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Final Report

Using Interactive Virtual Presence to Support Accurate Installation of Child Restraints: Efficacy and Parental Perceptions

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ABSTRACT

Child restraint systems (car seats) reduce injury risk for young children involved in motor vehicle crashes, but parents experience significant difficulty installing child restraints correctly. Installation by certified child passenger safety (CPS) technicians yields more accurate installation, but is impractical for broad distribution. A potential solution is use of interactive virtual presence via smartphone application (app), which permits “hands on” teaching through simultaneous and remote joint exposure to 3-dimensional images. In two studies, we examined the efficacy of remote communication via interactive virtual presence to help parents install child restraints. Study 1 was conducted at existing car seat checkpoints and Study 2 at preschools/daycare centers. In both cases, existing installations were assessed by certified CPS technicians using an objective coding scheme. Participants then communicated with remotely-located certified CPS technicians via a smartphone app offering interactive virtual presence. Technicians instructed participants to install child restraints and then the installation was inspected by on-site technicians. Both before and after the remote interaction, participants completed questionnaires concerning perception of child restraints and child restraint installation, self-efficacy to install child restraints, and perceived risk of injury to children if they were in a crash. In both studies, accuracy of child restraint installations improved following the remote interaction between participants and certified CPS technicians. Together, the two samples achieved a weighted average of 90% correct installations across a multi-point inspection. Both samples reported increased self-efficacy to install child restraints and altered perceptions about the accuracy of the child restraint installations in their vehicles. Findings support use of interactive virtual presence as a strategy to realize accurate installation of child restraints.

EXECUTIVE SUMMARY

Child restraint systems (car seats) reduce injury risk for young children involved in motor vehicle crashes, but parents experience difficulty installing car seats correctly. Installation by certified child passenger safety (CPS) technicians yields more accurate installation, but is impractical for broad distribution. A potential solution is use of interactive virtual presence via smartphone application (app), which permits “hands on” teaching through simultaneous and remote joint exposure to 3D images. In 2 studies, we examined the efficacy of remote communication via interactive virtual presence to help parents install child restraints. Study 1 was conducted at car seat checkpoints and Study 2 at preschools/daycare centers. In both cases, existing installations were assessed by certified CPS technicians using an objective coding scheme. Participants then communicated with remotely-located certified technicians via a smartphone app offering interactive virtual presence. Technicians instructed participants to install child restraints and then the installation was inspected by on-site technicians. Both before and after the interaction, participants completed questionnaires concerning perception of car seats and car seat installation, self-efficacy to install car seats, and perceived risk of injury to children if they were in a crash. In both studies, accuracy of child restraint installations improved following remote interaction between participants and certified CPS technicians. Together, the samples achieved a weighted average of 90% correct installations across a multi-point inspection. Both samples reported increased self-efficacy to install car seats and altered perceptions about the accuracy of car seat installations in their vehicles. Findings support interactive virtual presence as a strategy to realize accurate installation of child restraints. Interactive virtual presence between certified CPS technicians and the public via smartphone app

has potential to improve proper child restraint installations broadly, including to vulnerable and underserved rural populations.

CHAPTER 1. BACKGROUND

Motor vehicle crashes are a leading cause of death among American children (National Center for Injury Prevention and Control, 2017). For the youngest children, child restraint systems (car seats; henceforth, “child restraints”) reduce risk of serious injury and death (Berg, Cook, Comeli, Vernon, & Dean, 2000; Lane, Liu, & Newlin, 2000; Tessier, 2010). Unfortunately, parents experience significant difficulty installing child restraints correctly, with inaccurate installation rates typically ranging between 70 and 90% (Blair et al., 2008; Brown, Hatfield, Du, Finch, & Bilston, 2010; Duchossois, Nance, & Wiebe, 2008; Koppel & Charlton, 2009). Although incorrect installation is generally preferred over non-use, improving the accuracy of installation will reduce pediatric injury and death rates, and is encouraged by experts as the most effective strategy to preserve child safety in motor vehicle crashes (Beringer-Brown, Pearce, & Rush, 2005; Lesire, Cuny, Alonzo, & Cataldi, 2007).

