One is the loneliest number: Exploring the role of the second driver in Australian rail operations

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Abstract

Background: In Australia, train driving is undertaken in single or dual driving modes. While single driver operations are already an increasing trend in the rail industry, research has yet to examine the circumstances under which these modes of operation are most appropriate. Understanding the differences in workload for the single driver and overall error tolerance is critical for safe implementation, particularly for the freight task, which has traditionally been relegated a dual driving operation. Aims: The aim of this study was to investigate the factors that train drivers felt might be related to safe operation of the train in single and dual driving. Method: Data were collected using a qualitative methodology that combined focus groups, interviews, and observations. In total, sixty-five train drivers participated from 7 rail organisations across Australia. Data were inductively coded and analysed thematically. Results: Positive evaluations of dual driving focused on safety and shared responsibility with particular emphasis on signal observance and workload management. Negative evaluations revealed concern for distraction, inattention, and importantly, personality differences. Two drivers were considered important for freight operations, however the utility of a dual driving mode in metro operations were met with more reserve, where being alone with the task was actually valued. Conclusion: The findings revealed a substantial psychosocial component to perceptions of safety in single versus dual driving, and identified a number of factors that could be tested in a simulator environment. Subsequent study may use these findings to generate evidence-based guidelines for single and dual driver operations under different safe working environments.

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As a task, train driving is relatively complex [5-7]. Signals are often hidden from view and the track physics and weather variations often create adhesion problems and braking inconsistencies. The task requires the driver to process a variety of vestibular, kinaesthetic, acoustic, and peripheral visual information sources [8]. Consequently, train drivers are often involved with future state prediction, even in moments of low observable workload, thus rail navigation relies on a good awareness of the evolving situation. Much of the requisite cognition is backed by the theories of applied attention and situation awareness [9, 10], which implicate a requirement for sustaining attention and maintaining route knowledge. This includes a variety of individual and external factors (e.g. understanding train handling characteristics, foundational rules, position of signal and stopping distances). However, sustaining attention for long periods in an unchanging environment increases the drivers’ vulnerability to various task-related disturbances and risk factors, such as monotony and fatigue [11].

Moving from the dual-driving mode to single driving-mode is likely to result in an increase in single driver workload, since that driver would also conduct all functions formerly performed by the second driver. Dual driving operations may also protect against errors born from monitoring and checking thus removing a second driver could remove a layer of safety defense [12]. Conversely, there is evidence to suggest that some functions of the second driver may...
not always be carried out effectively [13], and the second driver may provide a potential source of inattention and/or distraction from the primary task. It is also important to note that new train technologies are altering the train-driving dynamic, and creating a new, generally efficient version of the traditional task [6], but while such technologies may provide driving support and contribute to safety management, they cannot remove human error from the system. Understanding the potential safety consequences of moving from dual to single train-driving is therefore critical for understanding how implementation of single driving may be undertaken in freight operations, to avoid creating new hazards.

Much of the rail literature base is informed by European train driving operations where dual driving happens to be very uncommon. Although, dual driving is more common in the United States, Australia’s rail environment is very unique in that the signalling design conventions vary in every state and the task involves longer journeys over very remote territory, often under extreme temperature and weather conditions. In summary, there is a dearth of literature that has actually examined or analysed the dual train-driving mode with a view to compare operations under different and challenging working conditions, particularly in the Australian context.

Aims and objectives

This paper reports preliminary data from a wider study that set out to explore how route knowledge and driving strategies were acquired and applied in rail operations in Australia. The findings reported here were driven by the overarching research question, ‘What does the second driver do?’ In view of this question the aims of the paper were to provide a better understanding of the factors related to safe operation of the train in single and dual driving using the following three objectives:

1. To determine the positive or negative attributes of the second driver, as perceived by train drivers operating in single and dual-driving modes
2. To determine the attributes of the second driver considered critical for maintaining safety, managing risk and error tolerance levels
3. To explore the utilities of the second driver that extended beyond safety

Method

Rationale and approach

The nature of the research inquiry meant that the study required an approach capable of eliciting highly skilled knowledge [14]. Given that the study was focused on gaining insight into ways of working and specific tasks in the train cab environment, the participants from whom data would need to be elicited were train drivers. However, skilled knowledge is intuitive, tacit and can be very difficult to elicit particularly in the rail operational context [5]. Converging interview and observational methods has been shown to elicit this type of knowledge well, thus a participative process of directly talking with experts and observing them at work would be needed to conceptualise the issue [15].

