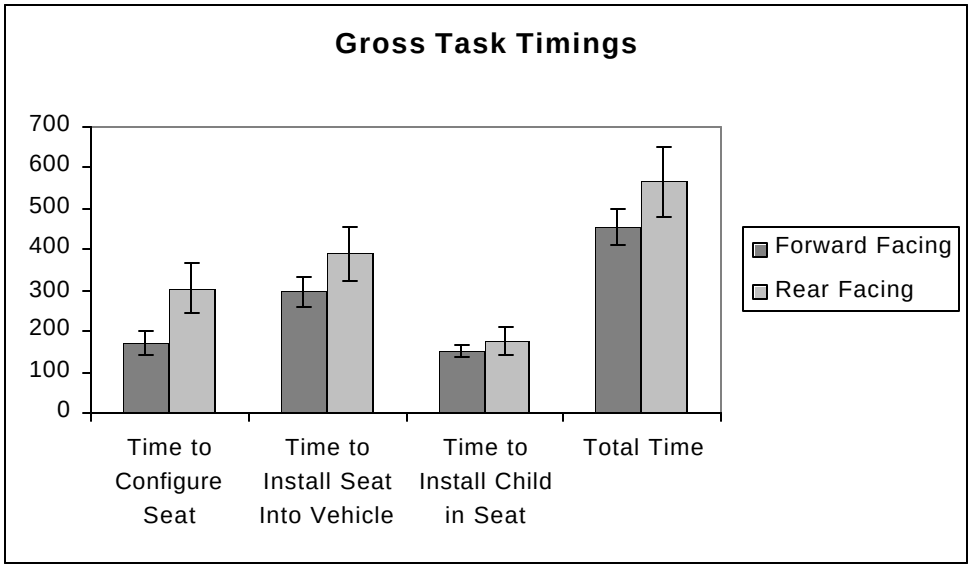
Again, a significant effect of experience was found, $t=2.47$, $p<.05$, revealing that experienced participants had significantly lower individual error scores than inexperienced participants (4.943 *vs.* 7.97) for the task of installing a child into the CRS.

An additional test performed on these data indicated that age also had an effect on participant error, $t=2.72$, $p<.01$, whereby younger participants (20 to 39 years) made significantly fewer errors than older participants (40+ years) (4.492 *vs.* 7.641) when installing the child into the CRS.

5.1.5 Task Timings

The time to complete each of the major tasks was recorded for each participant. These data were used to calculate the average time to configure the CRS (prior to an installation), the time to install the CRS into the vehicle, and the time to install the child into the CRS. The time to install the CRS into the vehicle and the child into the CRS were summed to calculate a total time spent on the tasks for each participant. The averages of these times are illustrated in Figure 11 for both forward- and rear-facing configurations. These data (in seconds) indicate that the task of installing a CRS into the vehicle, and the task of installing a child into a CRS were completed in a combined time of less than 10 minutes rear-facing, and in a combined time of less than 8 minutes forward-facing. These times are less than the suggested maximum combined installation time of 15 minutes that is specified in ISO 13215-2 Requirements and Test Procedures for Correct Installation (1999).

Figure 11. Task timings.



5.2 SUBJECTIVE QUESTIONNAIRES

5.2.1 Label Usability

At the end of each session, participants completed a label usability questionnaire that required them to rate the usability characteristics of the labels they had used during the trial (not performed for the No labels condition).

5.2.1.1 Impact on task performance

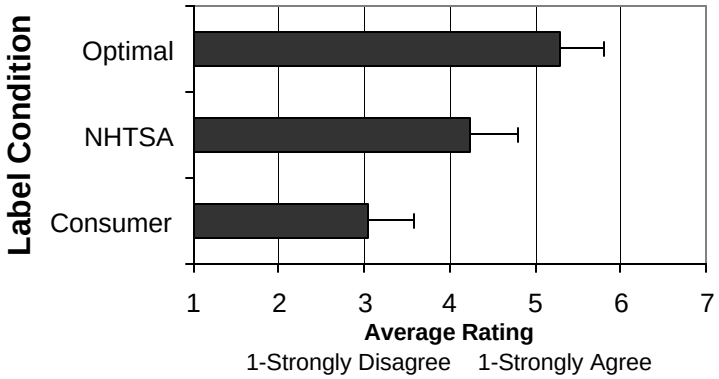
Participants were required to rate their level of agreement with the following statements concerning the impact of label design on task performance:
The labels (were):

- Easy to Locate
- Helped Complete Tasks More Quickly
- In a Useful Location
- Easy to Read
- Helped Complete Tasks Correctly

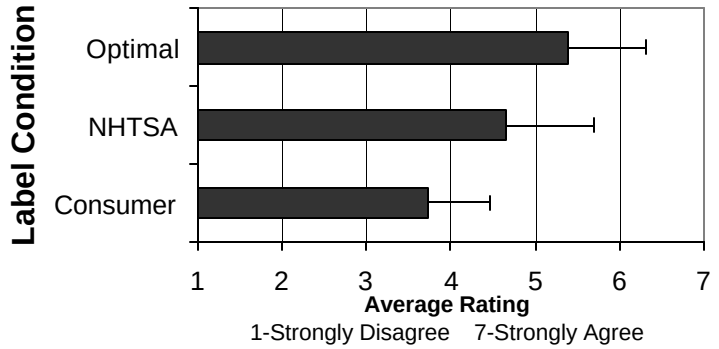
Figure 12 summarizes overall label ease-of-use. This is represented by an overall average that was computed from an overall ease-of-use rating for each participant. These data indicate that the Optimal Design condition had the highest overall usability, followed by the NHTSA labels and the Consumer labels. It is important to note that the Consumer labels had negative overall usability ratings (less than 4) for both forward- and rear-facing, and that both the NHTSA and Optimal Design conditions raised that usability level onto the positive side of the rating scale.

Figure 12. Label overall ease-of-use (a) forward-facing; (b) rear-facing.

(a)



(b)



A one-way ANOVA showed a significant main effect of label design, $F=4.48$; $p<.05$. Post hoc analysis with Tukey's test revealed that the Optimal label condition received a higher overall usability rating than the Consumer condition (47.45 *vs.* 26.72).

A one-way ANOVA also revealed a main effect of education level on overall label usability, $F=4.03$, $p<.05$. The post hoc analysis showed that this resulted from a significant difference between Graduate and University level participants; participants with Graduate University degrees rated label usability lower than participants with Bachelor University degrees (13.33 *vs*. 47.46). It should be noted that most participants in the study indicated high school education as their highest level of education achieved.

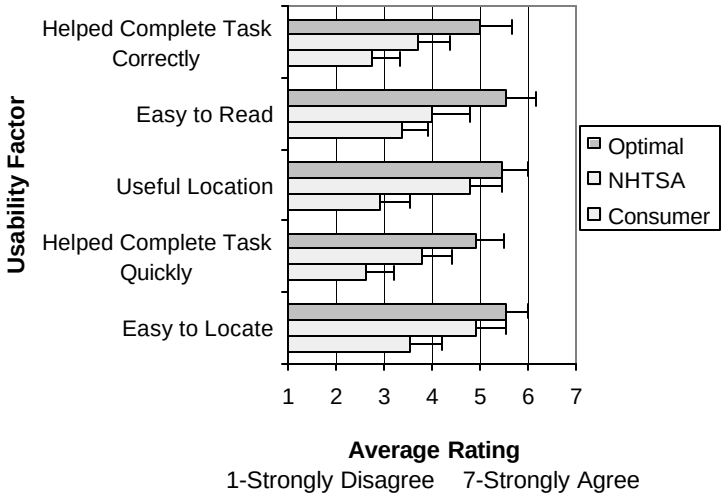
Figure 13 summarizes the detailed label ease-of-use data by feature. These data show the continued trend of the Optimal Design labels having a greater ease-of-use compared to both the NHTSA and Consumer labels.

