It Wasn't My Fault: Does Crash Culpability Improve Predictive Outcomes In a Self-Report Study?

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Abstract

Introduction: Research that has focused on the ability of self-report assessment tools to predict crash outcomes has proven to be mixed. As a result, researchers are now beginning to explore whether examining culpability of crash involvement can subsequently improve this predictive efficacy. This study reports on the application of the Manchester Driver Behaviour Questionnaire (DBQ) to predict crash involvement among a sample of general Queensland motorists, and in particular, whether including a crash culpability variable improves predictive outcomes. Surveys were completed by 249 general motorists on-line or via a pen-and-paper format. Results: Consistent with previous research, a factor analysis revealed a three factor solution for the DBQ accounting for 40.5% of the overall variance. However, multivariate analysis using the DBQ revealed little predictive ability of the tool to predict crash involvement. Rather, exposure to the road was found to be predictive of crashes. An analysis into culpability revealed 88 participants reported being "at fault" for their most recent crash. Corresponding between and multi-variate analyses that included the culpability variable did not result in an improvement in identifying those involved in crashes. Conclusions: While preliminary, the results suggest that including crash culpability may not necessarily improve predictive outcomes in self-report methodologies, although it is noted the current small sample size may also have had a deleterious effect on this endeavour. This paper also outlines the need for future research (which also includes official crash and offence outcomes) to better understand the actual contribution of self-report assessment tools, and culpability variables, to understanding and improving road safety.

Key words: Culpability, Driver Behaviour Questionnaire (DBQ), and crashes.

Introduction

A considerable amount of research has been conducted utilising the Manchester Driving Behaviour Questionnaire (DBQ) to understand driving behaviour and the relationship with negative outcomes such as crashes and offences. Originally developed in 1990 by Reason, Manstead, Stradling, Baxter & Campbell, 1990, it has now been extensively utilised in the prediction of individual differences in crash involvement, and to a lesser extent, predicting those who will incur demerit points. For example, a meta-analysis of the DBQ revealed that the scale had been used in 174 published studies with 45,000 respondents (de Winter & Dodou, 2010). The scale has undergone changes during this time (Lawton, Parker, Stradling & Manstead, 1997), and now most often measures three distinct (but related) aspects of driving behaviours: high code violations (e.g., speeding), errors and deliberate violations. The DBQ has been utilised in a number of countries to explore a range of road safety issues, including: driving behaviour within different age groups, gender differences, impact of self-report bias, mental health issues, fleet drivers, vehicle type, etc.

Despite its wide-spread popularity, researchers continue to question the psychometric properties of the DBQ and its ability to accurately predict which drivers are most likely to be involved in a crash (af Wåhlberg, 2009; af Wåhlberg, Dorn & Freeman, 2012; Newman & VonSchuckmann, 2012). More specifically, de Winter and Dodou's (2010) meta-analysis of the DBQ revealed that the violations subscale predicted crashes with an overall correlation of .13 (based on zero-order effects reported in tabular form) which the authors interpreted as evidence of the usefulness of the tool to obtain insight into driving behaviours for various populations. In contrast, other researchers

consider this association to be quite low and likely spuriously inflated due to method effects (af Wåhlberg et al., 2012). In addition, the very low mean scores present on many DBQ items and subscales may effectively undermine the usefulness of the tool to accurately measure the impact of safety-related interventions (Harrison, submitted for publication), particularly if correlations are identified which in turn draw on relatively rare dependent variable events such as crashes. The search for a means by which to accurately measure and predict unsafe driver behaviour has lead researchers to consider the development of alternatives to the DBQ (Newman &VonSchuckmann, 2012; Wishart, Freeman, Davey, Wilson & Rowland, 2012), although the development of a more valid scale still remains elusive.