Experts propose various explanations for why child restraints may be installed incorrectly by parents, but one prominent explanation is the fact that installation is complex and difficult to complete properly. Installation techniques vary widely across vehicles and across child restraints, require frequent changes as children grow and develop, and incorporate manipulation of multiple straps and harnesses. For these reasons, individualized assistance and training to install child restraints by certified CPS technicians, such as those holding national child passenger safety certifications from Safe Kids Worldwide, yields installation rates that far surpass parental use of a manufacturer’s instruction manual alone (Brown, Finch, Hatfield, & Bilston, 2011; Lane et al, 2000; Tessier, 2010). In most locales, however, only a small percentage of child restraints are installed with the assistance of certified CPS technicians. In the US state of Florida, for example, data from the Florida Occupant Protection Resource Center indicates about 15,000 child restraints were checked or installed in the year 2015 (Florida Occupant Protection Resource Center, 2016). In that same year, there were over 224,000 live births in Florida (Florida Department of Health, 2016). Barriers to installation education include convenience to families and access to certified technicians given the labor and costs for governments or non-profit agencies to administer installation programs. Risk of incorrect child restraint installation is particularly high in rural areas (Hafner et al., in press).

A potential solution to these barriers is use of an interactive virtual presence app that provides augmented and merged reality for certified CPS technicians to work remotely with parents to install child restraints into their vehicles. Interactive virtual presence apps provides joint exposure to 3-dimensional images and simultaneous verbal and visual communication, such that a certified technician located remotely can communicate both verbally and visually with a parent to point, explain, instruct, and signify how to install a child restraint properly. Initial testing of such an app as a tool to install child restraints with a group of young adults offered evidence of efficacy. In a randomized experimental design with 39 young adults who had no previous experience installing child restraints, engagement with the app proved more effective in yielding accurate child restraint installations than use of an instruction manual alone (Schwebel, Johnston, & Rouse, 2017).

The present study evaluates whether interactive virtual presence improves the accuracy of existing installation of child restraints in vehicles. We sought to accomplish two primary aims, each tested using a within-subjects design among a sample of parents and other adults who frequently drive with young children in their vehicle. First, we hypothesized communication with a remotely-located certified CPS technician using an interactive virtual presence app would increase the accuracy of existing child restraint installations. Second, we hypothesized participants would perceive higher safety, greater self-efficacy to install child restraints, and reduced risk for child injury following the remote virtual interaction with the certified technician.

Our hypotheses were tested among two samples. The first sample made appointments at car seat checkpoints and therefore had pre-existing concern about the safety of their installations. The second was recruited from individuals who were dropping off or picking up children at community preschools/day care centers and therefore had made no pre-existing effort to have their child restraint installations checked.

CHAPTER 2. RESEARCH METHODS

PARTICIPANTS

In Study 1, twenty adults ages 18-72 (mean = 35.90 years, SD = 12.05) were recruited from community-based car seat checkpoints at multiple sites in Northern and Central Florida. The Study 1 protocol was reviewed and approved by the Institutional Review Board at University of Florida.

Study 2 participants were recruited from two preschools/daycare centers in Birmingham, Alabama. Fifty-two adults ages 20-71 (mean = 35.59 years, SD = 10.59) were recruited during drop-off and pick-up times at the preschools. In some cases, parents expressed an interest in the study and then were scheduled for an appointment time in the coming few days. In other cases, recruitment and enrollment happened immediately. The Study 2 protocol was reviewed and approved by the Institutional Review Board at University of Alabama at Birmingham.

All participants in both studies provided informed consent to participate. Exclusion criteria were inability to communicate in English or inability to conduct the physical tasks required to install a child restraint. No potential participants were excluded from either study for these reasons.

PROTOCOL

The study protocol was identical for both studies. Study 1 participants were approached during scheduled car seat checkpoints at multiple locations in Northern and Central Florida and Study 2 participants during drop-off and pick-up times at preschools and daycare centers in the Birmingham, Alabama area. In both cases, participants were permitted to schedule later appointment times to participate if they desired.

Following consent processes, participants responded to a 22-item baseline questionnaire addressing participant and family demographics, perceptions about child restraints and child restraint installation, and previous behavior and experience surrounding child restraint installations. While participants completed the questionnaire, an on-site certified CPS technician inspected the currently-installed child restraint and rated it using an objective rating scale, detailed below. Participants were not informed about the results of this inspection until after the study was complete. If more than one child restraint was present in the vehicle, a "target" child restraint for the research was chosen at random. Booster seats were excluded from the research.

Next, the participant was remotely connected to an off-site certified CPS technician, who instructed the participant on how to install the child restraint into the vehicle using an interactive virtual presence app. In most cases, this involved removing the existing child restraint installation and re-installing it. Participants were provided a tablet for this purpose; remote technicians used their own smartphones or tablets, as they preferred. Following the remote interchange, the on-site CPS technician again inspected the child restraint installation using an objective rating scale and without informing participants about the results of the inspection until the study was complete. During the inspection, the participant completed a 13-item questionnaire assessing their perceptions of the remote communication and child restraint installation process, as well as their broader perceptions about child restraints and child restraint installation. Prior to departure, all child restraints in the vehicle (including those not randomly selected as the "target" for research purposes if multiple child restraints were present) were re-inspected for safety. If needed, participants were assisted with re-installation by the on-site certified technician. Participants were offered a gift card to reimburse them for their time.

