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child passenger**

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THE CHILD SUPPORT SEAT—A NEW TYPE OF PROTECTION SYSTEM FOR THE OLDER CHILD PASSENGER

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Abstract—A protection system for the older child passenger consisting of a specially designed cushion has been allocated to 50 families. The parents completed a questionnaire and were interviewed following 3 months' and one year's use of the seats concerning their safety, comfort and handling qualities. These results are discussed as well as suggestions to manufacturers concerning the improvement of the system.

BACKGROUND

The group most neglected when considering the problem of child protection in cars is that of the 4- to 12-year-old child, i.e. children who have outgrown a child seat. The problems of constructing a good system for children in this age group differ markedly from those of constructing a system for younger children.

Parents and others who drive with a young child in the car are well aware of the need for keeping the child in place in order to prevent disturbance to the driver. There is also an obvious need to restrain the child during turning and braking maneuvers. Factors related to the protection of the child during an accident as well as the comfort of the child are of course also important to parents (see, e.g. Arnberg, 1974, 1978; Arnberg, Arnberg and Trinca, 1978), but it is doubtful whether these factors alone would induce parents to obtain a child restraint system, as most parents judge the risk for an accident to be rather low.

The older child, however, can keep himself in place and is no longer a great disturbance to the driver. This has resulted in the fact that parents often have overlooked the safety needs of children in this age group. Many parents seem to feel that the child manages well in the back seat. In many European cars with bucket seats, however, the child often has a habit of standing between the front seats and is thus completely unprotected in the event of an accident. The recognition of the need for restraining all passengers in a car has become more and more widespread. Accident analyses have shown that all passengers in a car are safer if they are fastened in, regardless of whether this occurs in the front or rear seat (Andersson and Jonasson, 1977; Williams and Zador, 1976). Thus interest has increased for developing a protection system for children who have outgrown a child seat but are still too small to use an adult belt.

During the past decade preliminary tests have been carried out at the Swedish Road and Traffic Research Institute studying seat belts and harnesses designed especially for children. The results have shown that few children have accepted using these systems, mainly because they must remain seated in a position which does not allow them to see out. During this age it is important for children to observe what is happening on the road and to be able to follow their parents' comments concerning this activity. A protection system taking this factor into consideration would therefore be highly desirable.

Several manufacturers have recently developed a system which elevates the child, enabling him to see out. This system consists of a specially designed cushion which is placed on the ordinary back seat. The cushion elevates the child to window height and in this position the adult belt assumes a better fit. Two variants of this system are available in both Sweden and Australia. The first variant consists simply of a thick foam rubber cushion (including back support). In simulated crash tests in Melbourne, however, (Arnberg and Mollnar, unpublished research findings) it has been shown that those cushions do not function well and may even increase the risk for injury during an accident. This is because of the softness of the cushion as well as the fact that it is not held in place by the adult belt. These factors give the cushions a tendency to slide forward during an accident, resulting in the child being left hanging in the seat belt by the neck. Turbell (personal communication), from simulated crash test studies at the Swedish Road and Traffic Research Institute, as well as from earlier experience, has also warned against this type of system.

The second variant consists of a relatively hard cushion held directly in place by the seat belt in order to prevent its sliding forward during a collision. The fixation points on the cushion also improves the belt geometry making the belt fit better around the pelvis of the child. The belt then crosses the upper part of the body in an ideal way, the hooks of the cushion preventing the lap belt from sliding upwards.

Two of these latter types of cushions, one designed by Volvo in Sweden and the other designed by Repco in Australia, have performed well in simulated crash tests. The results have indicated that the child, when restrained in such a system, has a much greater chance of surviving an accident than if unrestrained. It must be recognized, however, that these systems in no way have the protection capacity of rearward facing child seats. From Andersson and Jonasson's [1977] findings, that it is at least somewhat effective restraining the older child in an adult belt system, one can draw the logical conclusion that the child restrained in such a system is at least as well protected as an adult passenger restrained in a seat belt.