One-way ANOVAs were performed to evaluate the effects of label design on each of the 'ease-of-use' statements. A significant effect of label design was found for the following two statements: the labels were Easy to Locate, $F=3.51$, $p<.05$, and the labels were in a Useful Location, $F=4.46$, $p<.05$. Tukey's test revealed that, in both cases, the Optimal Design labels received significantly higher ratings than the Consumer labels. It is also interesting to note that the Consumer labels were rated on the negative side of the usability scale for all features except ease of locating them when the CRS was rear-facing.

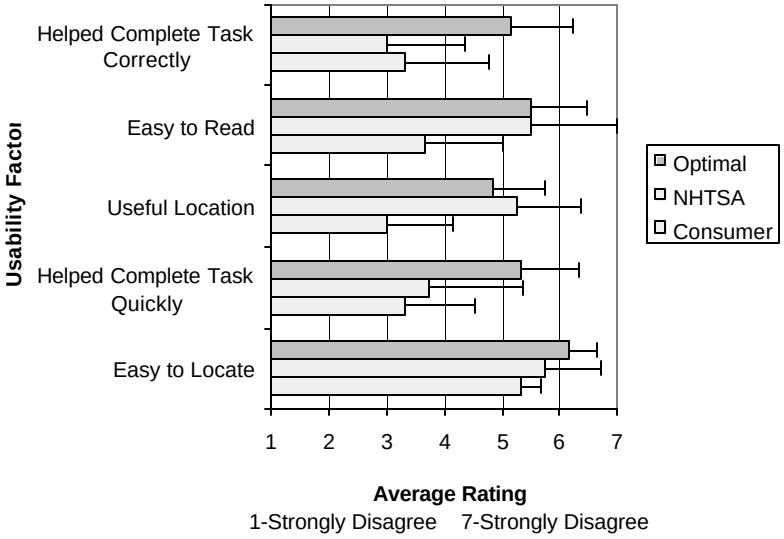
It should be noted that, due to the low number of participants that actually installed the CRS in the rear-facing configuration, the "n" for rear-facing was much lower than that for forward-facing. As a result, the forward-facing data is a more complete assessment of label design.

Figure 13. Label ease-of-use ratings (a) forward-facing; (b) rear-facing).

(a)



(b)



5.2.1.2 Ease-of-understanding

Participants were required to complete a subsequent set of label usability questions that focused on the labels' ease-of-understanding. They were asked to rate their level of agreement with the following statements:

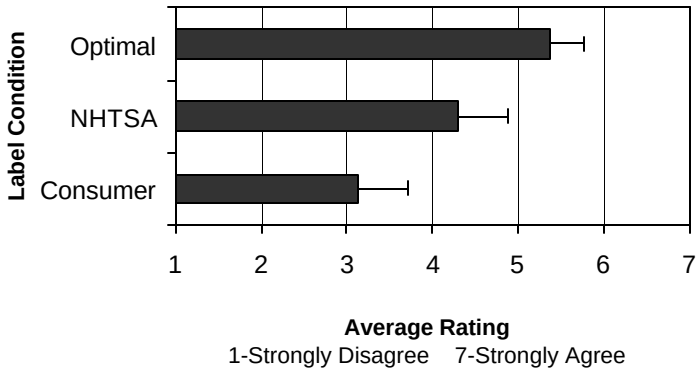
It was easy to understand:

- Instructions on the Seat
- Images on Labels
- Arrow Indicators
- Warnings

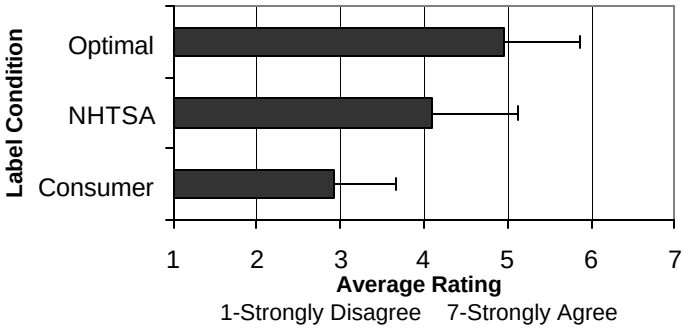
Figure 14 summarizes the overall label understanding ratings, which indicate that the Optimal Design labels were easiest to understand, followed by the NHTSA and then Consumer labels. In accordance with the Consumer label ease-of-use finding, the Consumer labels also displayed overall negative (less than 4) ratings on the ease-of-understanding scale, while the NHTSA and Optimal Design conditions improved this metric.

Figure 14. Label overall ease-of-understanding (a) forward-facing; (b) rear-facing.

(a)



(b)



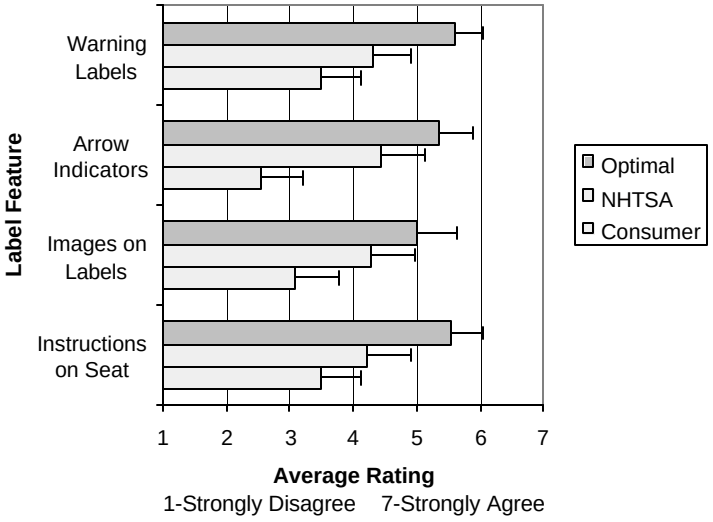
A one-way ANOVA found a significant main effect of label design on overall ease-of-understanding, $F=4.63$, $P<.05$. Post-hoc analysis revealed that the Optimal Design labels were rated as significantly easier to understand than the Consumer labels (21 *vs.* 11.55).

Figure 15 summarizes the ratings of each of the ease-of-understanding statements. All aspects of the Optimal Design labels resulted in higher understanding ratings, especially the arrow routing indicators and the additional instructions provided by the Optimal Design labels.

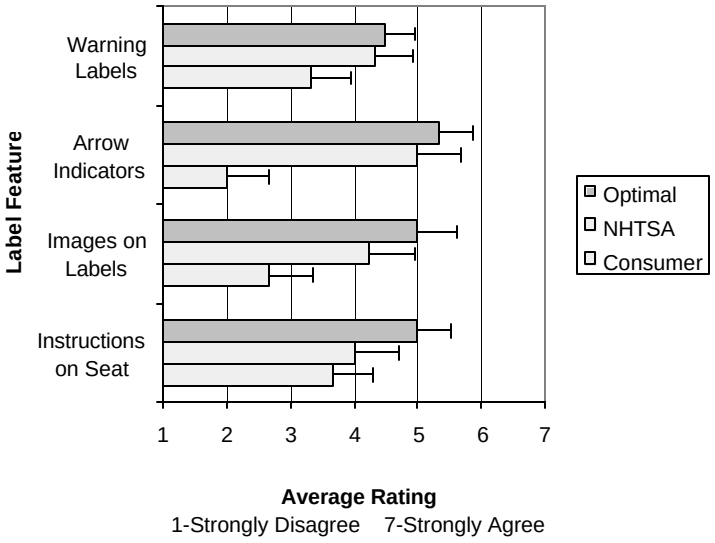
One-way ANOVAs were performed to evaluate the effects of label design on each of the ease-of-understanding statements. A significant effect of label design was found for the statement: "It was easy to understand the arrow routing indicators", $F=4.59$, $p<.05$. Tukey's test revealed that the arrow indicators on the Optimal labels were rated as easier to understand than those on the Consumer labels (5.33 *vs.* 2.80).

