Mistakes or Deliberate Violations? A Study into the Origins of Rule Breaking at Pedestrian Train Crossings

James Freeman and Andry Rakotonirainy
Centre for Accident Research and Road Safety – Queensland (CARRS-Q)
Queensland University of Technology

Abstract

Train pedestrian collisions are the most likely to result in severe injuries and fatalities when compared to other types of rail crossing accidents. However, there is currently scant research that has examined the origins of pedestrians’ rule breaking at level crossings. As a result, this study examined the origins of pedestrians’ rule breaking behaviour at crossings, with particular emphasis directed towards examining the factors associated with making errors versus deliberation violations. A total of 636 individuals volunteered to participate in the study and completed either an online or paper version of the questionnaire. Quantitative analysis of the data revealed that knowledge regarding crossing rules was high, although up to 18% of level crossing users were either unsure or did not know (in some circumstances) when it was legal to cross at a level crossing. Furthermore, 156 participants (24.52%) reported having intentionally violated the rules at level crossings and 3.46% (n = 22) of the sample had previously made a mistake at a crossing. In regards to rule violators, males (particularly minors) were more likely to report breaking rules, and the most frequent occurrence was after the train had passed rather than before it arrives. Regression analysis revealed that males who frequently use pedestrian crossings and report higher sensation seeking traits are most likely to break the rules. This research provides evidence that pedestrians are more likely to deliberately violate rules (rather than make errors) at crossings and it illuminates high risk groups. This paper will further outline the study findings in regards to the development of countermeasures as well as provide direction for future research efforts in this area.
Keywords: Trains, pedestrian level crossings, deliberation violations, mistakes.

Address for Correspondence: James Freeman. Centre for Accident Research and Road Safety, Institute of Health and Biological, Innovation, K Block, 130 Victoria Rd Kelvin Grove Campus, Kelvin Grove 4059 Queensland University of Technology, Australia. Ph: +61 7 31384677; Fax: +61 7 3138 0111; Email: je.freeman@qut.edu.au

1. Introduction

Collisions between trains and pedestrians are the most likely to result in rail-related fatalities (Federal Railroad Administration 2006; Nelson 2008; Sochon, 2008), as only one third of pedestrians survive these collisions (Lobb, Harre & Terry, 2003). This statistic is also much higher than train motor vehicle collisions (Australian Transport Safety Bureau 2004). Within Australia, there were 392 rail accidents (involving pedestrians) that resulted in fatalities between January 2001 and December 2010, excluding suicides (Australian Transport Safety Bureau 2011). An earlier study reported that pedestrians (excluding suicides) comprise 66% of all fatalities at crossings (Australian Transport Safety Bureau 2004). Furthermore, in regards to serious injuries, researchers examined data between 2003 and 2007 and reported 51 people on average were hospitalised each year due to train-pedestrian collisions in Australia (Henley & Harrison 2009). Given the significant personal, social and emotional burden of such collisions, understanding the origins of such events is of primary importance.

1.1 Errors versus Deliberate Violations

One of the central unanswered questions relating to collisions between trains and pedestrians is whether they result from pedestrians making errors or deliberating violating crossing rules. In regards to this question, the largest body of research to date has focused on
train vehicle collisions. This research has generally indicated that drivers are likely to inadvertently engage in risky behaviours as a result of not detecting crossings, failing to notice approaching trains and misjudging the risk of approaching trains (Australian Transport Safety Bureau 2002; CRC 2010; Wallace 2008). These may broadly be conceptualised as human error, and may result from various cognitive factors including inattention, distraction, poor knowledge, misjudgment and limited sight distance (Freeman et al., 2013). In fact, failure to detect warning signals (or understand their meaning) has previously been calculated to account for nearly half of all fatal level crossing crashes in Australia (ATSB Statistical Unit 2002). Additionally, poor knowledge of level crossing procedures and/or road rules has also gained attention within the field, as researchers have proposed that road users have poor knowledge of train speeds as well as the ability to slow quickly (if needed) to avoid an accident (Richards & Heathington 1990). Researchers have hypothesised that pedestrians may also have poor knowledge regarding the penalties associated with breaching crossing rules (Wallace 2008), although little research has been conducted into this area. One of the few studies to focus on pedestrians’ knowledge of penalties revealed that almost half of a sampled group did not believe or were unaware that it was illegal to cross when a train was approaching (Lloyd’s Register Rail 2007). The same Victorian study reported that 18% of the sample reported unintentionally being caught on train tracks when a train was approaching (Lloyd’s Register Rail 2007). The most common reason reported for this outcome was not being aware of the train approaching or a second train approaching.