In order to study how parents and children like using this type of system, as well as to be able to make suggestions concerning their further improvement, a number of the seats have been allocated to parents with children in three different age groups. The present report summarizes findings concerning a number of different aspects of the seats after they were used first for three months, and then for one year.

METHOD

Cushions

Two types of cushions were allocated in the study, one manufactured by Volvo and the other by Repco (see Figs. 1, 2, 3, 4 and 6).

Subjects

The cushions were randomly allocated to parents of 3-, 6-, and 8-year-old children. Parents were selected from those responding to an earlier questionnaire in which they were asked questions concerning the frequency with which they transported children in the car as well as whether they would be willing to participate in a study investigating the use of a new protection system for older children. The seats were given free of charge as an incentive for participating in the study.

Forty-two of the 49 distributed questionnaires were returned and of these, 38 parents were positive toward participating in the study. Twenty-six of these parents who drove daily with a child in the car were chosen. (Five of these families had two children participating in the study). The resultant thirty-one children tried thirty Volvo and eight Repco cushions. In several cases the parents were given more than one cushion in order for a direct comparison to be made. The parents owned a variety of cars, all with three-point safety belts installed in the rear seat.

In connection with the main study, a secondary study was also carried out in which 10 cushions (both Volvo and Repco) were tried by 20 children of employees in several local government agencies.

Procedure

The parents participating in the study visited the project leader individually at which time the seat was installed and tried by the child. In the several cases where two cushions were distributed to one family, a cushion of each type was always allocated in order to allow for a direct comparison to be made. Opportunity was allowed to answer any questions which the parents might have concerning the seats.

Follow-up questionnaires

The parents were asked to complete a questionnaire concerning the seats after they had used them for three months, and then again after one year. The questionnaires were followed by a short interview.

Fig. 1. The Volvo cushion with a three-point-belt.

Fig. 2. Placing the child on the Volvo cushion.

Fig. 3. The Volvo cushion with a three-point-belt.

Fig. 4. The Repco cushion. Notice that the head is above the back support.

Fig. 5. The Repco cushion placed in the middle of the back seat, with special child harness and head support. This appears to be a good alternative for the future.

Fig. 6. Side view of Repco cushion held in place by a four-point-belt.

RESULTS

Safety aspects

Most parents, after using the seats for three months, were uncertain concerning the safety aspects of the seats, which is not surprising considering the lack of information concerning this relatively new system (see Table 1). Following one year's use of the seats, the majority of the parents (75%) rated the safety of the seats as good. Even in those cases where the safety of the seats was judged to be good, however, there were several complaints related to safety factors. The most serious complaint concerned the lack of head and neck support for the child, which was especially critical for the older children whose heads extended above the back of the rear seat. In response to a direct question concerning whether the parents felt the child would have adequate head support during a potential rear collision, all of the parents of the 8-year-olds except three responded "no." This same opinion was held by half of the parents of the 6-year-olds and, after a year, by many of the parents of the 3-year-olds. Depending on the child's height and the car's design, even the youngest children using this system may thus fail to receive adequate head support. Several parents who owned cars in which special head support was lacking in the rear seat but present in the front seat therefore felt it was safer to place the child in the front seat.

Another safety-related complaint was that the belt sometimes rubbed against the child's neck. This was especially true for some of the smaller 3-year-olds for whom the adult belt did not really fit properly. A higher type of support seat may thus be necessary for very small children.

Some parents also complained that there was a tendency for the child to slide off the Volvo seat during turning due to the lack of side support. In general the Repco seat was judged to be somewhat safer than the Volvo seat, and no parent felt it to be unsafe.

The results in the secondary study were similar except for the fact that the need for some type of neck support was emphasized to an even greater extent.

Comfort aspects

Most of the parents judged the seats to be comfortable for their children after using them for three months (see Table 2).