INTERACTIVE VIRTUAL PRESENCE APP

Participants and remote technicians communicated using HelpLightning, a commercially available app that functions on smartphones and tablets. Prior to the study, remote technicians engaged in a 3-hour training session to learn how to use the app effectively. Participants were given instructions on the use of the app prior to connecting to the remote technician. No technical concerns about the app's functioning were expressed by participants or remote technicians.

In technical language, HelpLightning offers interactive visual and aural communication and a virtual interactive presence to users. It provides merged reality and virtual interaction. Users can instantly and simultaneously view and merge two real-time perspectives, offering opportunity for remote collaboration while interactively examining, pointing to, illustrating and discussing a video stream. In lay language, users requiring help – in this case the research participants – may place their smartphone over a targeted area to allow the expert – in this case the remotely-located certified CPS technician – to "freeze" that image and then point to particular areas with their hands and/or with software tools like arrows and pointers located within the app. Thus, for example, if the research participant was unsure where to connect a lower anchor, he or she could show the technician the back seat of the car and request that the technician point to the location of the lower anchor.

CODING OF CAR SEAT INSTALLATION ACCURACY

In both studies, on-site certified CPS technicians used a structured coding sheet to rate installation of the child restraints both before and after participants interacted with the remote technicians. The coding sheet was initially developed based on recommendations from Children's of Alabama National Child Passenger training guides, technician guide, and CPS

Check Form; a thorough review of multiple child restraint manufacturer user manuals; criteria from the SafeKids Worldwide Child Passenger Safety Checklist; and adoption of criteria used in previous published studies (Lane et al., 2000; Tessier, 2010; Swartz et al., 2013) and the measures used in our previous research (Schwebel et al., 2017). It was then refined iteratively through input from multiple expert researchers in child safety and injury prevention, plus review by three certified CPS technicians. It was further refined after pilot-testing at a car seat check prior to implementation in the study.

Coding criteria for four child restraint types were developed, representing forward and rear-facing seats and installation with lower anchors or seat belts. The installation of each seat was evaluated using between 18 and 21 items across 5 categories: (a) seat integrity (e.g., crash history, expiration, recall); (b) installation of the seat into the vehicle (e.g., placement and direction, positioning, movement); (c) the harness and tether straps (e.g., threading, twisting); (d) the lower anchors or seat belts (e.g., correct clipping of lower anchors; correct threading and tightness of seat belts); and (e) the base (only for rear facing child restraints with detachable base; e.g., movement and recline angle). Items that were not relevant to a particular child restraint or vehicle were omitted, and the percentage of correct installation facets for each category was used for data analysis. We also computed an overall percentage of correct aspects of the full installation (labeled "accuracy of full installation") across all categories. The coding sheets are reproduced in Appendix A, with footnotes added to denote which criterion was coded into which category and bolding added to denote correct installation.

DATA ANALYSIS

Data analysis proceeded in four steps, each conducted separately for the two samples. We did not merge samples for analysis because they were drawn from different populations (one a group of individuals attending car seat checkpoints and the other a group delivering children to and from daycares/preschools). First, we considered descriptive data about the samples, including their use of child restraints and smartphones plus their previous experience obtaining instruction in child restraint installation. Second, we considered the safety of child restraint installations upon arrival and again after receiving instruction from the remote technician. Repeated-measures *t*-tests were computed to assess change over time, although we also considered descriptive data on post-interaction outcomes since a substantial portion of the child restraints in Study 1 arrived newly-purchased and uninstalled. Third, we examined participants' perceptions about child restraint installation both before and after interacting with the remote technician. The Sign Test was used to assess change over time in these ordinal outcome variables. Finally, we examined descriptive data concerning participants' impressions about the remote instruction they received.

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CHAPTER 3. RESULTS

Table 3-1 presents descriptive data about both samples. Participants were primarily female (70% in Study 1, 87% in Study 2) and parents (80% in Study 1, 85% in Study 2). They were diverse in terms of race/ethnicity, education, and household income. Almost all (100% in Study 1, 98% in Study 2) reported daily smartphone use and most reported their children usually rode in child restraint seats. They had mixed previous experience with certified CPS technicians and use of child restraint instruction manuals.