The issue of the presence (and awareness) of a second train shortly after the first has passed is receiving increasing focus within the literature. An American study calculated that 18% of pedestrian accidents were related to the presence of a second train (Federal Railroad Administration 2008; Illinois Commerce Commission 2005). The above mentioned Victorian
study reported that 16% of the sample would at least sometimes cross (and violate warning signals) after one train had passed (Lloyd’s Register Rail 2007). The authors also examined Victorian coroners’ reports of pedestrian level crossing fatalities which revealed that the presence of a second train was often mentioned (Lloyd’s Register Rail 2007). Furthermore, poor knowledge (and/or under estimation) of train speeds has also been proposed to be a contributing factor (CRC 2010). For example, an earlier review of 18 pedestrian fatalities between 2002 and 2004 revealed that misjudgment was a primary factor in 8 cases, and a further 6 pedestrians were under the influence of alcohol or drugs (Australian Transport Safety Bureau 2004).

While it has been hypothesised that road users are more likely to make errors (compared to violations) at crossings, the reverse has been proposed for pedestrians (CRC 2010; Freeman et al., 2013). For example, pedestrians ignoring warning signs has been reported as a contributor in some United States studies (Federal Railroad Administration 2008; Illinois Commerce Commission 2005). One of the few Australian studies to focus on the issue reported that 31% of a sample of pedestrians admitted crossing the tracks even when they knew a train was approaching (Lloyd’s Register Rail 2007). The most common reason reported for such behaviour was being in a hurry. Another study that examined both vehicle drivers and pedestrians reported that pedestrians are more likely to speed up and cross the tracks when a train is approaching (Beanland, 2013). A review of rail literature commissioned by the Cooperative Research Centre (CRC) for Rail Innovation (2010) found that a small group of studies reported that the origins of pedestrians’ behaviour (involving violating traffic or level crossing rules) was due to maximizing convenience (Daff & Cramphorn, 2006; Federal Railroads Administration 2008; Lobb 2006; Lobb, Harre & Sudendorf 2001). It has yet to be confirmed whether pedestrians make calculated risks,
although it has been hypothesised that some weigh the perceived safety of a route against the
time and effort that would be required to use it (Lobb, 2006). Additionally, researchers have
suggested that risky crossing behaviour may be reinforced if individuals consistently engage
in such behaviour and avoid the negative consequences (CRC 2010; Davey et al. 2008). This
phenomenon is otherwise known as “punishment avoidance.” Preliminary research has also
found that violations are more likely to occur in the presence of pedestrians (Khattak & Luo
2011).

1.2 High Risk Groups and Factors

An analysis of the individual characteristics associated with fatalities and serious
injuries at level crossings reveals some groups are at a disproportionate risk of being struck by
a train. These groups are: (a) males, (b) school children and other young persons, (c) people
with disabilities as well as (d) older pedestrians (Lloyd’s Register Rail 2007). However,
comprehensive information about why these groups remain at-risk has yet to be obtained
(CRC 2010). Nevertheless, what is known is that males are consistently over-represented in
both vehicle and pedestrian incidents at level crossings (CRC 2010; Henley & Harrison
2009). For example, previous Australian research calculated that 84% of train-pedestrian
fatalities involved males (Australian Transport Safety Bureau 2004), which is also reflected in
train-vehicle collisions e.g., 80% (Australian Transport Safety Bureau 2002). A European
study also reported males are over represented in train-pedestrian fatalities (Silla & Luoma
2012).