Study design

The study needed to use train drivers as the substantive sample with experience of the train-driving task and as experts upon their own experiences. Thus, it necessitated a qualitative approach, which would allow access to this information. In all, three different methods were used to collect qualitative information from drivers about their task and the role of a second driver. These were semi-structured focus groups, structured interviews and observations of drivers at work. The approach was grounded in a framework of participative ergonomics [16] and designed to transition participants from a group in a classroom, to a one-to-one interview, to the individual in the cab. It was important to determine what the effect of losing or gaining a driver would be in the two types of task environment. To stimulate insight in the context of the operational task, the focus groups included a pen-paper task that required participants to use their own experiences to invent challenging scenarios. These drawings were subsequently used as a platform to simulate and juxtapose the two different driving environments so that participants involved in single driving could consider the relative impact of an extra driver on their route, and participants involved in dual driving could consider the relative impact of losing a driver. During cab rides, participants also undertook a think-aloud task where they verbalised their actions and decision making for approximately 20 minutes [17].

Research environment and participant profile

Data were collected from seven different Australian rail organisations operating in three sorts of environments: (a) urban, which were passenger focused and performed in metropolitan areas; (b) regional, also involved passenger transportation but these operations also drove from metropolitan districts to more interurban or rural areas; and (c) freight, which were regional but also involved heavy-haul operations in remote and isolated parts of Australia. Urban and regional passenger environments were typically performed as single driver operations. In comparison, the freight environments included in this study were all dual driving operations.

Participants were recruited from rail organisations that supported the research. The process of recruitment was facilitated by contacts at the middle-management level. This involved advertising the research at station depots and distributing project information sheets so that data collection could be scheduled and coordinated around the demands of work rostering. Participation in the study was voluntary, but as the organisation supported the research, attendance was equivalent to paid work and undertaken during work hours. The study met the requirement of the human ethics committee of Central Queensland University (approval no: H12/03-032).

A total number of 65 participants took part in the study (urban = 27; regional = 11; freight = 27). The average age was 46 years (range: 30 to 64).9 Participants in the regional category were in the minority, and represented drivers that

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Note that while 65 individuals participated, 6 did not disclose their ages and are not included in these statistics.
operated over long distances in diesel-electric railcars and locomotive hauled passenger trains. As participants in the metropolitan and regional environments were all involved in single driver operations, this mode represented 59% of participation. In comparison 41% of the data was collected from freight/heavy haul operators. Just less than two-thirds of drivers had greater than ten years driving experience (Figure 1A) and 59% of drivers had experience in single driving (Figure 1B). None of the participants that were currently involved in dual operations had come from a single driving background.

**Process**

Focus groups were the first stage in the data collection process, coordinated in groups of 4-to-5 participants and each ran for approximately 60-to-90 minutes. Table 1 categorises the range of topics and the order in which they were covered, along with detail of the typical content and some example questions. The first portion of the focus group collected views around specific driving skills associated with route knowledge and train driving ability. Perspectives were collected by focusing on aspects of the task that were easy or challenging e.g. 'take me through an easy part of the route that you drive over regularly,' and probed against performance shaping factors associated with the driving conditions (e.g. day/night differences, rail adhesion), the rail environment (e.g. level crossings, signal type), and the individual (e.g. fatigue).

The second portion of the focus group involved a pen-paper task. The task itself was undertaken with coloured felt-tip pens and A3 sheets of paper, and initiated by a request to 'invent a stretch of railway that would be really hard to driver over.' The content in the railway, length, formalism, and the area of focus that constituted difficulty were left to the participant. Once invented, participants were asked to imagine driving over their routes to introspect further on what they had drawn. Thus, the invented scenario was used to collect perspectives on driving styles and strategies, explore how the task would look from different angles and to determine how different variables (e.g. time pressure) would affect the task.