Table 3-2 presents results from both studies addressing the first primary aim, that accuracy of child restraint installation would improve following remote interaction with the remote CPS technician. In Study 1, 9 of the 20 (45%) participants arrived with newly-purchased child restraints that were not yet installed, yielding some missing data prior to the remote interaction. Among those seats that were installed, accuracy of installation was improved in all categories, including the full installation score which improved from 92% to 97% correct. None of the changes were statistically significant in the small sample. Given the rate of uninstalled child restraints upon arrival, we also interpreted descriptive data following the interaction, which ranged from 93% to 100% correct and included an overall score of 97% correct.

In Study 2, the composite score of overall installation accuracy increased significantly following interaction with the remote technician, from 83% to 87% ($t\ (42) = -2.23$, $p < .05$). We also saw statistically significant increases in two specific aspects of the installation: seat integrity (from 92% to 97%, $t\ (43) = -2.29$, $p < .05$) and lower anchors/seat belts (from 79% to 90%, $t\ (41) = -3.15$, $p < .01$).

Table 3-3 addresses the second study aim, that participants' perceptions about child restraint safety and installations would improve following the interaction with the remote technician. In both samples and for all four categories, there was statistically significant change. Following the interaction, participants were significantly more likely to perceive their child restraint was installed correctly, more confident about their household's ability to install child restraints properly, less likely to rate the difficulty of installing a child restraint as hard, and less likely to think their child would be injured if they were in a crash.

The final step of data analysis was to consider perceptions about the remote interaction with the CPS technician. As shown in Table 3-4, participants in both samples generally found the communication to be easy, helpful, and detailed. They felt the remote instruction was equivalent to what they might have received live, and that remote instruction could potentially replace in-person instruction.

CHAPTER 4. CONCLUSIONS, RECOMMENDATIONS AND SUGGESTED RESEARCH

Our results suggest interactive virtual presence may be an effective tool to remotely assist individuals in the correct installation of child restraints. These results extend earlier data from a sample of non-parent young adults (Schwebel et al., 2017) and indicate the need to continue investigating the potential of interactive virtual presence technology to supplement or even replace live installation of child restraints by certified CPS technicians. Use of interactive virtual presence apps can overcome significant barriers of existing live installation strategies, including the burdens of scheduling convenient visits among families with busy schedules or chaotic lifestyles; reaching individuals in remote and rural locations; and providing sufficient geographic coverage of certified CPS technicians. There may also be potential to serve international demand in locations where the supply of certified CPS technicians is low, serve non-English speaking parents in the US who only have English-speaking technicians available in their local area, and serve parents of children with special needs for restraint selection or installation.

Ultimately, we envision centralized centers that offer CPS technician advice on installing child restraints using interactive virtual presence. Using poison control centers as a model, these centers might be funded by government, industry, or non-profit entities. A single center could potentially provide complete and broad temporal and spatial coverage. We are not aware of any data concerning the number of errors live CPS technicians make when installing child restraints on-site, but across both studies, the use of interactive virtual presence yielded a weighted accuracy of approximately 90%. Increased communication training of technicians, technician practice over time, and improvements in interactive merged reality software may increase this rate.

Across both studies, the child restraint installation errors that remained following the interaction with the remote technician were scattered. Some were comparatively minor – for example, the seat was not yet locked into the base or excess straps were not tucked away. Some were not fixable without obtaining a new child restraint – for example, the harness straps were frayed or the seat was on recall – and would have occurred at the same rate in the presence of a live CPS technician. And some were rather significant errors that may have been made by any certified technician, but perhaps were more likely with a remote rather than a live technician. Examples of these errors included an incorrect recline angle, a base or seat that moved more than an inch in a particular direction, or twisted straps.

A key aspect of our finding is that we not only improved the accuracy of the installations, but we also altered individuals' self-efficacy to install child restraints and perceptions about the accuracy of the installations. Health behavior change models such as Social Cognitive Theory (Bandura, 1977, 1997) and the Health Belief Model (Rosenstock, 1974) emphasize the need for self-efficacy as a precursor to or component of health-related behavior change. Parents are unlikely to seek out help to improve the installation of their child restraint if they do not possess sufficient self-efficacy that accurate installation is possible, either on their own or through help from an expert. In both samples, the interactions with the remote technician increased participants' self-efficacy significantly.

The interaction with the remote technician also changed participants' perceptions of their children's safety, as they reported reduced likelihood of child injury if they were in a crash after the interaction with the remote technician. This change in perception probably has some veracity, and it also coincides with health behavior change theories, which imply perceptions of vulnerability to a negative health outcome are needed to create behavior change. In this case, the participants demonstrated some perceived vulnerability prior to deciding to join the study (and in the case of Study 1, setting an appointment at a car seat checkpoint). Consistent with health behavior change theory, that perceived vulnerability decreased following the health behavior change (obtaining expert advice to install the child restraint and perceiving that advice as helpful and effective).