Secondly, school children have also been identified to be at an increased risk at level
crossings (Khattak & Luno 2011; Lobb et al. 2003; Spicer 2008). A video surveillance study
of crossing behaviours in Nebraska revealed that children approximately 8 years of age
accounted for a disproportionate amount of gate-violations (25%) compared to older
pedestrians and cyclists (Khattak & Luno 2011). An earlier New Zealand study reported that 50% of train-pedestrian fatalities and 40% of injuries involved persons aged between 10 and 19 (New Zealand Health Information Service, 1999, cited in Lobb et al. 2003). However, and similar to above, there is limited research into the origins of why school children are at an increased risk (CRC 2010). Nevertheless, these might include poor scanning behaviours, underdeveloped cognitive and risk perception abilities as well as impulsiveness (CRC 2010).

In regards to scanning behaviours, one of the only studies in the area reported pedestrians aged between 12 and 17 years had the poorest scanning behaviours at crossings (McPherson & Daff 2005). This is consistent with what is known within the broader developmental neuroscience field that indicates adolescences are most likely to make risky decisions (Albert & Steinberg 2011). More specifically, underdeveloped perceptual/cognitive skills (Congiu et al. 2008) divided attention combined with poor scanning (Dunbar, Lewis & Hill 2001), and limited crossing experience (Connelly et al. 1998) have all been proposed to contribute to younger persons increased risk. Additionally, intentional risk taking has also been hypothesized to be a significant contributing factor (Lloyd’s Register Rail 2007), although consistent with broader knowledge in the field, it remains unclear why this group are at an increased risk of being struck by a train (Freeman et al., 2013).

In addition to males and younger groups, people with physical disabilities (or mobility aids) and older pedestrians are at an increased risk of being struck by a train. This may stem from a number of reasons, including: (a) getting mobility aids stuck in train tracks (b) being vulnerable to uneven or poorly maintained surfaces and (c) slower crossing speeds (CRC 2010; McPherson & Daff 2004). However similar to above, little is currently known regarding the exact risks for this group’s increased vulnerability at pedestrian crossings.
Taken together, a number of outstanding questions remain regarding the origins of pedestrians’ behaviours at level crossings, which has clear implications for the development of effective evidence-based interventions. Due to this lack of research, the present study aims to examine the etiology of pedestrian’s crossing behaviour (in a large sample) through quantitative analysis. The three main areas of focus are examining: (a) whether pedestrians are more likely to make deliberate violations versus errors at crossings, (b) whether these factors are consistent across age groups and (c) what other factors increase the likelihood of breaking crossing rules.

2. Method

2.1 Participants

A total of 636 individuals volunteered to participate in the study (in the Brisbane region) comprising of 119 minors (<18 years), 460 younger adults (18 – 59 years) and 57 older adults (60+ years). The mean age of the sample was 34.94 (range 10 to 82) years. Males constituted 56.6% (n = 360) of the sample while 43.4% (n = 276) were females. For the younger adults, 56.50% (n = 260) had obtained a tertiary degree, and another 19.34% (n = 89) had completed year 12. For the older adults, 58.9% (n = 33) had obtained a tertiary degree, 12.5% (n = 7) had completed year 12. The most frequent reported income brackets for the younger adult group was $52,000-$83,999 p.a. (27.9%, n = 121) followed by the $>84,000 p.a. bracket (22.9%, n = 99). For the older adult group, the most frequent income bracket was $13,000-$31,199 p.a. (31.4%, n = 16) with 19.6% (n = 10) participants earning below this level and 31.4% (n = 16) earning above this level. In regards to detection, 10 participants had previously been fined for breaking the rules at a pedestrian level crossing.

2.2. Materials and Procedure
A questionnaire was developed (and piloted with 20 participants) which contained questions on demographics and level crossing usage, knowledge and experiences with level crossings, frequency of making deliberate violations and mistakes as well as reasons for making violations and errors. The Brief Sensation Seeking Scale (BSSS) developed by Hoyle, Stephenson, Palmgreen, Lorch & Donhew (2002) was also utilised to measure the extent of sensation seeking propensities, particularly among the younger group.