Following one year's use of the seats, however, only slightly over half of the parents were satisfied with the comfort of the seats, and of the parents of the 8-year-olds, only 0.33 were satisfied. This was only true for the Volvo seat however. The parents who had received a Repco cushion continued to be satisfied with the seats after one year's use. When the children were questioned concerning the comfort of the Volvo seat, nearly all of the 3- and 6-year-olds, but only about half of the eight-year-olds felt the seat was comfortable after three months' time. After a year, however, half of the 3- and 6-year-olds, as well, were no longer satisfied with the comfort of the seat. The children felt that the Volvo cushion was too hard, that the front edge was too high, and that the cushion was too short so that the legs were left hanging in the air and sometimes fell asleep. The design of the seat also caused the children to slide sideways in the

Table 1. Parents' rating of the safety of the seats following three months' use (one response per seat)

Age of child	Good	Poor	Uncertain	N
	Per cent	Per cent	Per cent	
3 years	36	0	64	11
6 years	33	17	50	12
8 years	40	20	40	15

Table 2. Parents' rating of the comfort of the seats following three months' use

Age of child	Good	Poor	Uncertain	N
	Per cent	Per cent	Per cent	
3 years	77	15	8	11
6 years	73	0	27	12
8 years	86	14	0	15

seat. These complaints did not occur, however, in connection with the Repco seat whose comfort was judged to be good both after three months' and one year's time.

With regard to the question of whether the seat belt irritated the child, 2 children in every age group stated that this was the case after having used the seats for one year.

After the one year evaluation, half of the children had tried sleeping in the seats for shorter periods, although in most cases the child slept lying down in the back seat. The lack of neck support made it impossible for nearly all of the 8-year-olds, and many of the 6-year-olds, as well, to sleep in the seat.

Ability of child to see out

An important aspect of the comfort of the seats is whether or not they enable the child to see out. Table 3 shows the percentage of children in each age group who were able to see out of the car while sitting in the seats.

For some of the three-year-olds, the design of the back seat made it impossible to see out even when the children were elevated. This problem, however, disappeared during the later follow-up questionnaire. The older children had trouble seeing out as well because the elevation made them assume too high a position.

Handling aspects

Most of the parents judged the handling qualities of the cushions to be good after having used them for three months (Table 4).

After having used the seats for one year, the parents' satisfaction with the handling qualities of the Volvo seat increased to 65%. The handling qualities of the Repco cushion, however, were judged to be worse by those parents having the opportunity to compare both seats. Although no parent judged the handling qualities of the Repco cushion to be poor, they complained that it was too heavy and that children under 6 years were not able to carry the cushion themselves.

Fastening the child into the system was felt by four parents using the Volvo system to be difficult after three months' use of the seats, although no parent felt that this was difficult after having used the seats for a year.

After only one month all of the 6- and 8-year-olds were able to fasten themselves into the system. All of the children except two 3-year-olds were able to remove themselves from the seat. After one year's use of the seats half of the 3-year-olds could also fasten themselves into the seat and all but one could remove the seat belt themselves.

Frequency of use

The parents in the study were chosen because they transported the child in the car frequently, usually on a daily basis. This is rather common in Sweden as many parents must transport their children by car to and from day nurseries. This, of course, was less true for the 8-year-olds who were attending school, and this age group in general travelled less frequently in the car.

Table 3. Percent of children who were able to see out (results after three months' use of the seats)

Age of child	Able to See Out	Unable to See Out	No.
	Per cent	Per cent	
3 years	73	27	11
6 years	100	-	12
8 years	80	20	15

Table 4. Parents' rating of the handling qualities of the cushions following three months' use

Age of child	Good	Poor	Uncertain	N
	Per cent	Per cent	Per cent	
3 years	73	9	18	11
6 years	58	-	42	12
8 years	60	7	33	15

Table 5. Frequency of use after three months' and one year's use of the seats

Age	Every time Per cent		Sometimes Per cent	
	3 months	1 year	3 months	1 year
3 years	73	36	27	64
6 years	75	25	25	75
8 years	60	27	40	73

Most of the parents had used the cushion every time the child was in the car after the three-month follow-up, but only approximately one-third of the parents did so after the one-year follow-up (Table 5).