Finally, our results indicate user endorsement of the potential for remotely-providing instruction in child restraint installation using an interactive virtual presence app. This endorsement offers promise for the potential of broad implementation following rigorous evaluation in a randomized trial.

Our research suffered from some limitations. Although we conducted two studies with independent samples, each sample was recruited from a single geographic area and was limited in size. We trained the remote technicians to use the interactive virtual presence app, but they anecdotally reported that they felt they interacted more effectively with the app after using it for some time (post-hoc analyses of data from Study 2 did not yield significant differences in results for latter participants versus earlier ones, however, nor did they yield significant differences across remote technicians working with participants). Finally, we used an objective coding scheme to assess accuracy of child restraint installation, but we combined accuracy across front and rear-facing seats, and across use of lower anchors versus seat belts. The wide variation in child restraints, vehicles, and attachment systems complicates valid and accurate assessment of installation accuracy, so we developed an objective and valid coding scheme to capture as much detail as we could, recognizing the imperfections in any coding or scoring scheme. We also note one error in the coding sheets that was discovered after the research was complete. No assessment of top tether anchoring was conducted for forward-facing seat belt installations, and future research should incorporate that assessment into a coding paradigm.

Despite these limitations, our results offer compelling evidence that interactive virtual presence interactions with certified CPS technicians may improve the installation of child restraints. Implementation is a logical next step, although that movement should be predicated on a large-scale randomized trial evaluating and demonstrating the efficacy of installation via remote interactive virtual presence compared to the current best practice (live technician). If results from such a trial are similarly positive, broad implementation through industry, government, non-profit, and hospital agencies or partnerships is advised.

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Table 3-1. Descriptive Data for Samples

Variable	Study 1 (N=20) M (SD) or %	Study 2 (N=52) M (SD) or %
Age (years)	35.90 (12.05)	35.59 (10.59)
Female (%)	70%	87%
Race/Ethnicity (%)		
Caucasian	45%	69%
African American	20%	19%
Other or Multi-Racial	35%	12%
Relation to child		
Parent	80%	85%
Grandparent/Great-Grandparent	15%	14%
Younger sibling	5%	0%
Education		
High School/High School Diploma	10%	12%
Some College/Associate’s	35%	29%
College Degree	25%	31%
Post-Graduate Training/Degree	30%	18%
Household income		
Under $40,000	35%	16%
$40,000-$79,999	35%	37%
$80,000-$119,999	20%	29%
$120,000 and above	10%	18%
Use smartphone daily	100%	98%
How often child rides in car seat		
Never	6%	0%
Occasionally or Sometimes	6%	2%
Often or Almost always	6%	10%
Always	82%	88%
Previous experience with certified CPS technician	40%	19%
Previous use of car seat instruction manual		
None	16%	26%
A little	11%	14%
Some	16%	22%
Quite a bit or Extensive	58%	39%

Table 3-2. Accuracy of Child Restraint Installation before and after Remote Assistance

	Study 1 (N=20)			Study 2 (N=52)		
Variable	Pre M% (SD)	Post M% (SD)	*t* (df)	Pre M% (SD)	Post M% (SD)	*t* (df)
Seat integrity	90% (19)	98% (7)	-1.61 (13)	92% (14)	97% (8)	-2.29 (43)*
Seat installation	92% (13)	96% (9)	-0.88 (13)	86% (17)	85% (23)	.44 (41)
Harness & tether straps	99% (5)	100% (0)	-1.00 (12)	80% (24)	84% (23)	-1.02 (40)
Lower anchor/seat belt	93% (15)	97% (7)	-1.00 (13)	79% (25)	90% (13)	-3.15 (41)**
Base	89% (17)	93% (15)	-0.43 (8)	72% (36)	70% (40)	.20 (18)
Full installation	92% (11)	97% (4)	-1.54 (14)	83% (13)	87% (10)	-2.23 (42)*

Note: M = Mean; SD = Standard Deviation; df = degrees of freedom.

* $p < .05$. ** $p < .01$.