2.3 Procedure

The minors were recruited from two high schools in the Brisbane metropolitan area situated in close proximity to a level crossing. Two procedures were utilised. The questionnaire was completed via pen and paper at schools. Participants were provided with a movie voucher. The younger adult and older adult groups were recruited via a radio interview promoting the study, newspaper and online advertisements, and disseminating flyers at level crossings as well as snowballing techniques. All adult participants completed an online questionnaire and were given a $20 Coles-Myer voucher. Both versions of the questionnaire were identical, with some irrelevant demographic questions omitted from the minors’ version of the questionnaire (e.g. current employment status, yearly income and highest level of education.)

3. Results

3.1 Level Crossing Usage

In terms of usage, the minor group were proportionately the most frequent users of level crossings with 10.92% (n = 13) using crossings daily and 23.52% (n = 28) using crossings weekly. In contrast, for the younger adult group, 5.43% (n = 25) reported using crossings daily and 10.00% (n = 46) used crossings weekly or less often. For the older adult
group, no participants used level crossings on a daily basis, but 42.10% (n = 24) used the crossings weekly or monthly. The usage frequency for the different age groups is shown in Table 1.

Table 1. Frequency of Level Crossing Usage

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Less than Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minors</td>
<td>10.92% (n = 13)</td>
<td>26.89% (n = 32)</td>
<td>21.01% (n = 25)</td>
<td>41.17% (n = 49)</td>
</tr>
<tr>
<td>Younger Adults</td>
<td>5.65% (n = 26)</td>
<td>15.43% (n = 71)</td>
<td>17.83% (n = 82)</td>
<td>61.08% (n = 281)</td>
</tr>
<tr>
<td>Older Adults</td>
<td>0.00% (n = 0)</td>
<td>19.30% (n = 11)</td>
<td>22.81% (n = 13)</td>
<td>57.90% (n = 33)</td>
</tr>
</tbody>
</table>

3.2 Knowledge and Experience

A series of questions focused on participants’ knowledge and experiences at pedestrian crossings. Participants responded “yes”, “no” or “unsure” as to whether they believed it was legal to cross a level crossing in the presence of: (a) a bell sounding, (b) lights flashing and (c) when the automatic gates were closed. In the current context, a bell may sound (and/or lights flash) before automatic gates close at active sites in the sampled area. Overall, rule knowledge was high, with the lowest percentage of correct answers being for crossing when the bell is sounding (combined percentage 82.28%). For all three rules the age group with the greatest percentage of participants answering correctly were the older adults. For the individual groups, younger participants were least likely to report accurate knowledge regarding lights flashing (75.63%) and crossing after the gates are closed (75.63%). However, and from a different perspective, the results indicate that between 10% to 18% of level crossing users (in the current sample) were either unsure or did not know (in some circumstances) when it was legal to cross a level crossing. The percentages of correct answers overall and for individual age groups are shown in Table 2. None of the differences between age groups were statistically significant.
Table 2. Percentage of Participants Answering Crossing Rule Questions Correctly

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Bell Sounding (%)</th>
<th>Light Flashing (%)</th>
<th>Gate Closed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minors</td>
<td>76.47% (n = 91)</td>
<td>75.63% (n = 90)</td>
<td>75.63% (n = 90)</td>
</tr>
<tr>
<td>Younger Adults</td>
<td>83.47% (n = 384)</td>
<td>87.61% (n = 403)</td>
<td>88.48% (n = 407)</td>
</tr>
<tr>
<td>Older Adults</td>
<td>92.90% (n = 52)</td>
<td>93.0% (n = 53)</td>
<td>93.0% (n = 53)</td>
</tr>
<tr>
<td>Overall</td>
<td>82.28% (n = 527)</td>
<td>85.85% (n = 546)</td>
<td>86.47% (n = 550)</td>
</tr>
</tbody>
</table>

