Using Naturalistic Driving Study Data to Understand Child Vehicle Occupant Behaviour When Travelling in Child Restraint Systems

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Abstract

Children's behaviour when travelling in child restraint systems (CRS) may affect injury risk. The aim of this research was to use naturalistic driving study (NDS) video data to explore child vehicle occupant behaviour and out-of-position (OOP) status (i.e., head position in relation to the protective structure of CRS). A total of 414 trips and five epochs per trip were analysed. This paper provides descriptive analyses of children's CRS correct use/misuse, head position, interactions and behavioural affect. Results may propose additional seating positions and postures for future crash testing of CRS, to help reduce injury risk in these less typical user positions.

Background

Motor vehicle crashes remain a leading cause of child fatality and serious injury (Australian Bureau of Statistics, 2016). Full safety benefits of a child restraint system (CRS) require correct use (Brown et al., 2006). Previous observational studies have shown that children are frequently out-of-position (OOP) during everyday trips (Charlton et al., 2010). The aim of this research was to explore child vehicle occupant behavior, including OOP status (head position), restraint use, interactions, behavioural affect and activities, using naturalistic driving study (NDS) video data. This study is part of a broader Australian Research Council Linkage Project (Charlton et al., 2013).

Method

Forty two Melbourne-based families participated in the study. Families had at least one child aged between 1 and 8 years travelling in a CRS/booster seat. Families drove a study vehicle for approximately two weeks. Two study vehicles were fitted with data acquisition systems including a continuous video/audio recording system. Child vehicle occupant behaviours were determined by manual review of the video/audio recordings. For each trip (n = 414), one child occupant was randomly selected for coding at 5 time points during the trip (5%, 25%, 50%, 75% and 95% of trip) for five-second epochs each. A subjective classification was used for head position (Optimal/OOP/extreme OOP - pooled across fore-aft and lateral planes). Restraint use was scored for correct/incorrect use. Behavioural affect was categorised as positive/negative (happy/sad or agitated) and passive/active (still/moving). Children's interactions with other occupants were recorded (yes/no) and their activities were described. Descriptive analyses were used to characterise children's behaviours to explore relationships between head position (optimal vs OOP and extreme OOP, pooled) and variables of interest.

Results

Analysis of children's behaviour in 2070 epochs revealed that children were correctly restrained for more than half of the epochs (56%) and that they were most likely to be displaying a passive behavioural affect (74%). Children's head positions were optimally placed for the majority of epochs (74%). Interactions were common (60%) and conversation was the most frequent activity (49%). Extreme OOP, including far forward, and extreme left/right leaning, was recorded for two percent of epochs and OOP was observed for 24 percent. There was a significant relationship

between children's head position and restraint use, $\chi 2$ (df = 1, n = 777) = 16.92, p=<0.000. Optimal head position was more likely if restraint use was correct. The relationship between head position and occupant interaction was statistically significant, $\chi 2$ (df = 1, n = 1919) = 5.52, p = <0.019, with OOP more likely if interactions were present. Head position was also related to passive/active affect, $\chi 2$ (df = 1, n = 1915) = 173.26, p= <0.000, with optimal position more likely when children's affect was passive.

Conclusions

Most epochs revealed correct restraint use and optimal head placement for children travelling in CRS. The findings from this study will inform head placements of ATDs for sled testing that more accurately mimic realistic scenarios to examine injury potential in simulated crashes. Future research will model the relationship between a larger set of child occupant variables and head position to better understand child injury risk.

Table 1. NDS child vehicle occupant behaviour by event (n=2070)

NDS child vehicle occupant behaviour variables	Total
	N (% coded)
Restraint use†	
All correct	436 (56)
Incorrect*	341 (44)
Child head position††	
Optimal	1442 (74)
OOP	505 (26)
Behavioural affect†††	
Positive passive	1376 (72)
Positive active	479 (25)
Negative passive	39 (2)
Negative active	21 (1)
Interactions with others‡	
Yes	1143 (60)
No	776 (40)
Primary activity‡‡	
Conversation	890 (49)
Looking	514 (28)
Playing with toys	118 (6)
Sleeping/drowsy	100 (5)
Eating/drinking	90 (5)
Touching/looking at self	89 (5)
Watching DVD	30 (2)

*Incorrect use is not exclusive and may include lap, belt or both lap and belt misuse.
† Unknown restraint use (*n*=1293)
†† Unknown head position (*n*=123)
††† Unclassified behavioural affect (*n*=155)
‡ Unknown interaction/s (*n*=151)
‡‡ Unknown activity (*n*=156)

References

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