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**Table 1. Overview of the semi-structured focus group protocol**

<table>
<thead>
<tr>
<th>Topics covered</th>
<th>Typical content</th>
<th>Example questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>General experience</td>
<td>Background, prior experience</td>
<td>Can you tell me a bit about your background — have you driven trains in other organisations?</td>
</tr>
<tr>
<td>Skills</td>
<td>Route knowledge</td>
<td>How did you develop your route knowledge to take account of day and night differences?</td>
</tr>
<tr>
<td>Specific challenges</td>
<td>Environmental, route features, driveability</td>
<td>What sections of railway make a route challenging to drive over?</td>
</tr>
<tr>
<td>Impact factors</td>
<td>External, internal, individual</td>
<td>What environmental or railhead conditions make a route challenging?</td>
</tr>
<tr>
<td>Pen-paper task</td>
<td>Route invention</td>
<td>Invent a really hard stretch of railway.</td>
</tr>
<tr>
<td>Pen-paper task</td>
<td>Navigational techniques, strategies</td>
<td>List the strategies that you would use to navigate this route.</td>
</tr>
<tr>
<td>In-cab environment</td>
<td>Dual/single driving mode juxtaposition</td>
<td>Do you think that having two drivers would enhance your train driving operations?</td>
</tr>
<tr>
<td>Driving styles</td>
<td>Examples (skilled and unskilled)</td>
<td>Can you give me any examples of some good or skilled driving styles and practice?</td>
</tr>
<tr>
<td>In-cab environment</td>
<td>Driving roles</td>
<td>What role does the additional driver play in your train driving operations?</td>
</tr>
</tbody>
</table>

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Drivers involved in single driving were asked to consider the impact of adding an additional driver to their scenario, and how they envisaged the task and driving responsibilities would be shared as a consequence. Drivers involved in dual driving were asked to consider the impact of losing the co-driver from their scenario, and the difference it would make to the job structure and workload in the scenario. An example drawing from the pen-paper task is given in Figure 2.

After the focus groups, participants were interviewed individually. Each interview was conducted using the critical decision method [18], lasted 60 minutes, and included six steps (Table 2). At the start of the interviews, drivers were asked to talk about their ‘experience with driving a train,’ specifically where their ‘skills as a train driver were really challenged,’ or ‘the last time they drove over a really challenging section of route.’ A drawing of the incident was obtained during recall (step 2) and used to clarify and verify the experience (steps 3 and 4). In the event that an incident could not be identified, the participant was asked to consider a challenging section of a route they drove over regularly.

<table>
<thead>
<tr>
<th>Step</th>
<th>Process</th>
<th>Typical content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identifying the incident</td>
<td>Route identification and selection</td>
</tr>
<tr>
<td>2</td>
<td>Recalling</td>
<td>Probe gaps, conceptual leaps, ambiguity</td>
</tr>
<tr>
<td>3</td>
<td>Retelling</td>
<td>Clarification</td>
</tr>
<tr>
<td>4</td>
<td>Verification</td>
<td>Construct timeline, decision points, major events</td>
</tr>
<tr>
<td>5</td>
<td>Progressive deepening</td>
<td>Critical decisions, cues, strategies, anomalies</td>
</tr>
<tr>
<td>6</td>
<td>What-if queries</td>
<td>Courses of action, expert-novice differences</td>
</tr>
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After the one-to-one interviews, participants were observed driving in the actual cab or in a simulator, undertook a think-aloud task, and were interviewed informally. The purpose of the cab rides was to better contextualise the data and to use the in situ environment to qualify what was gathered in the previous steps. Generally speaking, participants used the cab rides to go over the information they had discussed during the previous two stages. Note that whilst a number of methods were adopted in this step, only informal interview transcript-based data was included in the analysis for this study.

Data analysis

The transcripts from the focus groups, one-to-one interviews and cab rides were analysed with the aid of NVivo [19]. Themes and conceptual groupings were drawn from phrases, comments and features of the transcripts, which grounded findings in the data [20]. The categories and themes were not predefined, thus they emerged entirely from inductively analysing the transcripts. Pictorial data generated from the pen-paper task were referenced and compared against the verbal elaborations in the transcripts through a process of cross-data validation [21]. This created consistency and allowed for further refining in the coding and categorisation of these data.

Results

The results are in two sections. Section one summarises the nature of the critical incidents generated during the focus group pen and paper task. The second section identifies three themes from a preliminary analysis of participants’ perceptions of single and dual driving from the focus groups, interviews, and cab observations.