3.3 Deliberate Violations

A central aim of the study was to investigate the frequency of making deliberate violations at pedestrian crossings versus making mistakes. As a result, participants were asked if they had ever crossed at a railway pedestrian crossing when the lights were flashing, the gate was closed, deliberately ignored warning signal, made a mistake at a level crossing or been fined for breaking the rules at a level crossing. Responses were in a yes or no format. For any of the intentional violation questions (e.g., lights flashing, gates closed or deliberately ignored a signal), 156 participants (24.52%) reported having intentionally violated the rules at level crossings in at least one of these ways. Participants were provided with an opportunity to explain the reasons for their behaviour, with the overwhelming majority indicating they were “in a rush” or “running late.” Males were significantly more likely to break the rules compared to females (111 versus 45), $X^2 (2, N = 636) = 18.32, p = .000$. The age group with the highest incidence of intentional rule breaking was minors (35.3%, n = 42). However, for the younger adult group, 23.0% (n = 106) and 14.0% (n = 8) of the older adult group had also intentionally broken the rules. Percentage and frequency scores for the intentional violations can be seen in Table 3. A chi-square analysis conducted between the intentional violation rates across the ages determined there was a statistically significant difference, $X^2 (2, N = 636) = 11.38, p = .003$. A corresponding question regarding crossing when the lights were flashing (measured on a 7 point likert scale) revealed that the
participants were statistically more likely to violate the rules after the train has passed ($M = 2.32$) versus before the train has passed ($M = 1.71$) \[ t (636) = -10.65, \ p < .001 \].

3.4 Errors

In contrast, errors were not as common an occurrence. More specifically, only 3.46% (n = 22) of participants reported this experience. Similar to the violation data, there was proportional variation in the incidence of mistakes between the age groups with the highest percentage of minors making mistakes (5.0%, n = 6) followed by older adults (5.2%, n = 3) and lastly younger adults (2.8%, n = 13). In regards to crossing after the train had passed, 17 participants (2.67%) reported crossing after a train had passed and not realised a second train was approaching. Due to the small numbers involved, statistical analyses could not be undertaken to determine if these differences were statistically significant or expected by chance. However, participants who made deliberate violations were also more likely to make errors at level crossings $X^2 (2, \ N = 636) = 11.09, \ p = .002$. The prevalence of deliberate violations and mistakes made between the three age groups are shown below, in Table 3.

Additionally, intentions to break crossing rules again in the next six months were measured on a 7 point likert scale (1 = likely to 7 = unlikely). While the mean of 6.63 (SD = 1.16) indicates the sample were generally not likely to violate crossing rules, a closer examination of the data revealed that males were statistically more likely than females $t (636) = -5.07, \ p < .000$ and minors were more likely than the combined group of adults $t (636) = -4.52, \ p < .000$. Consistent with previous research that has indicated past behaviour is a good predictor of future behaviour (Freeman & Watson, 2006), those who admitted breaking crossing rules in the past, were more likely to indicate a willingness to engage in similar behaviour in the future ($M = 5.91$ versus $M = 6.86$; $t (636) = -9.55, \ p < .000$).
### Table 3. Incidence of Deliberate Violations and Errors between the Age Groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Deliberate Violations</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minors</td>
<td>35.3% (n = 42)</td>
<td>5.0% (n = 6)</td>
</tr>
<tr>
<td>Younger Adults</td>
<td>23.0% (n = 106)</td>
<td>2.80% (n = 13)</td>
</tr>
<tr>
<td>Older Adults</td>
<td>14.0% (n = 8)</td>
<td>5.20% (n = 3)</td>
</tr>
<tr>
<td>Overall</td>
<td>24.52% (n = 156)</td>
<td>3.46% (n = 22)</td>
</tr>
</tbody>
</table>

#### 3.5 Sensation Seeking

To determine if reported violation behaviours were related to sensation seeking (particularly among the younger cohort), the Brief Sensation Seeking Scale (BSSS) (Hoyle, Stephenson, Palmgreen, Lorch & Donhew, 2002) was utilised. For the current study, sensation seeking was considered to be “the need for varied, novel, and complex sensations and the willingness to take physical and social risks for the sake of such experiences” (Zuckerman, 1979, p.10). The BSSS is an 8-item scale which evaluates an individual’s propensity to seek these sensations and experiences. Consistent with previous research (Martins et al., 2008), minors recorded the highest sensation seeking scores, followed by younger adults and older adults. The mean scores for minors was also comparable with previous BSSS-based research (Hoyle et al., 2002). Not surprisingly, minors reported significantly higher BSSS scores compared to adults ($M = 3.05$ versus $M = 2.62$, correlation $r = -.20^{**}$), although it may be suggested the difference is minimal in practical terms, $t (636) = 5.29$, $p < .000$. Furthermore, a similar finding was identified between BSSS scores and those who did violate the rules ($M = 2.96$) and those who did not ($M = 2.60$), $t (636) = 5.01$, $p < .000$.