Figure 15. Label features ease-of-understanding (a) forward-facing; (b) rear-facing.

(a)



(b)



5.2.2 Task-based Usability

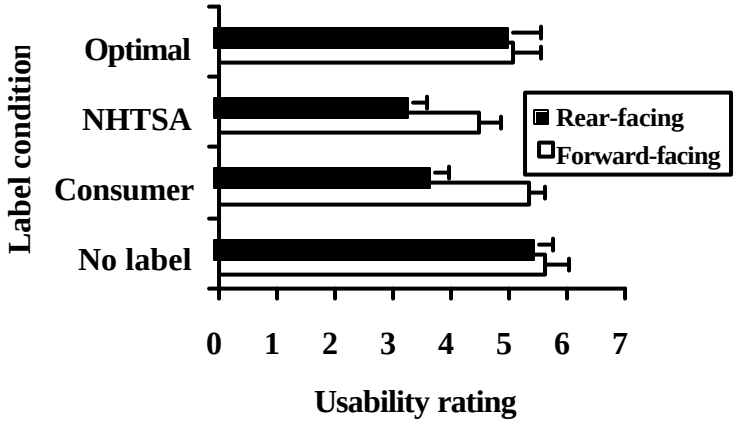
Participants were required to complete a subjective task-based usability questionnaire immediately after performing each CRS installation (forward- and rear-facing; CRS-in-vehicle and child-in-CRS). The questionnaire rated the participants' level of agreement with the following statements:

It was very easy to:

- Adjust the CRS Prior to Installation
- Place the CRS in the Vehicle
- Secure the CRS in the Vehicle
- Place the Child in the CRS, and
- Secure the Child in the CRS.

Figure 16 summarizes the overall task-based usability for forward- and rear-facing installations. A one-way ANOVA indicated a main effect of label type on overall task-based usability, $F=3.06$, $p<0.05$, with the No Label condition being rated as significantly easier to use than the NHTSA condition. These data suggest that if an individual does not have any instruction or feedback regarding an installation task s/he will rate the task as easier to perform.

Figure 16. Overall task-based usability ratings (1=strongly disagree; 7=strongly agree).



The itemized task usability ratings (Figures 17 and 18) indicate the tasks participants felt they had the most difficulty performing. For both forward- and rear-facing conditions, the lowest ease-of-use ratings occurred for securing the CRS into the vehicle, with the rear-facing condition being rated lower than the forward-facing condition.

Figure 17. Itemized usability ratings (forward-facing).

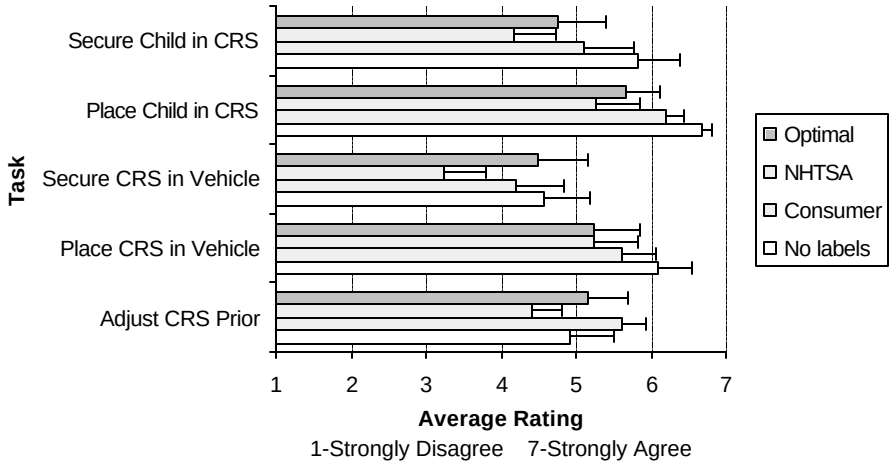
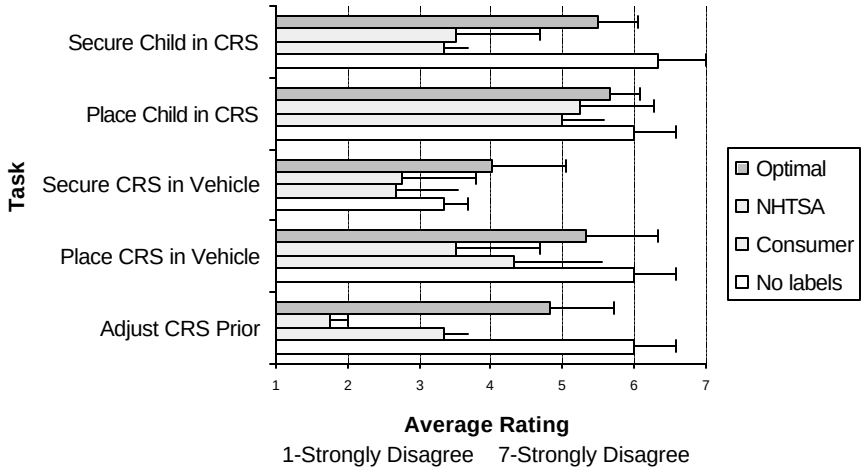


Figure 18. Itemized usability ratings (rear-facing).



In the rear-facing condition, the NHTSA and Consumer conditions had the lowest usability ratings for securing the CRS into the vehicle and for securing the child into the CRS. For these tasks, the Optimal and No labels conditions had a greater ease-of-use rating; the Optimal labels had specific label features that were incorporated into their design to make this task easier, while the No labels condition may have been perceived as "easy" because participants were not provided with information that would dispute the choices they made.

6. CONCLUSIONS AND RECOMMENDATIONS

The study results lead to the following conclusions about CRS use and CRS label and warning design:

1. The Optimal Design labels resulted in higher usability ratings, and for key areas such as selecting the correct CRS orientation for infants (rear-facing), the Optimal Design labels resulted in improved task performance, compared to the other label conditions. This suggests that labels that are designed using 1) human factors principles, and 2) hierarchical task analyses that identify critical task information requirements for label features, result in increased usability and improved task performance compared to labels designed using other methods.
2. From a statistical perspective, implementation of the proposed changes to the U.S. FMVSS requirements concerning CRS labeling will likely not result in increased performance or usability compared to existing consumer labels that follow the current CMVSS/FMVSS requirements. In order to achieve significantly higher compliance, ease-of-use, and task performance, it would be necessary to implement the features of the Optimal Design condition.
3. Pictograms improve the usability of labels, and appear to improve label compliance, especially when the label is positioned in the appropriate location.
4. As the Optimal Design labels received high ratings for location and ease-of-reading, it is inferred that it is beneficial to have all English language labels located optimally on one side of the CRS, and all French language labels located optimally on the other side of the CRS.
5. Experienced CRS users make fewer errors when installing a CRS into a vehicle, and a child into a CRS, than inexperienced users.
6. Younger CRS users (20 to 39 years) make fewer errors installing a child into a CRS than older users (40+ years).