Table 3-3. Perceptions about Remote Assistance to Install Child Restraints

	Study 1 (N=20)			Study 2 (N=52)		
Variable	Pre %	Post %	*p*-value[a]	Pre %	Post %	*p*-value[a]
How likely do you think it is that the car seat in your vehicle is installed correctly ?			.007			<.001
Not at all	15%	0%		0%	0%	
A little or somewhat	30%	0%		62%	0%	
Quite or very	55%	100%		37%	100%	
How confident are you that you or someone in your household knows how to install car seats correctly ?			.006			<.001
Not at all	10%	0%		4%	0%	
A little or somewhat	45%	5%		56%	12%	
Quite or very	45%	95%		43%	88%	
Rate the difficulty of properly installing a car seat?			.007			<.001
Easy or somewhat easy	40%	65%		21%	65%	
In between	20%	20%		42%	27%	
Somewhat hard or hard	40%	15%		37%	8%	
How likely is your child to be injured if you were in a car crash?			.001			<.001
Not at all	10%	50%		14%	41%	
A little or somewhat likely	75%	45%		65%	59%	
Quite or very likely	15%	5%		18%	0%	

[a] Results from Sign Test

Table 3-4. After Installation, Impressions about Remote Assistance to Install Child Restraints

	%, Study 1 (N=20)	%, Study 2 (N=52)
How easy to communicate with instructor?		
Easy or somewhat easy	75%	88%
In between	20%	8%
Somewhat hard or hard	0%	4%
How helpful was instruction?		
Not at all or a little bit	0%	8%
Somewhat	0%	4%
A fair amount or quite a bit	100%	88%
How detailed was instruction?		
Not at all or a little bit	0%	4%
Somewhat	10%	8%
A fair amount or quite a bit	90%	88%
Was it difficult to understand the instructions?		
No, not really or a little bit	80%	96%
Somewhat	10%	2%
Yes, a fair amount or yes, quite a bit	10%	2%
How much would it have helped if the instructor was with you in person rather than talking remotely?		
Not at all or a little bit	40%	47%
Somewhat	25%	14%
A fair amount or quite a bit	35%	39%
Could remote instruction replace in-person instruction?		
No, definitely or probably not	5%	8%
Not sure	5%	16%
Yes, probably or definitely	90%	76%

Appendix A. Coding Sheets

ID: ___________ Date: ________ On-site Tech: ______________________ Remote Tech: _______________

Pre or **Post** (circle) Child DOB: _________ Child height: ___________ Child weight: ___________

Temperature: ________ Other weather conditions: ____

Car Make/Model/Year: ____ Site: ______________________

Start time (clock): ___________ End time (clock): ___________ Stopwatch time: __________

Coding Sheet for Car Seat Study – **Anchors used, Rear-Facing**

[[Seat and overall]]

1. Is the car seat securely locked into the base?[1] ....**YES**.......NO.....UNK... ...NA
2. Is the car seat installed in front of an airbag?[1] ....YES.......**NO**.....UNK... ...NA
3. Is the seat facing the correct direction for make/model/child?[1] .......................**YES**.......NO......UNK.. ...NA
4. Is the carrying handle in correct position?[1]..**YES**.......NO......UNK.. ...NA
5. Has the seat been in a crash?[2] ....YES.......**NO**......UNK.. ...NA
6. Is the seat expired?[2] ....YES.......**NO**.......UNK ....NA
7. Is the seat a make/model that is on recall?[2] ....YES.......**NO**......UNK.. ...NA
8. Are any straps torn, frayed or damaged (check all)?[2] .....................................YES.......**NO**......UNK.. ...NA

[[Harness Straps]]

9. Are the harness straps threaded correctly behind the seat?[3] .............................**YES**.......NO...... UNK....NA
10. Are the harness straps twisted?[3]..YES.......**NO**...... UNK....NA

[[Base – Remove car seat from car]]

11. Does the base or seat move more than 1 inch left and right?[4] ..........................YES.......**NO**...... UNK....NA
12. Does the base or seat move more than 1 inch forward and back?[4] .................YES.......**NO**...... UNK....NA
13. Is the recline angle correct for the make/model/child?[4]...................................**YES**.......NO...... UNK....NA

[[Anchors – Start to release Base from car]]

14. Are both anchors and seat belts used at the same time?[5] ................................YES.......**NO**...... UNK ....NA
15. Are lower anchors clipped facing down?[5] ....**YES**.......NO...... UNK ....NA
16. Are lower anchors clipped into the proper anchors (and not the same one)?[5]..**YES**.......NO......UNK .. ...NA
17. Are the lower anchor straps threaded/routed correctly?[5]..................................**YES**......NO.......UNK .. ...NA
18. Are the lower anchor straps twisted?[5]...YES......**NO** UNK .. ...NA

1. Item used to assess seat installation as well as overall accuracy of full installation.
2. Item used to assess seat integrity as well as overall accuracy of full installation.
3. Item used to assess harness and tether straps as well as overall accuracy of full installation.
4. Item used to assess base as well as overall accuracy of full installation.
5. Item used to assess anchors and seat belt as well as overall accuracy of full installation.