To determine the predictors of violating crossing rules, a logistic regression was performed to investigate the predictive role of age, gender, frequency of crossing usage, crossing rule knowledge and sensation seeking to the outcome variable of breaking the rules.
Given the relatively small proportion of the sample who acknowledged breaking the rules, those who admitted a deliberate violation or an error were combined to form the dependent variable. Frequency of crossing usage was recoded into: (a) daily/almost daily, (b) weekly, (c) monthly, (d) less than monthly. Crossing rule knowledge was divided into those who answered all three questions correctly versus those who did not (82.1% versus 17.9%). Table 4 displays the regression coefficients, Wald statistics, odds ratios (OR), and 95% confidence intervals.

The overall model was a significant predictor of the outcome variable ($\chi^2(8) = 60.331$, $p = .000$). Taken together, 13.6% of the estimated total variance was accounted for in the model and 77.4% of the sample was correctly classified. In regards to significant predictors, three items were found to be significant predictors of crashes: gender (Wald = 7.938, $p < .05$); Usage frequency (Monthly Wald = 19.259, $p < .001$ & Daily Wald = 5.286, $p < .001$) and sensation seeking (Wald = 11.315 , $p < .001$). As a result, being male, using crossings more frequently and reporting higher sensation seeking propensities were significant predictors of breaking crossing rules. An additional regression analysis that only included deliberate violators (and not errors) revealed the same predictive variables.

Table 4. Predictors of Breaking Crossing Rules
14

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>OR</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-.003</td>
<td>.006</td>
<td>.195</td>
<td>.997</td>
<td>.985</td>
<td>1.010</td>
</tr>
<tr>
<td>Gender</td>
<td>-.595</td>
<td>.221</td>
<td>7.938*</td>
<td>.551</td>
<td>.364</td>
<td>.834</td>
</tr>
<tr>
<td>Usage Frequency (&lt;monthly)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usage Frequency (monthly)</td>
<td>1.180</td>
<td>.269</td>
<td>19.259**</td>
<td>3.253</td>
<td>1.921</td>
<td>5.510</td>
</tr>
<tr>
<td>Usage Frequency (weekly)</td>
<td>.47</td>
<td>.304</td>
<td>2.384</td>
<td>1.600</td>
<td>.881</td>
<td>2.904</td>
</tr>
<tr>
<td>Usage Frequency (daily)</td>
<td>.839</td>
<td>.365</td>
<td>5.286*</td>
<td>2.315</td>
<td>1.132</td>
<td>4.734</td>
</tr>
<tr>
<td>Knowledge</td>
<td>.407</td>
<td>.240</td>
<td>2.876</td>
<td>1.503</td>
<td>.939</td>
<td>2.407</td>
</tr>
<tr>
<td>Sensation seeking</td>
<td>-.456</td>
<td>.136</td>
<td>11.315*</td>
<td>.634</td>
<td>.486</td>
<td>.827</td>
</tr>
</tbody>
</table>

Model Chi-Square 60.331** (df = 7)

4. Discussion

Currently, a number of outstanding questions remain regarding the origins of pedestrians’ behaviours at level crossings as research has traditionally focused on motorists’ behaviour. The present research aimed to examine: (a) whether pedestrians are more likely to make deliberate violations versus errors at crossings, (b) whether these factors are consistent across age groups and (c) what factors increase the likelihood of breaking crossing rules.