As a result of these conclusions, regulatory agencies should consider the following recommendations when considering future CRS label design regulations:

1. *Require the use of sans-serif fonts*. Human factors design principles indicate that sans-serif font is not only easy to read (Trommelen, 1994), but people are more likely to read warnings that use sans-serif fonts (Braun, Silver, & Stock, 1992).
2. *Use orange colour-coding for the rear-facing configuration*. Colour-coding should be used on the borders of labels that highlight the instructions for forward- and rear-facing configurations. Orange should be used for rear-facing labels (red is reserved for messages or warnings indicating a great level of perceived hazard), as users tended to overlook these and install the infant dummy forward-facing regardless of its age and weight. While the intent is to use orange colour-coding to attract users' attention to the rear-facing option on convertible CRSs, this issue may need to be re-examined using the complete range of age, height, and weight requirements (e.g., infant, toddler, and children up to 80 lbs). Current experience with field data indicates that installation performance with rear-facing CRSs is typically very good compared to that with forward-facing CRSs.
3. *Use pictograms for key tasks*. These include: CRS orientation, chest clip height, harness tension, and seat belt route. Further, pictogram labels should be co-located at the location on the CRS where the user will be performing the task, as was the case in the Optimal Design labels in this study. On convertible CRSs, it is recommended to use a pictogram that shows an infant associated with the rear-facing condition and a child associated with the forward-facing condition, and it should include directional arrows indicating the proper CRS orientation for a child and an infant. Finally, a forward-/rear-facing pictogram label should be located on the front of the CRS to increase the likelihood of detection.
4. *Separate the placement of bilingual instructions*. It is recommended that English language labels be located on one side of the CRS and that French language labels be located in the same positions on the opposite side of the CRS. Although such a pattern may pose some difficulties when installing a CRS against one side of a vehicle, the benefits related to convenience and ease of locating the instructions are expected to outweigh any disadvantages.
5. *Consider providing guidance on label location in relation to task performance.*

7. REFERENCES

Barone, A., Greenley, M., & Norris, B. (2002). *Behavioural Evaluation of the Effectiveness of Child Restraint System (CRS) Labels/Warnings: Label Design Report.* Report to Transport Canada. Greenley & Associates: Ottawa, Ontario.

Braun, C., Holt, S. & Silver, C. (1995). Adding consequence information to product instructions: Changes in hazard perception. In: M. Wogalter, S. Young, & K. Laughery (Eds.) *Human Factors Perspectives on Warnings, Volume* 2. Human Factors and Ergonomics Society: Santa Monica, CA.

Braun, C., Silver, N.C., & Stock, B. (1992). Likelihood of reading warnings: The effect of fonts and font sizes. In: K. Laughery, M. Wogalter, & S. Young (Eds.) *Human Factors Perspectives on Warnings*. Human Factors and Ergonomics Society: Santa Monica, CA.

Cheatham, D. & Wogalter, M. (1999). Connoted hazard and perceived conspicuity of warning configurations. In: M. Wogalter, S. Young, & K. Laughery (Eds.) *Human Factors Perspectives on Warnings, Volume 2*. Human Factors and Ergonomics Society: Santa Monica, CA.

Czernakowski, W., & Müller, M. (1991). Misuse mode and effects analysis (MMEA): an approach to predict and quantify misuse of child restraint systems (CRSs). In: *Proceedings of the 35th Annual Conference of the Association for the Advancement of Automotive Medicine*, pp.27-43.

Czernakowski, W., & Müller, M. (1993). Misuse mode and effects analysis: an approach to predict and quantify misuse of child restraint systems. *Accident Analysis and Prevention, 29*, 125-132.

DeJoy, D. (1989). Consumer Product Warnings: Review and analysis of effectiveness research. In: K. Laughery, M. Wogalter, & S. Young (Eds.) *Human Factors Perspectives on Warnings*. Human Factors and Ergonomics Society: Santa Monica, CA.

International Standard Organization (ISO). (1999). ISO 13215-2: Requirements and test procedures for correct installation (panel method), part of Road Vehicles-Reduction of misuse risk of child restraint systems. Geneva, Switzerland.

Godfrey, S., Allender, L., Laughery, K., & Smith, V. (1983). Warning messages….Will the consumer bother to look? In: K. Laughery, M. Wogalter, & S. Young (Eds.) *Human Factors Perspectives on Warnings*. Human Factors and Ergonomics Society: Santa Monica, CA.

Godfrey, S. & Laughery, K. (1984). The biasing effects on product familiarity on consumers awareness of hazards. In: K. Laughery, M. Wogalter, & S. Young (Eds.) *Human Factors Perspectives on Warnings*. Human Factors and Ergonomics Society: Santa Monica, CA.

Kumagai, J.K., Angel, H.A., & Iwasa-Madge, K.M. (2000). Child restraint system harness usability study - Contract Report to Transport Canada. Humansystems Incorporated: Guelph, Ontario.

Noy, I.Y. & Arnold, A-K. (1995). Installing child restraint systems in vehicles: Towards Usability Criteria. Transport Canada Road Safety, Ergonomics Division – Technical Memorandum TME 9501.

Ortiz, J., Resnick, M., & Kengskool (2000). The effects of familiarity and risk perception on workplace warning compliance. In: M. Wogalter, S. Young, & K. Laughery (Eds.) *Human Factors Perspectives on Warnings, Volume 2*. Human Factors and Ergonomics Society: Santa Monica, CA.

Pedder, J., Legault, F., Salcudean, G., Hillebrandt, D., Gardner, W., & Labrecque, M. (1994). Development of the CanFIX infant and child restraint/vehicle interface system. In: *Proceedings of the 38th STAPP Car Crash Conference, SAE Paper No.842221*, 235-244.

Rudin-Brown, C.M., Kumagai, J.K., Angel, H.A., Iwasa-Madge, K.M., & Noy, Y.I. (in press). Usability issues concerning child restraint system (CRS) harness design. *Accident Analysis and Prevention*.

Shaver, E. & Braun, C. (2000). Effects of warning symbol explicitness and warning color on behavioural compliance. In: M. Wogalter, S. Young, & K. Laughery (Eds.) *Human Factors Perspectives on Warnings, Volume 2*. Human Factors and Ergonomics Society: Santa Monica, CA.

8. APPENDIX A: Locations of Consumer, NHTSA, and Optimal labels on CRS.

8.1 CONSUMER LABELS

Manufacturer and Certification Label

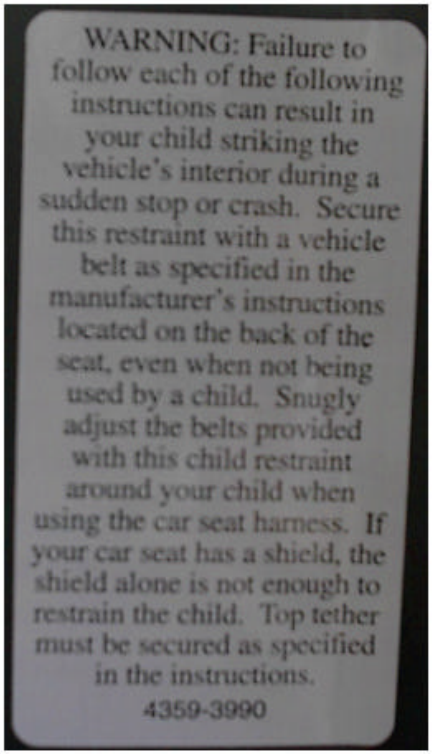
1

2

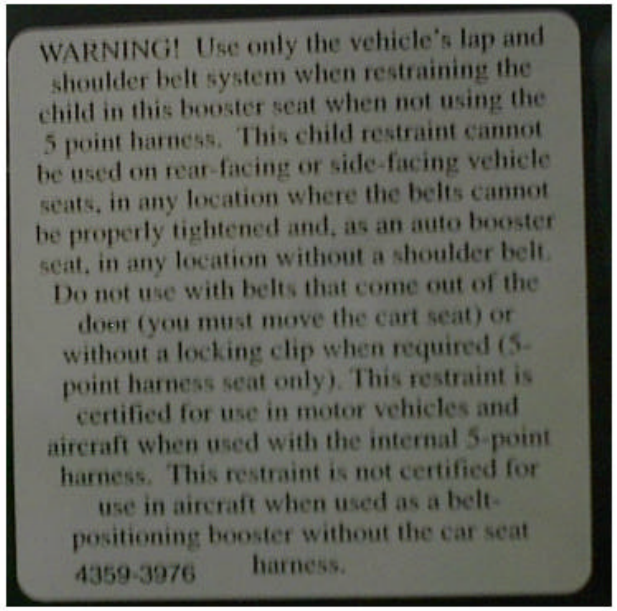
Side A

General Warning Label (English Side)

3



4



3

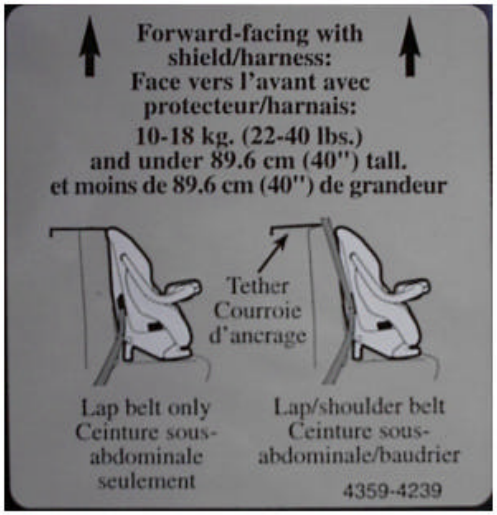
4

Side B

Rear Facing and Forward Facing Installation Labels

5

Side A



5

6

6

Side B

8.2 NHTSA LABELS

Harness Slot Labels

1

Rear Facing: Harness should be level with or just below infant's shoulders.