Reasons for not using the seat at the first follow-up included the child's being unaccustomed to using a seat belt, as well as having become accustomed to lying down in the back seat. In one case a baby carrier took up so much space that there was no room for the cushion.

In the secondary group, one child was frightened when restrained and totally refused to use the seat. Contrary to most children, however, she had never used a child seat before.

After one year's time, however, the number of reasons for failing to use the cushion regularly were more numerous, e.g.:

- (1) The child's refusing to use the system and the parents' not taking the time to persuade the child to do so.
- (2) Not taking the trouble to use the seat for only short trips.
- (3) Lack of room for the seat due to other passengers, child seats, baby carriers, etc.
- (4) Not transferring the seat from one car to another.
- (5) Forgetting to use the cushion after having removed it from the car when the child was not present.
- (6) Inability of the child to sleep in the system during longer trips.
- (7) Inability of the child to sit still.
- (8) Discomfort of the seat (mostly in the case of older children whose legs hung down over the seat edge).

Whether parents and children liked using the seats

After three months' use of the Volvo seats, approximately two-thirds of the children found them only acceptable. Only two of the children (both 8-year-olds), however, found the seat entirely unacceptable. The results were similar in the secondary group, although more children in this group directly disliked the seat and several even returned it after only having used it for a short time. After a year, the popularity of the Volvo seat had sunk even more although all but four of the children continued to accept using it.

The Repco seat was liked by all of the children, both after 3 months and year. In general, the younger children preferred this seat as it offered better side support and stability. Larger or older children, however, were unable to fit into the Repco seat due to the side supports.

The parents were somewhat more positive to the seats than the children were, both after 3 months and 1 year's time.

DISCUSSION

The type of protection cushion which was allocated in the present study has been shown to be both practical and easy to handle for both parents and children. The protection value of such a system is also considerably greater than having the child unrestrained in the back seat, although parents are not always aware of the safety aspects. This lack of awareness must be seen, however, in relation to the parent's experience with rearward-facing child seats, the safety aspects of which are generally well known.

A most important requirement for any protection system is that the child's head does not come up above the seat. With regard to the protection cushions, it would seem that rear collisions could be particularly dangerous. Neck support should be made a part of such systems for the following reasons:

- (1) The protection effect would be greater.

(2) Parents could more easily visualize the protection effect.

(3) The child's head would be held upright during sleeping.

A neck support which can be sold together with the cushion would therefore be highly desirable, although standard neck support for passengers in the rear seat would be an even better alternative.

The cushion's comfort value was judged to be good in the beginning of the evaluation period, but following a year's use, some problems appeared. Using a softer material for the cushions would probably result in a considerable increase in their use. A washable cover, which could also insulate the seat from heat and cold, provided with extra padding on the seat area, would also be highly desirable.

The shape of the Volvo seat was not entirely acceptable due to the lack of side support, causing the child to slide sideways in the seat. In families which had been allocated both Volvo and Repco seats, the Repco seat was always preferred, despite the fact that it was heavier and thus more difficult to handle. Some type of side support would therefore be desirable in connection with the Volvo seat, although this might mean that larger children might not be able to fit into the seat. The uniform cushion size for children of all sizes resulted in the fact that young children were still unable to see out while older children were elevated to too high a position to be able to see out. One solution might be to have cushions of varying sizes to accommodate children of different sizes.

In conclusion, it can be stated that the use of the cushions was rather consistent, and with design improvements, use would probably increase further. Information concerning the value of this type of restraint system is needed immediately in order to ensure that all car passengers are provided with an adequate restraint system.

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