Firstly, participants generally exhibited a high level of level crossing rule knowledge in regards to the presence of: (a) a bell sounding, (b) lights flashing and (c) automatic gates closing. In regards to the latter, it is currently possible for pedestrians to push open closed gates at active crossings in the Brisbane region, although a trial of “locking gates” is soon to be implemented. Regardless of the wider implementation of this initiative, it is encouraging that the sample generally recognised the inappropriateness of attempting to open gates that are...
closed. Within the wider rail safety arena, research has demonstrated that the effective positioning and use of barriers can reduce trespassing onto railway tracks (Silla, 2009). However, from a different perspective, it may be considered somewhat surprising that up to 18% of the sample were either unsure or did not know (in some circumstances) when it was legal to cross at a level crossing. This is consistent with one of the few studies in the area that revealed almost half of an Australian-sampled group did not believe or were unaware that it was illegal to cross when a train was approaching (Lloyd’s Register Rail 2007). This has implications for the development of awareness/education schemes, particularly given the tremendous amount of research that has demonstrated injury prevention education is an important and effective tool to reduce injuries and fatalities (Crandall, Zarzaur & Tinkoff, 2013). However, it is noted that preliminary education-based campaigns have not proven extremely effective (Lobb et al., 2001; Lobb et al., 2003; Shonfeld & Musumeci, 2003), although this may be due to other deleterious effects on safety discussed below e.g., sensation seeking propensities.

Secondly, and in regards to a central question of this program of research, participants were more likely to report deliberately breaking the rules compared to making errors (24.52% versus 3.46%). That is, almost a quarter of the sample admitted previously breaking crossing rules at one time. This study is one of the first to confirm the hypothesis that pedestrians at level crossings are more likely to ignore warning signals rather than make mistakes (CRC, 2010; Freeman et al., 2013). A corresponding preliminary analysis revealed that the reason for this behaviour was most closely associated with being “in a rush” or “running late”, which supports one of the only studies to examine this issue (Lloyd’s Register Rail 2007). Further research is now required to determine whether pedestrians make calculated risks before crossing or if such behaviour is more impulsive, as well as what interventions would
be most effective in reducing the likelihood of engaging in such behaviours e.g., barriers, enforcement or education-based signs.

Thirdly, further analysis revealed that those most likely to engage in such behaviours were males, particularly, younger males. More specifically, a comparative age analysis also revealed that minors (e.g., under 18) were statistically more likely to report intentionally violating the rules compared to younger and older adults. This finding again supports the assertion that males, including school children, constitute a significant high risk pedestrian group (Lloyd’s Register Rail 2007), which is evidenced in their overrepresentation in recorded incidents at level crossings (Australian Transport Safety Bureau 2002; CRC 2010; Henley & Harrison 2009). In regards to school children, this group has been proposed to be at an increased risk for a number of reasons, including poor scanning behaviours, underdeveloped cognitive and risk perception abilities as well as impulsiveness (CRC 2010). While a corresponding examination of scanning and cognitive abilities was not possible in the current study, a complementary analysis of sensation seeking traits revealed this factor to be predictive of crossing violations, as was as frequency of crossing usage. In regards to the former, developmental neuroscience has consistently indicated that adolescence are more likely to make risky decision (Albert & Steinberg 2011), and/or take physical and social risks for the sake of experience (Zuckerman, 1979a). In fact, sensation seeking has been shown to be a predictor of a wide array of problem behaviours (Zuckerman, 1994), and now, risk taking at pedestrian level crossing may yet prove to fall into this category. Sensation seeking has also been shown to be higher in males (Hoyle et al., 2002), which may suggest why a disproportionate percentage of males reported rule violation in the current study. Research has indicated that individuals high in sensation seeking are drawn to high risk activities (Hoyle et al., 2000) as this group underestimate the risks associated with such behaviours.
(Hoyle et al., 2002). Furthermore, risk estimates have been hypothesized to be negatively associated with novel activities (Zuckerman, 1979b), although this may not necessarily be the case for the current context given that more frequent crossing usage was predictive of breaking the rules. Rather, high sensation seekers may be more likely (than low sensation seekers) to both try (and repeat) a wide array of risky activities (Hoyle et al., 2002). If further research proves this to be the case, than a challenge remains as to the development of effective countermeasures that can negate (or prohibit) the expression of high sensation seekers’ behaviours, particularly among minors. Future applied research may yet demonstrate this can be achieved through incapacitation and/or deterrent based interventions that either prohibit or deter offending behaviours.