▪Forward-Facing: Harness should be level or just above child's shoulders.

2

Orienté vers l'arrière : Le harnais doit être au niveau des épaules du bébé ou juste au-dessous.

Orienté vers l'avant : Le harnais doit être au niveau des épaules de l'enfant ou juste au-dessus.

Air Bag Warning Label

3

WARNING! / AVERTISSEMENT!

DO NOT place rear-facing child seat on front seat with air bag.

DEATH OR SERIOUS INJURY can occur.

The back seat is the safest place for children 12 and under.

N'INSTALLEZ PAS un siège pour enfant orienté vers l'arrière sur le siège avant d'un véhicule équipé de coussins gonflables.

LA MORT OU DES BLESSURES GRAVES pourraient en résulter.

La banquette arrière du véhicule est l'endroit le plus sûr pour les enfants de 12 ans et moins.

Manufacturer and Certification Labels

4

Cosco Alpha Omega

02-C53-BNP

Manufactured In/Date de fabrication

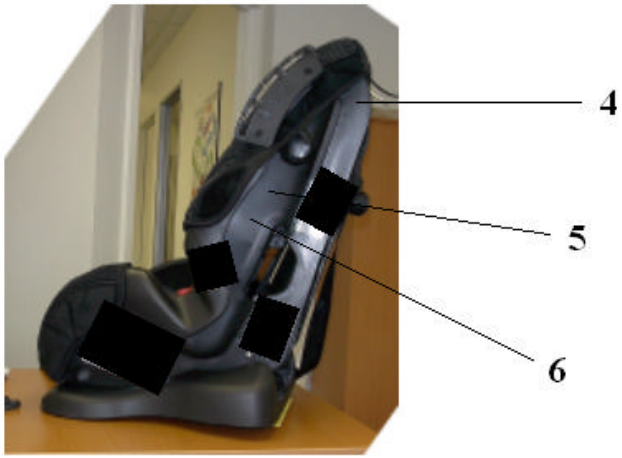
Month/Mois Year/Année

11/2001

US: Dorel Juvenile Group Inc.
2525 State St., Columbus, IN 47201

Canada: Dorel Juvenile Group Inc.
Le Groupe Juvénile Dorel inc.
804, rue Deslauriers
Saint-Laurent (Québec)
Canada H4N 1X1

5



6

This restraint is certified for use in motor vehicles and aircraft when used with the internal 5-point harness. This restraint is not certified for use in aircraft when used as a belt-positioning booster without the car seat harness

Ce siège est certifié pour être utilisé dans un véhicule automobile et dans un avion si on se sert du harnais à 5 points intégré. Ce siège non n'est pas certifié pour être utilisé dans un avion s'il est utilisé comme coussin d'appoint pour aider à positionner la ceinture et sans le harnais.

Side A

General Warning Label

7

WARNING! DEATH OR SERIOUS INJURY CAN OCCUR
• Follow all instructions on this child restraint • Secure this child restraint with the vehicle's child restraint anchorage system if available or with a vehicle belt. • Place this child restraint in a rear-facing position when using it with an infant weighing between 2.3-10 kg (5-22 lbs) and is 48.3-88.9 cm tall (19-35 inches), or 10-15.9 kg (22-35 lbs) and not yet 12 months old • Snugly adjust the belts provided with this child restrain around your child • Register your child restraint with the manufacturer.

8

AVERTISSEMENT! RISQUE DE MORT OU DE BLESSURES GRAVES
• Suivez toutes les directives d'utilisation relatives à ce siège pour enfant. • Maintenez ce siège pour enfant avec le dispositif d'ancrage du véhicule, s'il en est muni, ou avec la ceinture du véhicule. • Orientez ce siège vers l'arrière quand vous y placez un bébé pesant entre 2,3 et 10 kg (5 à 22 lb) et mesurant entre 48,3 et 88,9 cm (19 à 35 po), ou pesant entre 10 et 15,9 kg (22 à 35 lb) et âgé de moins de 12 mois. • Serrez les courroies de ce siège pour enfant autour de votre enfant. •Enregistrez votre siège pour enfant auprès de son fabricant.

Rear Facing and Forward Facing Installation Labels

9

Rear-Facing Infant Position

Siège pour bébé orienté vers l'arrière

• Use only with children who weigh 2.3-10 kg (5-22 lbs) and are 48.3-88.9 cm tall (19-35 inches), or 10-15.9 kg (22-35 lbs) and not yet 12 months old • WARNING! Your child can suffer severe head and/or neck injury if rear-facing restraint is placed in front seat of vehicle	• Uniquement pour les enfants pesant entre 2,3 et 10 kg (5 à 22 lb) et mesurant entre 48,3 et 88,9 cm (19 à 35 po), ou pesant entre 10 et 15,9 kg (22 à 35 lb) et âgés de moins de 12 mois. • AVERTISSEMENT! Votre enfant peut subir de graves blessures à la tête et/ou au cou s'il se trouve dans un siège pour enfant orienté vers l'arrière placé sur le siège avant du véhicule.
Lap Belt Only Ceinture sous-abdominale seulement 	Lap/Shoulder Belt Ceinture sous-abdominale-baudrier 

Side A

10

Forward-Facing Infant Position

Siège pour bébé orienté vers l'avant

Use only with children who weigh 10-18kg (22-40 lbs), are 102 cm (40 inches) or less and over 12 months old.

Uniquement pour les enfants pesant entre 10 et 18 kg (22 à 40 lb), mesurant 102 cm (40 po) ou moins et âgés de plus de 12 mois.

Lap Belt Only

Ceinture sous-abdominale seulement

Lap/shoulder belt

Ceinture sous-abdominale-baudrier

8.2 OPTIMAL LABELS

Child Seat Recline Position Labels

1 Rear-Facing

- Newborns: Seat must be fully reclined
- Infants: Seat must be fully or partially reclined.

2 Orienté vers l'arrière

- Nouveau-né : le siège doit être complètement incliné.
- Bébé : le siège doit être complètement ou partiellement incliné.

3 Forward-Facing

- Use only for children over a year old: Seat can be reclined or in upright position.

4 Orienté vers l'avant

- Uniquement pour les enfants de plus de 1 an; le siège peut être incliné ou droit.

5 To Recline Seat / Pour incliner le siège

Pull red handle toward you and lift to recline seat.	Tirez la poignée rouge vers vous et soulevez-la pour incliner le siège.

5-Point Harness Labels

6

The chest clip should be in line with the child's mid-chest (arm pit level)

L'agrafe de poitrine doit être placée au niveau des aisselles (mi-poitrine).

7

There should be one finger width between the child and the shoulder strap

Le jeu entre l'enfant et la bretelle doit corres-pondre à l'épaisseur d'un doigt.

8

To Adjust Shoulder Strap Tension

- To Loosen: Lift release lever and pull shoulder straps.
- To Tighten: Pull front strap through release lever.