Section 1: Focus groups

Incidents and features in the scenarios

Participants used a variety of scenarios as a basis for challenging journeys and critical incidents in the pen and paper task during the focus group. These included human factors issues such as distraction and inattention, though virtually every scenario was designed under conditions necessitating high workload and sustained attention in high infrastructure densities. In most cases, threat from movement authority violation or signal passed at danger (SPAD) events were conveyed via unintended escalations of speed, sighting restrictions (e.g. from blind corners or poor visibility), and decision errors (e.g. from route verification, signal misreading). In some scenarios, the incidents were presented as technical and thus unavoidable (e.g. rail level crossing obstructions, signal failure). A summary of the features contained in the scenarios is given in Figure 3.

Figure 3. Summary of all features associated with the route and various aspects of the rail domain that were identified in the invented scenarios

Table 2. Overview of the one-to-one interview protocol

<table>
<thead>
<tr>
<th>Step</th>
<th>Process</th>
<th>Typical content</th>
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Note that only 2 observational sessions were performed in a simulator.
Each scenario was designed with a series of route components in varying numbers. The incidents themselves were coordinated by the imperative to manage specific features of the environment or specific features of the train. As an example, a participant in a single driver environment created the challenging driving scenario shown in Figure 2 and aside from weather indications, the route components included all of the elements shown in Figure 3. The scenario itself was that of an ‘s’ shaped section of rail track containing a station, pedestrian and level crossings, and multiple signals. The track was created on a steep grade of a hill where soil and rock material was cut out to make way for the track (i.e. a ‘cutting’). This configuration of features were repeated four times over the ascending and descending grades of an entire hill creating a perpetual blind-corner driving (as a result of the cutting) with an emphasis on controlling speed, avoiding distractions, and managing a high general event rate in the environment. In this scenario, the addition of a second driver was simultaneously indicated as a potential advantage for managing the density of information in the environment, but also a potential hindrance in terms of driver distraction.

**Section 2: Interview and observations**

**Theme 1: Alone but connected in single driving**

The first of the identified themes illustrated the notion that the driver in single environments was alone but ostensibly connected. Although they worked alone, the drivers in single operations received internal stimuli from their route knowledge, experience, and levels of alertness. Drivers in the single mode also received external stimuli from signals (i.e. movement authority), radio communications, and any automatic systems (e.g. Automatic Train Protection system). Train drivers in these modes also transmitted information, and gave information back to the network controller, guards/ passenger service attendants, and/or to passengers over the passengers announcement system.

The level of concentration and attention required in single driving was considered to be very high. This was a function of driving at high speeds, seeing more caution signals (i.e. an increased attentive load), and because the driver was on their own, “you have to be with your speeds and where you’re travelling”, “you’re the only one there…everything you do revolves around you.” However, challenges in maintaining this concentration were continual. Some of challenges came from slipping between high and low workload states, for example going from clear to cautionary driving, “because it’s repetitive you go into auto mode.”

Other challenges came from being distracted by task-related sources (e.g. communication from network controller) or from “someone in the cab with you continually talking.”

“If I went on the train with [a primary driver] at one o’clock in the morning we’d probably talk about football and it might benefit him because it’s something interesting but if I was to sit there calling signals at him after two stations he’s going to throw me out of his cab.”

The single driving passenger environment was largely differentiated from freight (and therefore dual driving) via performance pressures, particularly time pressures:

“On freight you have a lot more time…but in here you just haven’t got a minute to scratch yourself, when I first came in here I just felt like I needed an extra couple of hands.”

It was also noted that it can often be difficult to manage conflict between control, guards and drivers, for example on the issue of time-keeping, largely because control and guards were not considered to understand the driver perspective. However, a second driver was only considered to be useful if they talked in a timely or on-task way, the driver was new and still needed guidance, the difficulty in the task was very high (i.e. from fatigue, visibility issues, and/or track complexity), or if the main driver was more extroverted and liked company. Most drivers in the single driving environment preferred their own company:

“It’s a distraction but if you’ve got a real mongrel of a job and you’re tired on your last leg working the train home, if you have someone come up the front, just having someone else there to have a bit of a chat it sort of makes you more alert.”

“I personally am very comfortable working on my own. Not for a second do I think I’m infallible of making an error but I’m pretty confident that I’m on the money most of the time.”

“Personally I like being by myself so this is a better job for me because you don’t end up being with someone that you don’t like all day.”