Culpability

One reason for the low predictive ability of the DBQ to identify crash outcomes may be because previous research has generally neglected to consider the issue of culpability. More specifically, it may be unreasonable to expect the DBQ to predict crashes among a sample of non-culpable drivers. That is, when the crash was not the fault of the sample respondent. The idea of including culpability in studies is not new, as researchers have long suggested that the ultimate measure of risky driving is involvement in crashes where the driver has been deemed at fault (Jonah, 1997). One explanation for the lack of culpability-based research is that culpability is hard to determine, not just because of deficits in crash information, but also because there is no explicit, accepted and validated definition of responsibility of crashes with traffic research, as well as a method to undertake necessary categorisations (af Wåhlberg, 2009). In fact, road users may share the blame for some crashes, just to differing degrees (af Wåhlberg, 2009). In the end, each researcher must make their own classifications, although perceived driver responsibility is the most common approach. Despite this, there has been some preliminary work undertaken in the area, although the percentage of at-fault drivers has ranged considerably across studies, from 25% (Waller et al., 2001) to 87.6% (Fischer et al., 2007). af Wåhlberg (2009) conducted a review of the culpability research arena and reported that the highest culpability levels were most often recorded by researchers, followed by companies, self-reports and then the police. It could be suggested that self-report of culpability should entail the lowest percentage of at-fault claims, given issues associated with self-report bias. Of note is that despite preliminary research in the area, there has yet to be a focus on whether examining culpability increases the predictive efficacy of popular driving assessment measures. As a result, the present study aimed to investigate:

(a) the psychometric properties of the DBQ with a sample of Australian drivers;
(b) whether participant's own assessment of crash culpability was similar to independent raters' assessments; and
(c) the predictive ability of the DBQ to identify self-reported crash involvement and traffic offences after consideration of culpability.

Method

Participants

A total of 249 Queensland motorists responded to online recruitment for the study. As such, there was no random assignment of participants to the sample group and a snow-balling approach was utilised, as participants were encouraged to forward the e-mail to others, such as family and friends. Data were collected over a five month period (September 2011 to January 2012) using both online and hardcopy versions of the questionnaire. Subsequent analyses revealed no between-group differences in responses between the data collection methods on key independent or dependent variables. On completion of the survey, participants received payment in the form of a gift voucher valued at $10. This study had ethical approval from the QUT human ethics research committee.

Sample Characteristics

Of the participants, 91 (36.5%) were males and 158 (63.5%) were females. The average age of respondents was 37.4 years old (range 18-65), with licences held for an average of 19.1 years (range 1-48). The majority of participants reported experiencing a crash at some point in their lifetime (77.5%) and drivers within this group were involved on average in 2.5 crashes over the last three year period (range 1-10). The largest proportion (30.6%) reported driving between 101 and 200km per week, while 16.9% reported driving less than 50km per week. The median driving duration for the sample was between 6 and 10 hours per week, and 72.3% of participants reported driving for less than 10 hours per week. Just over one third (34.9%) of participants reported losing demerit points in the past three years (e.g., receiving a fine), doing so an average of 1.9 occasions (range 1-7).

Materials

Participants completed a questionnaire comprised of items measuring demographics, crash history, driving offences, driving exposure, and the 20 item version of the DBQ (Lawton et al., 1997). Respondents indicated on a seven-point scale (1 = Never to 7 = Always) how often they commit each of the *errors* (8 items), *highway code violations* (8 items) and *aggressive violations* (4 items). Demographic questions covered age, gender and years since first obtaining their licence. To ascertain respondents' crash history, participants were asked the number of crashes experienced over their lifetime and the number of crashes experienced within the last three years. A crash was deemed to be any incident involving a motor vehicle that resulted in damage to a vehicle, property or injury. Participants also reported the number of occasions on which they had been fined or lost demerit points for traffic offences in the last three years, excluding parking offences.

Culpability

In order to explore driver culpability, respondents were required to briefly describe the latest crash in which they had been involved, regardless of how long ago it occurred. As part of this description, respondents were also required to indicate who they considered to be at fault and what factors (e.g. speeding, driving errors) contributed to the crash. These responses were later coded as being either 'culpable' or 'not culpable' by two independent raters. When determining culpability in the current study, coders were guided by general road rules. As noted above, there is no widely accepted or validated method to accurately and objectively determine culpability for crashes. See Table 3 for examples of coding.

Results

DBQ Psychometrics

Cronbach's alpha reliability coefficients were calculated to examine the internal consistency of the DBQ scales and are shown in Table 1. A comparison of the findings with previous Australian and New Zealand studies in which coefficient scores were provided (Davey et al., 2007; Freeman et al., 2009; Harrison, 2009; 2011; Sullman et al., 2002; Wishart, Freeman, Davey, Rowland, et al., 2012) indicate the internal reliability of the *Highway Code Violations* (.77) and *Aggressive Violations* (.61) scales to be generally comparable with previous findings. However the reliability of items coded as *Errors* was lower (.64) than has previously be found (Davey et al., 2007; Freeman et al., 2009; Harrison, 2009; 2011; Sullman et al., 2002; Wishart, Freeman, Davey, Rowland, et al., 2012). The mean scores for the DBQ scales and the three highest ranked DBQ items are also shown in Table 2.