Tension des bretelles

- Desserrage : soulevez le levier de dégagemenrt et tirez sur les sangles.
- Serrage : tirez les sangles à l'aide du levier de dégagement.

9 Release Lever

10 Levier de dégagement

Shoulder Harness Level Labels

11

WARNING!

- Rear Facing: Shoulder straps should be level with or just below infant's shoulders.
- Forward-Facing: Shoulder straps should be level or just above child's shoulders.

12

AVERTISSEMENT!

- Orienté vers l'arrière : réglez la fixation des bretelles au niveau des épaules du bébé ou juste en-dessous.
- Orienté vers l'avant : réglez la fixation des bretelles au niveau des épaules de l'enfant ou juste au-dessus.

13

Adjust Shoulder Strap Height

- Squeeze metal bar towards you and lift or lower it to correct harness height.
- Lock bar into new position.

14

Hauteur des bretelles

- Tirez la barre métallique vers vous, puis placez-la à la hauteur adéquate.
- Verrouillez la barre à sa nouvelle position.

Seat Orientation Labels

15

Rear-Facing

Use with infants up to one year old who are:

- 2.3-15.9 kg (5-35 lbs)
- 48.3-88.9 cm (19-35 inches)

Orienté vers l'arrière

Pour les enfants de 1 an ou moins qui :

- pèsent entre 2,3 et 15,9 kg (5 à 35 lb);
- mesurent entre 48,3 et 88,9 cm (19 à 35 po).

16

Forward-Facing

For use only with children at least 1 year old who are:

- 10-18 kg (22-40 lbs)
- 102cm (40 inches) or less

Orienté vers l'avant

Uniquement pour les enfants de 1 an ou plus qui :

- pèsent entre 10 et 18 kg (22 à 40 lb);
- mesurent 102 cm (40 po) ou moins.

Air Bag Warning

17

Tether Strap Labels

18 Tether strap used only in forward-facing child seat.

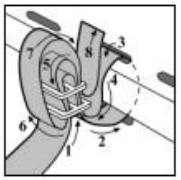
19 Sangle d'ancrage à utiliser seulement avec siège orienté vers l'avant.

20 Make sure tether strap is threaded correctly.

21 Assurez-vous que la sangle d'ancrage est correctement installée.

22 Tether Strap

23 Sangle d'ancrage

24 

25 

Picture 25 is located on the Tether Strap anchor

General Warning Labels

25

WARNING!

- Failure to follow the car seat instructions can result in your child striking the vehicle's interior during a sudden stop or crash.
- Secure the restraint with a vehicle belt as specified in the manufacturer's instructions.
- Snugly adjust the shoulder harness provided with this child restraint around your child.
- The tether strap must be secured as specified in the instructions.
- This child restraint cannot be used on rear-facing or side- facing vehicle seats, and in any location where the belts cannot be properly tightened.
- Do not use with belts that come out of the door or without a locking clip when required
- This restraint is certified for use in motor vehicles and aircraft when used with the internal 5-point harness.
- Please register your car seat with the manufacture.

Label 26 placed in same location on opposite side of seat.

26

AVERTISSEMENT!

- Si les directives d'utilisation du siège pour enfant ne sont pas suivies, votre enfant pourrait être projeté à l'intérieur du véhicule en cas d'arrêt brusque ou de collision.
- Fixez le siège à l'aide d'une ceinture de sécurité en suivant les directives du fabricant à l'arrière du dossier.
- Les bretelles du harnais du siège doivent être serrées de façon appropriée sur l'enfant.
- La sangle d'ancrage doit être fixée de la façon spécifiée dans les directives.
- N'installez pas le siège pour enfant sur un siège de véhicule orienté vers l'arrière ou vers le côté, ni à un endroit où la ceinture de sécurité du véhicule ne peut pas être serrée correctement.
- N'utilisez pas le siège avec une ceinture de sécurité logée dans une porte; utilisez l'agrafe de blocage lorsque celle-ci est requise.
- Homologué pour utilisation en automobile et en aéronef si on fait usage du harnais à 5 points intégré.
- Veuillez enregistrer votre siège pour enfant auprès de son fabricant.

Manufacturer and Certification Labels

27

Manufactured In/
Date de fabrication

Year/Année Month/Mois Day/Jour
02-C53-BNP
2001/11/12 A02C

U.S.: Dorel Juvenile Group Inc.
2525 State St., Columbus, IN
47201

Canada: Dorel Juvenile Group Inc.
Le Groupe Juvénile Dorel inc.
804, rue Deslauriers
Saint-Laurent (Québec)
Canada H4N 1X1

4359-3924*

28

Side A

Forward-Facing Installation Label

29

How to Insert Forward-Facing Seat in Car

For use only with children at least 1 year old who are:

- 10-18 kg (22-40 lbs)
- 102cm (40 inches) or less

31

Installation d'un siège orienté vers l'avant

Uniquement pour les enfants d'au moins 1 an:

- pesant entre 10 et 18 kg (22 à 40 lb);
- mesurant 102 cm (40 po) ou moins

30

How to Insert Forward Facing Child Seat in Car

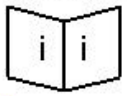
1. Adjust shoulder strap height (see back of seat).
2. Place child seat in the back seat of the vehicle.
3. Thread vehicle belt (a.shoulder/lap and b.lap only) through belt path indicated by orange arrows below.
4. Tighten vehicle belt by pushing down child seat with knee, and pulling up the shoulder belt until lap belt is tight.
5. Attach tether strap to bracket on vehicle's rear window shelf and adjust tightness.
6. Secure lap/shoulder belt:
   a. Use vehicle's automatic belt retractor for post 1994 cars
   b. Use locking clip for pre 1994 cars

#3a Lap/ Shoulder

#3b Lap Only

#5 Tether Strap

#6a See vehicle owner manual



#6b

32

Installation d'un siège pour enfant orienté vers l'avant

1. Réglez la hauteur des bretelles (voir à l'arrière du dossier).
2. Placez le siège sur la banquette arrière du véhicule.
3. Installez la ceinture de sécurité (a. ceinture sous-abdominale seulement et b. ceinture d'épaule/ sous-abdominale) du véhicule dans les encoches du siège prévues à cet effet comme indiqué par les flèches orange ci-dessous.
4. Serrez la ceinture de sécurité en poussant le siège vers le bas avec le genou et en tirant la ceinture vers le haut.
5. Fixez la sangle d'ancrage au point d'ancrage sur la plage arrière et réglez-en la tension.
6. Bloquez la ceinture de sécurité du véhicule à l'aide de :
   a) l'enrouleur automatique (années modèles 1994 et suivantes);
   b) l'agrafe de blocage (avant 1994).

