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Effects of passengers on bus driver celeration behavior and incident prediction

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Abstract

Problem: Driver celeration (speed change) behavior of bus drivers has previously been found to predict their traffic incident involvement, but it has also been ascertained that the level of celeration is influenced by the number of passengers carried as well as other traffic density variables. This means that the individual level of celeration is not as well estimated as could be the case. Another hypothesized influence of the number of passengers is that of differential quality of measurements, where high passenger density cirrcumstances are supposed to yield better estimates of the individual driver component of celeration behavior. *Method:* Comparisons were made between different variants of the celeration as predictor of traffic incidents of bus drivers. The number of bus passengers was held constant, and cases identified by their number of passengers per kilometer during measurement were excluded (in 12 samples of repeated measurements). *Results:* After holding passengers constant, the correlations between celeration behavior and incident record increased very slightly. Also, the selective prediction of incident record of those drivers who had had many passengers when measured increased the correlations even more. *Conclusions:* The influence of traffic density variables like the number of passengers have little direct influence on the predictive power of celeration behavior, despite the impact upon absolute celeration level. Selective prediction on the other hand increased correlations substantially. This unusual effect was probably due to how the individual propensity for high or low celeration driving was affected by the number of stops made and general traffic density; differences between drivers in this respect were probably enhanced by the denser traffic, thus creating a better estimate of the theoretical celeration behavior parameter C. The new concept of selective prediction was discussed in terms of making estimates of the systematic differences in quality of the individual driver data.

Keywords: Bus driver; Incident; Crash; Acceleration; Passengers; Methodology

1. Introduction

Ever since the discovery that different people have different numbers of injuries and other unplanned negative physical events (e.g., Greenwood & Yule, 1920), researchers have tried to find what it is that make this difference, and use it to predict beforehand who will be dangerous, mainly within the traffic area. Through the decades, several groups of variables have been tested as traffic incident predictors; motor coordination, personality, driving behavior, stress, attitudes, driving skill, errors, information processing, alcoholism, hazard perception, and many others (for reviews, see af Wåhlberg, 2003a; Lester, 1991). Although a few strong correlations have been reported now and then, in general results have been weak.

It has been suggested that these disappointing results are due to the multiple causes of incidents[1] (Arbous, 1951); any specific predictor is only associated with a few of the incidents on drivers' records, while the others are due to other factors. Therefore, multiple predictors would need to be used to achieve any useful predictive power. However, there is also

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[1] The word 'incident' is here used as similar to 'accident', but hopefully without the latter words connotations of randomness.

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the possibility of summing together many different predictors to a single variable.

It has been suggested that all driver behaviors of importance for safety are executed as speed changes and that the sum of a driver's overall acceleration behavior during a time period therefore will be predictive of his/her culpable incident involvement for the same period within the driver population and environment where his/her driving is undertaken. This is named celeration behavior, and the theoretical parameter is denoted C (af Wåhlberg, 2006a).

Unfortunately, C is difficult to measure, as it is really the sum of all speed changes over a very long time period. However, under the assumption that celeration behavior of individual drivers has some stability over time, it can be estimated by a few measurements. It has previously been found that bus drivers' two-year incident record can be predicted with a power of about .20 (Pearson correlation)(af Wåhlberg, 2006d) with single measurements, and that this association is strengthened when measurements are aggregated, as are correlations between measurements (af Wåhlberg, in press).

Meanwhile, it has also been shown that celeration behavior is positively influenced by traffic density (af Wåhlberg, 2003b). More specifically, the number of passengers per kilometer driven was shown to correlate weakly with celeration level. Similar results were reported by Clark and Cribbins (1968). This is a methodological problem, because the passenger effect is fairly random, because of duty rotation[2], while the driver effect is rather systematic (af Wåhlberg, 2003b). This means that the individual driver component is the best estimate of the C parameter, and if other influences, like number of passengers, can be held constant, this estimate will be even better, and so will the predictive power concerning incidents. As a side effect, it can also be expected that the reliability of celeration, (i.e., the intercorrelations between measurements), would increase somewhat if the influence of passenger was held constant.

Within the context of passenger effects, a new methodological tool will be discussed and tested; selective prediction, which means to exclude certain cases and see whether the correlation with the criterion increases for the rest. It is common practice, and almost a dogma, to use random sampling of subjects, and not to exclude any unless they are outliers. However, the outliers can be seen as special cases of a more general principle, where measurements of 'bad quality' are excluded. Concerning outliers, these are identified by their large difference from other cases. However, this is only an indication that something may be wrong with the data, it is not proof thereof. But what if another variable could be found that had some influence on the quality of all points of data? The suggestion is that not all subjects are equally well measured within a single measurement occasion; some individuals' values will be good representations of their overall values, while others' will not. For example, personality traits can be more or less stable. Some people behave similarly in all situations, while others will try to blend in with the situation and other people. The first group will be easy to estimate by observation, the other not.

Enter now the concept of selective prediction. This tool is useful in many ways. First, it can identify if a variable has an effect on the quality of another. Second, it influences later measurements and predictions. It will be predictive of which subjects you will need to measure again, and it will tell you something about the confidence you can have in a prediction of a single case (although some new kind of statistical method really needs to be developed for this). The method is simple: when correlating the predictor and the criterion, exclude cases systematically dependent upon their values on the third 'quality variable,' which in the example above would have been the stability of personality over environments. The result, if bad cases are excluded, will be an increase in the correlations with the criterion (assuming that there really is an association between these variables).

Turning back to driver celeration behavior, it should again be pointed out that in this research any measurement is really an estimate (c) of the total sum of all speed changes undertaken (the theoretical parameter C). As noted above, this estimate also contains some random influences from various traffic density parameters. However, it can also be suspected that the traffic density will have an impact on the quality of the measurement along the lines described above. The hypothesis here is that although all drivers have their own preferred or accepted level of celeration, this will be more apparent when there are other road users to interact with. On an empty motorway, whatever differences exist will be very small between drivers, as pointed out in some previous papers (e.g. af Wåhlberg, 2006b). Similarly, for the example above, it would be hard to determine the personality of a hermit.

For the passenger variable, the above reasoning means that it can be suspected that drivers measured when there are many passengers onboard (and probably high traffic density in general) have yielded values, which are more indicative of their C parameter, than are those of the drivers who were measured when traffic was thin. This also means that if you have repeated measurements, a driver excluded due to bad quality in one sample will not necessarily be so in another, because this is decided upon by the random passenger factor.

The selective prediction hypothesis could also lead to the prediction that samples with a higher mean of passengers will have stronger associations with incidents, a kind of group level selective prediction. However, it should also be remembered that a high mean is often accompanied by a high

[2] Most drivers work on a specific schedule, which means that they will have the same duty again within a foreseeable future, which does create some stability of exposure to number of passengers. However, most duty lists are rather long, which means that it will take weeks before a specific duty crops up again. Another way that stability could be introduced is by the content of the duty lists in total; a specific list (which a driver works within) will contain mostly early, day or late duty shifts. However, over a longer time period (a few years), this effect will lessen, because drivers change duty lists.