Note: Bolded responses are added and reflect correct installation.

ID: __________ Date: _______ On-site Tech: ____________________ Remote Tech: ______________

Pre or **Post** (circle) Child DOB: ________ Child height: __________ Child weight: __________

Temperature: _______ Other weather conditions: ____

Car Make/Model/Year: _____________________________________ Site: ____________________

Start time (clock): __________ End time (clock): __________ Stopwatch time: _________

Coding Sheet for Car Seat Study – **Seat Belts Only used, Rear-Facing**

[[Seat and overall]]

1. Is the car seat securely locked into the base?[1] ....................................**YES**..........NO.......... UNK ....NA
2. Is the car seat installed in front of an airbag?[1] ...................................YES..........**NO**.......... UNK ....NA
3. Is the seat facing the correct direction for make/model/child?[1] ...........**YES**..........NO.......... UNK ....NA
4. Is the carrying handle in correct position?[1] ....**YES**..........NO.......... UNK ....NA
5. Has the seat been in a crash?[2] ....YES..........**NO**.......... UNK ....NA
6. Is the seat expired?[2] ....YES..........**NO**.......... UNK ....NA
7. Is the seat a make/model that is on recall?[2] ....YES..........**NO**.......... UNK ....NA
8. Are any straps torn, frayed or damaged (check all)?[2] .........................YES..........NO**.........** UNK ....NA

[[Harness Straps]]

9. Are the harness straps threaded correctly behind the seat?[3] ...............**YES**..........NO.......... UNK ....NA
10. Are the harness straps twisted?[3] ....YES..........**NO**.......... UNK ....NA

[[Base – Remove car seat from car]]

11. Are both anchors and seat belts used at the same time?[5] ....................YES..........**NO**.......... UNK ....NA
12. Is the seat belt correctly threaded/routed through belt path?[5] .............**YES**..........NO.......... UNK ....NA
13. Is the seat belt taut and tight?[5] ....**YES**..........NO.......... UNK ....NA
14. Does the base move more than 1 inch left and right?[4] .........................YES..........**NO**.......... UNK ....NA
15. Does the base move more than 1 inch forward and back?[4] ................YES..........**NO**.......... UNK ....NA
16. Is the recline angle correct for the make/model/child?[4] .......................**YES**..........NO.......... UNK ....NA

[[Anchoring – Start to release Base from car]]

17. Is the seat belt twisted?[5] ....YES..........**NO**.......... UNK ....NA
18. Is the seat belt "locked"?[5] ....**YES**..........NO.......... UNK ....NA
19. Are the correct seat belt buckles used for the seat belts?[5] ..................**YES**..........NO.......... UNK ....NA

1. Item used to assess seat installation as well as overall accuracy of full installation.
2. Item used to assess seat integrity as well as overall accuracy of full installation.
3. Item used to assess harness and tether straps as well as overall accuracy of full installation.
4. Item used to assess base as well as overall accuracy of full installation.
5. Item used to assess anchors and seat belt as well as overall accuracy of full installation.

Note: Bolded responses are added and reflect correct installation.

ID: ___________ Date: ________ On-site Tech: ______________________ Remote Tech: _______________

Pre or **Post** (circle) Child DOB: _________ Child height: ___________ Child weight: ___________

Temperature: ________ Other weather conditions: ____

Car Make/Model/Year: ____ Site: ______________________

Start time (clock): ___________ End time (clock): ___________ Stopwatch time: __________

Coding Sheet for Car Seat Study – **Anchors used, Forward-Facing**

[[Seat and overall]]

1. Is the car seat installed in front of an airbag (front seat)?[1] ..............................YES.......**NO**......UNK......NA
2. Is the seat facing the correct direction for make/model/child?[1] .......................**YES**.......NO......UNK......NA
3. Has the seat been in a crash?[2] ....YES.......**NO**......UNK......NA
4. Is the seat expired?[2] ....YES.......**NO**......UNK......NA
5. Is the seat a make/model that is on recall?[2] ....YES.......**NO**......UNK......NA
6. Are any straps torn, frayed or damaged (check all)?[2] .....................................YES.......**NO**......UNK......NA
7. Does the seat lie flat on the vehicle's back – headrest not in the way?[1] ..........**YES**.......NO......UNK......NA
8. Are all excess seat/harness strap lengths secured properly?[1] ...........................**YES**.......NO......UNK......NA

[[Top Tether Straps]]