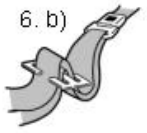
3a. Sous-abdominale

3b. épaule/ sous-abdominale

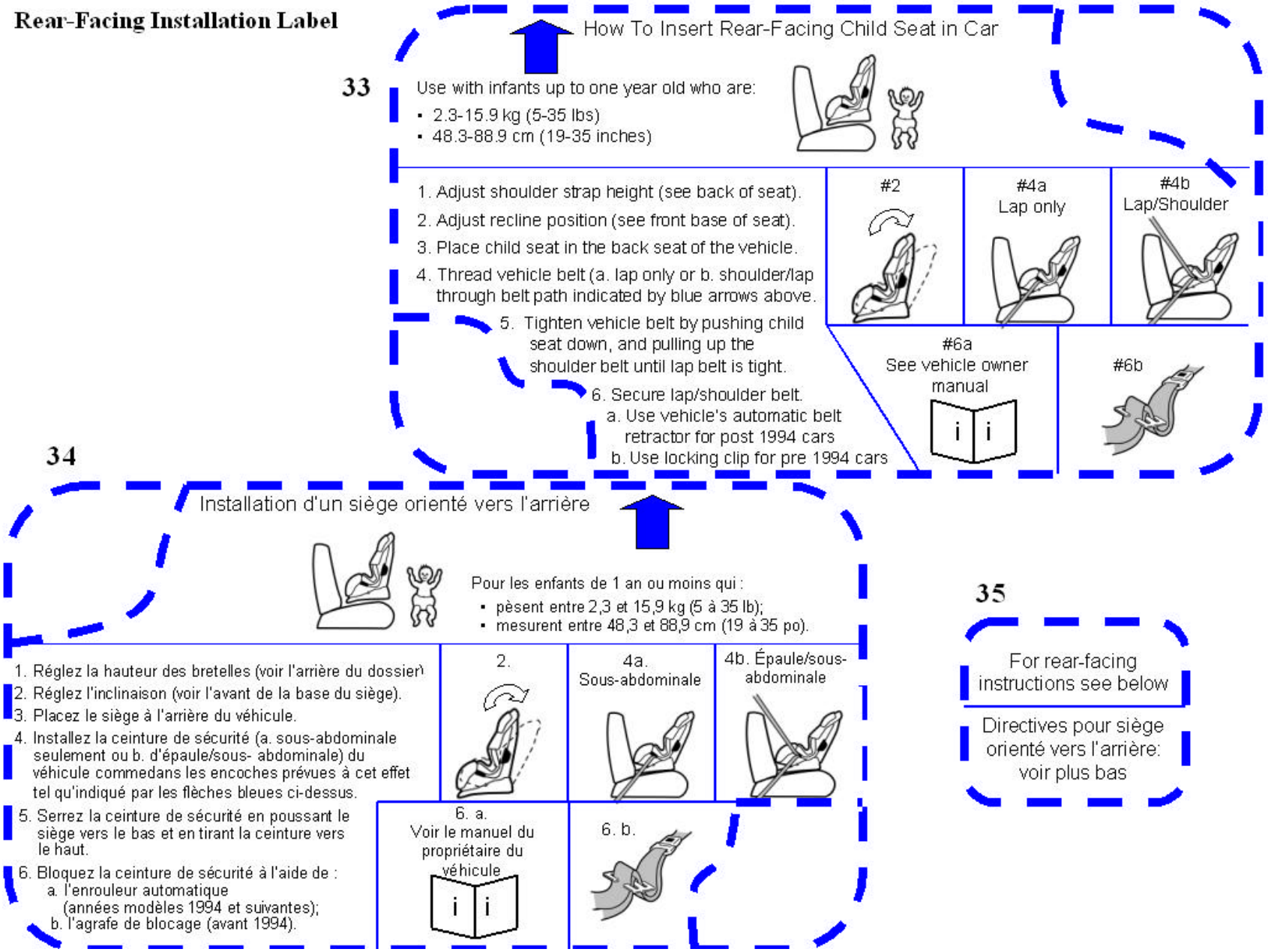
5. Sangle d'ancrage

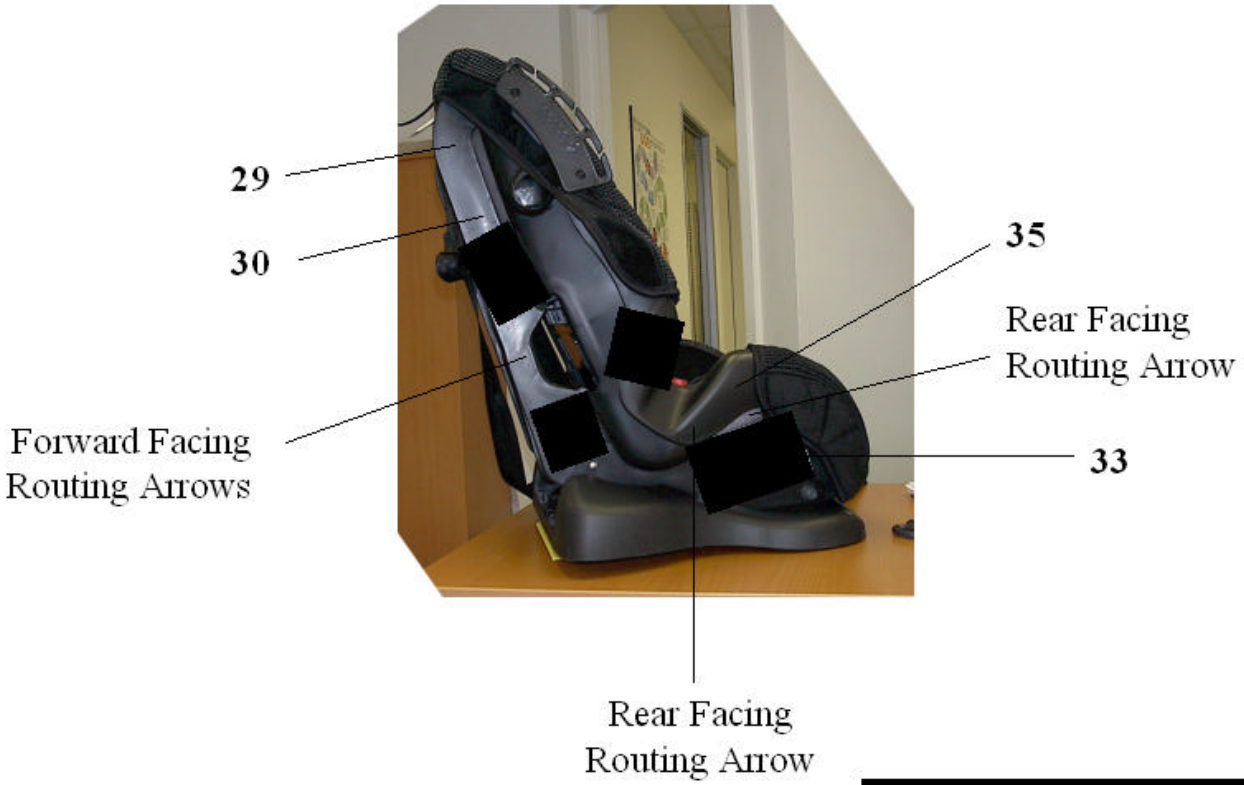
6.a) Voir le manuel du propriétaire du véhicule

6. b)



Rear-Facing Installation Label




29
30
35
Rear Facing
Routing Arrow
Forward Facing
Routing Arrows
33
Rear Facing
Routing Arrow
**French labels placed in same location on opposite side of seat

9. APPENDIX B: Subjective Questionnaire and Evaluation Checklist.

Subjective Questionnaire:

1. Please rate your level of agreement with the following statements:

	Strongly Disagree	**Moderately Disagree**	**Slightly Disagree**	**Borderline**	**Slightly Agree**	**Moderately Agree**	**Strongly Agree**
It was very easy to:							
1. Configure the seat prior to inserting it in the vehicle.	☐	☐	☐	☐	☐	☐	☐
Comments							
2. Place the seat into the vehicle.	☐	☐	☐	☐	☐	☐	☐
Comments							
3. Secure the seat to the vehicle.	☐	☐	☐	☐	☐	☐	☐
Comments							
4. Place the child in the seat.	☐	☐	☐	☐	☐	☐	☐
Comments							
5. Secure the child in the seat.	☐	☐	☐	☐	☐	☐	☐
Comments							

2. Please rate your level of agreement with the following statements:

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Borderline	Slightly Agree	Moderately Agree	Strongly Agree
I am very confident that I correctly:							
1. Configured the seat prior to inserting it in the vehicle.	☐	☐	☐	☐	☐	☐	☐
Comments							
2. Secured the seat to the vehicle.	☐	☐	☐	☐	☐	☐	☐
Comments							
3. Secured the child in the seat.	☐	☐	☐	☐	☐	☐	☐