**Theme 2: Safety and shared responsibility in dual driving**

The second of the identified themes highlighted positive evaluations of dual driving operations, and focused on two benefits: safety and shared responsibility. The themes and subcategories associated with this are summarised in Figure 4.
Safety in dual driving was emphasised in terms of the length of the trips and the isolated and remote environments, and the opportunity this created for exploitation of unsafe situations:

“With [freight trains] and what not, if things go wrong you need that second man, you definitely need that second man. If you’re the only driver, how does that person bandage you, deal with things? [...] in the vast majority of cases, by the time somebody got to you, you’re either very seriously ill or dead.”

“Well as soon as you step off the train you’re in danger basically because it’s – you’re walking in an environment that’s not designed to be walked on for a start.”

Another important safety-based enhancement was ascribed to having a “second pair of eyes”, especially in situations of high fatigue, and in cases of emergency or accidents:

“[...] a second set of eyes never hurts. You’ve got a second person there who’s, if they’re sitting in the guard’s compartment they’re not concentrating on the operation of the train, they’re concentrating on everything else that’s going on around them, so they might see something you don’t.”

“If it’s yellow light, slow down. Are you going to put the brakes on [primary driver], put the fucking brakes on! So there’s prompts and stuff.”

“[The second driver] can actually see some of the signals before you do.”

“It never hurts to have more than one pair of eyes.”

A “second pair of eyes” was also considered to be a useful asset for signal observance and verifying movement authority. This was linked to having a good overall driving awareness or mediating efficiently between awareness that was driving focused (i.e. related to train movements) or environment focused (i.e. related to signal observance and monitoring the whole environment for potential problems). Lastly, a second driver was also considered to moderate checks and balances, help decide what could be done in unexpected or unfamiliar situations, and provided an immediate resource that could help explore the best response:

“[...] if you’re driving down this tunnel, you had a good mate, I could see everything on the right hand side, I would continually tell him what’s going on.”

“Well maybe you’ve got someone who’s been asked to do something and he’s decided yeah that sounds okay to me and he’s gone ahead and done it and its been the wrong thing and maybe that extra person might have said well hang on let’s think about this for a sec, maybe we shouldn’t be doing this.”

The second positive evaluation of the dual driving environment was the imperative for shared responsibility. This included sharing workload but also the mental burden that would result from a critical failure (e.g. from driving past a signal set to stop/danger).

“[Driving] takes the taxing burden, one person can relax but still keep their eyes open while the other one’s actually doing the driving and adhering to everything that they see.”

“The other person would be observing and not goofing off necessarily but not in such a demanding role.”

“[...] when you’ve got the two of you, you can share the driving thing, when you’re by yourself you can’t.”

Participants indicated that a recovery of workload resulted when moving from the primary driving role to secondary role, and the ensuring respite was an important way of managing the intensity of the primary task. Thus having a second driver would enable the primary driver and second driver to regulate the driving demand between them. The implication from this was that the role of the second driver was comparatively much less demanding than the role of the primary driver.

**Theme 3: Distraction and personality differences in dual driving**

The third theme identified negatives evaluations of dual driving. This included the potential for the second driver to distract the primary driver, and from personality differences that could disrupt the dual driving dynamic. Given the levels of concentration required of train driving, being able to sustain attention at the right time was considered key to avoiding critical failures. A second driver was viewed as a potential safety risk and precursor to distraction through non-task-related conversation.

“You start gas bagging to them, they’re not concentrating, you’re not concentrating, and as a result you have an incident.”

“[...] definitely having somebody there that you’re talking to and you get deep into conversation, it’s a distraction.”

The second negative evaluation of dual driving concerned the potential for personality differences, specifically from personality conflicts. The data implied that compatibility between drivers in dual driving modes was the key to determining an optimum in-cab work partnership.

“You’ve also got the compatibility thing; you’ve got to have someone you get along with. You got someone there that you don’t get along well with, that’s going to be a long journey [...]”, one bloke I had was very shy and we never said anything except for when we first signed on and we’re going to [Depot A] and I’m driving because he didn’t want to and he’s just sitting there [without moving] the whole trip, I thought he was a statue.”

“What happens if you’re stuck with someone you don’t like? Oh yeah, yeah, Mr gloom n’ doom. That’s what I mean, if you spend a shift with doom and gloom and you’ll be suicidal at the end.”