9. Are the top tether harness straps twisted?[3] ....YES.......**NO**......UNK......NA
10. Is the top tether strap attached correctly?[3] ....**YES**.......NO......UNK......NA
11. Is the top tether strap clipped into the proper anchor?[3] ..................................**YES**.......NO......UNK......NA
12. Is the top tether strap taut and tight?[3] ....**YES**.......NO......UNK......NA

[[Seat]]

13. Does the car seat move more than 1 inch left and right?[1] ...............................YES.......**NO**......UNK......NA
14. Does the car seat move more than 1 inch forward and back?[1] .......................YES.......**NO**......UNK......NA

[[Anchors]]

15. Are both anchors and seat belts used at the same time?[5] ................................YES.......**NO**......UNK......NA
16. Are lower anchors clipped facing down?[5] ....**YES**.......NO......UNK......NA
17. Are lower anchors clipped into the proper anchors (and not the same one)?[5] .**YES**.......NO......UNK......NA
18. Are the lower anchor straps threaded correctly?[5] ....**YES**.......NO......UNK......NA
19. Are the lower anchor straps twisted?[5] ....YES.......**NO**......UNK......NA

[[Harness Straps]]

20. Are the harness straps threaded correctly behind the seat?[3] ...........................**YES**.......NO......UNK......NA
21. Are the harness straps twisted? [3] ....YES.......**NO**......UNK......NA

1. Item used to assess seat installation as well as overall accuracy of full installation.
2. Item used to assess seat integrity as well as overall accuracy of full installation.
3. Item used to assess harness and tether straps as well as overall accuracy of full installation.
4. Item used to assess base as well as overall accuracy of full installation.

[5.] Item used to assess anchors and seat belt as well as overall accuracy of full installation.
Note: Bolded responses are added and reflect correct installation.

ID: __________ Date: _______ On-site Tech: ____________________ Remote Tech: ______________

Pre or **Post** (circle) Child DOB: ________ Child height: __________ Child weight: __________

Temperature: _______ Other weather conditions: ____

Car Make/Model/Year: _____________________________________ Site: ____________________

Start time (clock): __________ End time (clock): __________ Stopwatch time: _________

Coding Sheet for Car Seat Study – **Seat Belts Only used, Forward-Facing**

[[Seat and overall]]

1. Is the car seat installed in front of an airbag (front seat)?[1] .... YES .... **NO** ..... UNK ..... NA
2. Is the seat facing the correct direction for make/model/child?[1] .... **YES** .... NO ..... UNK ..... NA
3. Has the seat been in a crash?[2] .... YES .... **NO** ..... UNK ..... NA
4. Is the seat expired?[2] .... YES .... **NO** ..... UNK ..... NA
5. Is the seat a make/model that is on recall?[2] .... YES .... **NO** ..... UNK ..... NA
6. Are any straps torn, frayed or damaged (check all)?[2] .... YES .... **NO** ..... UNK ..... NA
7. Does the seat lie flat on the vehicle's back – headrest not in the way?[1] ..... **YES** .... NO ..... UNK ..... NA
8. Are all excess seat/harness strap lengths secured properly (check all)?[1] .... **YES** .... NO ..... UNK ..... NA

[[Seat Belt]]

9. Is the seat belt correctly threaded/routed through belt path?[5] .... **YES** .... NO ..... UNK ..... NA
10. Is the seat belt twisted?[5] .... YES .... **NO** ..... UNK ..... NA
11. Is the seat belt taut and tight?[5] .... **YES** .... NO ..... UNK ..... NA
12. Is the seat belt "locked"?[5] .... **YES** .... NO ..... UNK ..... NA
13. Are the correct seat belt buckles used for the seat belts?[5] .... **YES** .... NO ..... UNK ..... NA

[[Seat]]

14. Does the seat move more than 1 inch left and right?[1] .... YES .... **NO** ..... UNK ..... NA
15. Does the seat move more than 1 inch forward and back?[1] .... YES .... **NO** ..... UNK ..... NA
16. Are both anchors and seat belts used at the same time?[5] .... YES .... **NO** ..... UNK ..... NA

[[Harness Straps]]

17. Are the harness straps threaded correctly behind the seat?[3] .... **YES** .... NO ..... UNK ..... NA
18. Are the harness straps twisted?[3] .... YES .... **NO** ..... UNK ..... NA

1. Item used to assess seat installation as well as overall accuracy of full installation.
2. Item used to assess seat integrity as well as overall accuracy of full installation.
3. Item used to assess harness and tether straps as well as overall accuracy of full installation.
4. Item used to assess base as well as overall accuracy of full installation.
5. Item used to assess anchors and seat belt as well as overall accuracy of full installation.

Note: Bolded responses are added and reflect correct installation.