Label Usability Ratings

1. Please rate your level of agreement with the following statements:

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Borderline	Slightly Agree	Moderately Agree	Strongly Agree	Not Applicable
The labels on the seat:								
1. Were easy to locate.	☐	☐	☐	☐	☐	☐	☐	☐
Comments:								
Helped me to complete the task quickly.	☐	☐	☐	☐	☐	☐	☐	☐
Comments:								
Were in a useful location.	☐	☐	☐	☐	☐	☐	☐	☐
Comments:								
Were easy to read.	☐	☐	☐	☐	☐	☐	☐	☐
Comments:								
Helped me to complete the task correctly.	☐	☐	☐	☐	☐	☐	☐	☐
Comments:								

2. Please rate your level of agreement with the following statements:

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Borderline	Slightly Agree	Moderately Agree	Strongly Agree	Not Applicable
It was Very Easy to Understand								
1. The written Instructions on the Child Seat	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
2. The images used on the labels	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
3. The arrow indicators used on the labels	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
4. The warning labels	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
5. The recommended child recline position instructions	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
6. The recommended shoulder height instructions	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
7. The recommended slot/belt path instructions	☐	☐	☐	☐	☐	☐	☐	☐
Comments								

User Confidence Ratings

1. Please rate the following statements.

I am very confident that :	**Strongly Disagree**	**Moderately Disagree**	**Slightly Disagree**	**Borderline**	**Slightly Agree**	**Moderately Agree**	**Strongly Agree**	**NA**
The child would be safe in the seat	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I installed the child seat correctly in the mock-up	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I followed all of the warnings on the child seat	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I used the chest clip correctly.	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I correctly adjusted the chest clip height.	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I connected the crotch strap correctly.	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I obtained the proper shoulder harness tension.	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I obtained the correct shoulder harness level.	☐	☐	☐	☐	☐	☐	☐	☐
Comments								

I am very confident that :	**Strongly Disagree**	**Moderately Disagree**	**Slightly Disagree**	**Borderline**	**Slightly Agree**	**Moderately Agree**	**Strongly Agree**	***NA***
I correctly adjusted the tether strap tension.	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I correctly secured the tether belt to the vehicle mock-up	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I correctly secured the seatbelt buckle	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I correctly routed the seatbelt through the child seat	☐	☐	☐	☐	☐	☐	☐	☐
Comments								
I correctly secured the seat belt tension	☐	☐	☐	☐	☐	☐	☐	☐
Comments								

10. APPENDIX C: Severity Scores, Frequencies, and RPN Values

CRS in Vehicle: Forward-Facing

Error	Severity Score	Label Condition: None		Consumer		NHTSA		Optimal	
		Freq	**RPN**	**Freq**	**RPN**	**Freq**	**RPN**	**Freq**	**RPN**
Installed in Proper Direction		100%		83.3%		100%		83%	
Tether Strap Twisted						18.2%			
Tether Strap Slack 1"	1					8%	8	18%	18
Tether Strap Slack 2"	3							9%	27
Tether Strap Slack 3"	3			10%	30				
Tether Strap Slack 4	3	10%	30						
Tether Strap Slack 5.5" or greater	8	25%	200	9%	72.8	42%	336		
Shoulder Belt Twist		50%		45.5%		25%		45.5%	
Lap Belt Twist				18.2%		8.3%		27.3%	
Seatbelt Routed Correctly		33.3%		18.2%		33.3%		18.2%	
Seatbelt Not Buckled	6							9.1%	54.6
Space Btw. Seat Back and Vehicle Cushion 1"	2	16.7%	33.4	18%	36	25%	50	36.3%	72.6
Space Btw. Seat Back and Vehicle Cushion 2"	4			9.1%	36.4	25%	100	27.3%	109.2
Space Btw. Seat Back and Vehicle Cushion 3"	5	25%	125	18%	90	8.3%	41.5	27.3%	136.5
Space Btw. Seat Back and Vehicle Cushion 4"	6	16.7%	100.2	18%	108	16.7%	100.2		
Space Btw. Seat Back and Vehicle Cushion 5"	6			9.1%	54.6				
Space Btw. Seat Back and Vehicle Cushion 6"	6	16.7%	100.2	18%	108	25%	150	9.1%	54.6
	Total RPN		**588.8**		**535.8**		**785.7**		**472.5**

CRS in Vehicle: Rear-Facing

Error	Severity Score	Label Condition							
		None		Consumer		NHTSA		Optimal	
		Freq	RPN	Freq	RPN	Freq	RPN	Freq	RPN
Installed in Proper Direction		25%		25%		33.3%		50%	
Shoulder Belt Twist		33.3%		33.3%				17%	
Lap Belt Twist		33.3%							
Seatbelt Routed Correctly	9	66.7%	600.3			50%	450		
Seatbelt Not Buckled	7								
Space Btw. Seat Front and Vehicle Cushion 1"	1	33.3%	33.3	33%	33.3	66.7%	66.7		
Space Btw. Seat Front and Vehicle Cushion 2"	3					33.3%	99.9	20%	60
Space Btw. Seat Front and Vehicle Cushion 3"	4								
Space Btw. Seat Front and Vehicle Cushion 4"	5								
Space Btw. Seat Front and Vehicle Cushion 5"	6								
Space Btw. Seat Front and Vehicle Cushion 6"	7			33.3%	233.1				
	Total RPN		**633.6**		**266.4**		**616.6**		**60**

Child in CRS: Forward-Facing

Error	Severity Score	Label Condition							
		None		Consumer		NHTSA		Optimal	
		Freq	RPN	Freq	RPN	Freq	RPN	Freq	RPN
Recline Position Inappropriate	4.6								
Five-Point Harness Buckle not Attached	10					8.3%	83	9%	90
Chest Clip not Attached	2					8%	16.60		
Chest Clip Level too Low	1.5	58%	87	75%	112.5	67%	100.5	64%	96
Chest Clip Level too High	2.5	13%	31.25	8%	20	17%	42.50		
Shoulder Harness Bar not Locked									
Shoulder Harness Level too High	1.7	100%	170	91%	154.7	92%	155.89	100%	170
Shoulder Harness Level too Low	2.3			9%	20.7				
Harness Tightness Wrong (2 Fingers)	1.3	92%	119.17	75%	97.50	67%	86.67	67%	86.67
Harness Tightness Wrong (3 Fingers)	3.7			8%	30.83	17%	61.67	8%	30.83
Harness Tightness Wrong (>4 Fingers)	6.3	8%	52.50	17%	105	8%	52.5		
Shoulder Harness Strap Twist	1.3			17%	21.71				
Crotch Strap Twist	3.5	18%	63	50%	175	36%	127.4	27%	95.55
	Total RPN		**522.92**		**737.94**		**726.72**		**570.25**

Child in CRS: Rear-Facing

Error	Severity Score	Label Condition							
		None		Consumer		NHTSA		Optimal	
		Freq	RPN	Freq	RPN	Freq	RPN	Freq	RPN
Recline Position Inappropriate	3			67%	200.1	25%	75		
Five-Point Harness Buckle not Attached	10								
Chest Clip not Attached	2.3							17%	38.41
Chest Clip Level too Low	2	67%	133.4	33%	66.6				
Chest Clip Level too High	2.5					75%	187.5		
Shoulder Harness Bar not Locked									
Shoulder Harness Level too Low	2.3								
Shoulder Harness Level too High	6.3	67%	420.21	67%	420.21	100%	630	67%	420.21
Harness Tightness Wrong (2 Fingers)	1.7	8%	13.6	8%	13.6	25%	42.5	17%	28.9
Harness Tightness Wrong (3 Fingers)	4.3	8%	34.4			8%	34.4	17%	73.1
Harness Tightness Wrong (>4 Fingers)	6.7			8%	53.6			8%	53.6
Shoulder Harness Strap Twist	2.7			33%	89.91				
Crotch Strap Twist	3.5	33%	116.55	33%	116.55	75%	262.5	50%	175
	Total RPN		**718.16**		**960.57**		**1231.90**		**789.22**