A final theme to emerge from the current study was that participants who reported violating crossing rules were more likely to use crossings regularly. This is in contrast to an earlier hypothesis that younger persons’ increased risk is attributable to limited crossing experience (Connelly et al. 1998). From a different perspective, the current finding is consistent with sensation seeking research which has indicated that high sensation seekers are more likely to engage in risky behaviours, and then afterwards, diminish the level of risk associated with the behaviour (Hoyle et al., 2002). Yet another alternative perspective emerges from the deterrence-based literature, which has illuminated the powerful effects of “punishment avoidance” (Freeman & Watson, 2006; Paternoster & Piquero, 1995). More specifically, an increasing body of literature has demonstrated that committing an offence and avoiding detection (and subsequent punishment) is a strong predictor of repeating the behaviour in the future (Freeman & Watson, 2006). In the current circumstances, and given the low probability of actually being apprehended for a pedestrian crossing offence, violators may be prone to repeat the behaviour out of habit and/or due to reduced perceived threat of
any associated consequences. Although this hypothesis will need to be tested through in
future studies. Further research is also required to determine whether pedestrians make
calculated risks (Lobb, 2006), or if such behaviour is impulsive and/or instinctual. In regards
to calculated risks, it is noteworthy that the current sample was more likely to violate the rules
after (rather than before) a train has passed. This is the first study to examine this issue and
the finding warrants further research into the risks associated with being hit by a second train.
Preliminary research into risks associated with a second train passing at a crossing has
revealed an increase in accidents (Federal Railroad Administration 2008; Illinois Commerce
Commission 2005; Lloyd’s Register Rail, 2007).

The study’s limitations should be borne in mind when interpreting the results. Firstly,
participants were not randomly selected, and as a result, questions remain regarding the
representativeness of the sample. Secondly, the study only contains self-reported data, and as
such, there may be some discrepancy between stated behaviour and actual events, particularly
when responses focus on aberrant behaviours. Thirdly, a large proportion of the sample did
not regularly use pedestrian crossings e.g., less than monthly.

5. Conclusions

Despite such limitations, the study findings indicate that pedestrians are more likely to
deliberately violate crossing rules (compared to making errors) and a sizeable proportion of
the sample reported this behaviour e.g., a quarter. The results provide support for a renewed
focus on understanding the origins of pedestrian level crossing behaviour as well as
developing effective tailored countermeasures. Such a focus can only assist in the pursuit to
reduce the burden associated with train-pedestrian collisions.
Acknowledgements: The authors are grateful to the CRC for Rail Innovation (established and supported under the Australian Government's Cooperative Research Centres program) for the funding of this research. Project No. R2.120: Understanding Pedestrian Behaviour at Level Crossings
REFERENCES


Australian Transport Safety Bureau 2011, Australian Rail Safety Occurrence Data, 1 January 2001 to 31 December 2011, ARSB, Canberra.


Cooperative Research Centre (CRC) for Rail Innovation 2010, An Investigation of Risk Takers at Railway Level Crossings, Project # R2.114, CRC.


Daff, M & Cramphorn, B 2006, Signal design for pedestrians as if they were thinking adults, Paper presented at the 7th International Conference on Walking and Liveable Communities, Melbourne.


Henley, G & Harrison, JE 2009, Serious injury due to transport accidents involving a railway train, Australia, 2002-03 to 2006-07, Australian Institute of Health and Welfare, Canberra.


McPherson, CD & Daff, M 2004, Innovations in disability access at pedestrian rail crossing, Paper presented at the 8th International level Crossing Symposium, Sheffield, United Kingdom.


Richards, SH & Heathington, KW 1990, Assessment of warning time needs at railroad-highway grade crossings with active control devices and associated traffic laws, *Transportation Research Record*, vol. 1160, pp. 52-59.