Most views suggested that a stringent and explicit set of rules were needed or would be needed to avert the negative effects from personality differences. The popular view was that a personality conflict bred inattention, created tensions, and therefore, could distract the primary driver from their role. Personality conflicts reportedly arrested any communication that could be beneficial (e.g. from signal observance).
and therefore negated the benefits of safety and shared responsibility.

“It depends on the person. If you want to learn or you think you know it...or you’re going to take advantage, oh this guy’s doing all the work, let him do it all.”

Discussion

Key factors for safe operation of the train in single and dual driving

The first aim of the paper was to determine the positive or negative attributes of the second driver, as perceived by train drivers operating in single and dual driving modes. Preliminary analysis revealed two positive themes related to safety and shared responsibility, and two negative themes associated with distraction and personality differences. The factors identified in the themes also interacted, for example personality differences were believed to undermine shared responsibility and impact safety, effectively negating what were considered key roles of the second driver. However, the main reasons that participants gave for when discussing these themes were often nuanced to essentially reflect the perspective that two drivers were good for driving trains in some situations, some of the time. Despite this, dual driving was perceived to be important for freight operations, largely because of the difficulty of the length of the trips and the isolation, which increased the risks of accident and breakdown.

The second aim of the paper was to determine the attributes of the second driver considered critical for maintaining safety, managing risk and error tolerance. These were individualistic, but appraised in terms of the needs of the main driver and the relative synergies of the second drivers’ role. Thus, the second driver was required to be active as opposed to passive, and to profile and distribute their cognition depending on the driving conditions. These were mediated through signal observance, enhanced awareness, check and balances, and their availability to share driving load and switching roles when needed. The value of the second driver was essentially based on their capacity to predict or second-guess the main driver’s needs.

The psychosocial dimension

The third aim of the paper was to explore any utility of a second driver that went beyond safety. Single driving was differentiated from dual driving because it was considered more repetitive, but unexpected changes associated with the track conditions, train conditions and driver competence were also more frequent. Whist single driving was perceived to require relatively higher levels of concentration, it was also considered to encourage an “auto mode” of driving from the repetition in the task. These data, whilst nuanced, evidenced a capacity to adapt to train driving in the single driver role, for example when task-related communication from a second driver was considered to be distracting. These results supported what is already known about the train driving task complexity but revealed a strong psychosocial dimension in terms if its engagement.

A “second pair of eyes” was considered to be a useful asset for a second driver, though the issue was debated, particularly in the single driving mode, where drivers indicated more familiarity with their routes, less fatigue-related issues, and more mechanical systems for assistance. Thus, in single driving, the utility of a second driver was also appraised in terms of his or her own needs or interpersonal qualities (i.e. as a trainee, or simply as good company). In the dual environment, the second driver was considered important from a task perspective, but the theme of personality differences highlighted an imperative for having good company, particularly given the isolated and remoteness of the environment. Thematicaly, the combination of shared responsibility and personality created a notion that the second driver may simply be valued for being what they are, that is another human (or a relatable consciousness) in close company (or proximity).

Limitations and future directions

The data reported from this study is exploratory, and though most participants were eminently qualified as subject matter experts, the findings also reflected their opinions and prejudices. This is the key limitation of this research, but not all of the ideas, assertions and hypothesised relationships have been tested in previous research – particularly the debate over whether talking is a distraction or helps to point out signals, or whether these aspects of the task are superfluous and there is greater primacy on psychosocial aspects. As a result, the value and contribution of this paper ostensibly lies in its identification of pertinent variables for further research. Consequently, there are a number of factors that may be tested to provide some empirical evidence and subsequent research may use these to generate evidence-based guidelines for single and dual driver operations under different safe working environments. Potential future directions for investigation in the rail operating environment are:

1. Type of talk: timely/on task or constant/not on task
2. Type of operation: freight or passenger
3. Driver experience: whether the driver is new/a trainee or has extensive experience
4. Personality: introverted (prefers to be alone) or extroverted (prefers company)
5. Difficulty of task: visibility, complexity, fatigue levels

Conclusions

This study used a framework of participative ergonomics to understand the factors that might be related to safe operation of the train in single and dual driving modes. Key factors were identified under the themes of safety, shared responsibility, distraction, and personality differences. The dual driving task was differentiated from the single driving and revealed a psychosocial component to perceptions of safety. The study identified compelling relationships between the themes, however the relationships associated with the themes need to be further examined, and a number of areas for future research were identified.
Acknowledgements

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