A series of t-tests revealed the mean of *Highway Code Violations* (i.e. speeding) to be significantly greater than the mean of *Errors* [t (247) = 14.09, $p < .000$] and also significantly greater than the mean of *Aggressive Violations* [t (248) = 8.05 $p < .000$]. The average means for *Aggressive Violations* was also found to be significantly greater than the means of *Errors* [t (247) = 6.26, $p <$

.000]. The findings suggest that speeding is the most common driving behaviour reported by the current sample as is consistent with previous research (Davey et al., 2007; Newnam et al., 2004; Sullman et al., 2002; Wishart, Freeman, Davey, Rowland, et al., 2012). In addition, Table 1 reports the mean and standard deviation scores for the three highest ranked items, which were: *Exceed the speed limit on a highway* (*M* = 3.00, *SD* = 1.48); *Become angered by another driver and show anger* (*M* = 2.25, *SD* = 1.31); and *Stay in a closing lane and force your way into another* (*M* = 2.17, *SD* = 1.22).

Table 1. *Mean Scores for the DBQ factors*

	Cronbach Alpha reliability coefficients	*M*	*SD*
Highway Code Violations (8 items)	.77	2.07	.71
Errors (8 items)	.64	1.46	.40
Aggressive Violations (4 items)	.61	1.72	.67
Highest Ranked Items			
1. Exceed the speed limit on a highway		3.00	1.48
2. Become angered by another driver and show anger		2.25	1.31
3. Stay in a closing lane and force your way into another		2.17	1.22

Principle components factor analysis with oblique rotation was undertaken to determine the factor structure of the DBQ, with eigenvalues greater than .40 utilised to identify factors. This revealed a three-factor solution that accounted for 40.50% of the total variance. The first factor accounted for 22.46% of the total variance and contained seven items, consisting of four *Highway Code Violations* items and three *Aggressive Driving* behaviour items. The second factor comprised ten items, consisting of all eight original items from the *Error* scale, one *Highway Code Violations* item and one *Aggressive Driving* behaviour item. The third factor contained three items, all of which were drawn from the *Highway Code Violations* scale. Of the twenty items, nine cross-loaded, with one item *Miss 'Stop' or 'Give Way' signs* cross-loading on all three factors. For some of the cross-loading items, an obvious association with other factors is present. For example to *become impatient with slow driver ahead and overtake on inside* and to *drive especially close to car in front* could be considered an aggressive act in some circumstances while also associated with speeding. All items and factors for the 20-item DBQ are reported in Table 2. The internal consistency of the new DBQ scores was examined by calculating Cronbach's alpha reliability coefficients which revealed that items generally associated with aggression had the highest reliability coefficient (.77) while items associated with driver error (.67) and highway code violations had lower reliability scores (.64).

Table 2. *Factor structure of the modified DBQ*

Items	F1	F2	F3
Become angered by another driver and show anger	.72		
Sound your horn to indicate your annoyance to another driver	.66		
Become impatient with a slow driver ahead and overtake on inside	.66		.48
Drive especially close to car in front to signal to driver to go faster	.64		.60
Become angered by another driver and give chase	.59	.33	
Race away from the traffic lights to beat driver beside you	.59		
Drive even though you suspect you are over legal blood-alcohol limit	.40		.39

Fail to notice pedestrians are crossing in your path of traffic		.64	
Pull out of a junction so far that you disrupt the flow of traffic		.56	
Nearly hit car in front while queuing to enter a main road		.56	
Miss 'Stop' or 'Give Way' signs	-.30	.55	.33
Skid while braking or cornering on a slippery road		.52	
Attempt to overtake someone you hadn't noticed turning		.52	
When overtaking underestimate the speed of an oncoming vehicle		.48	
Nearly hit cyclist while turning	.31	.46	
Stay in a closing lane and force your way into another	.36	.40	
Fail to check rear-view mirror before pulling out or changing lanes		.38	
Disregard the speed limit on a residential road			.77
Exceed the speed limit on a highway	.33		.74
Cross junction knowing traffic lights have already turned		.40	.58
Amount of variance explained	22.5	9.9	8.2

Coding Culpability

An examination was undertaken into participants' self-reported descriptions of their most recent crash. As noted earlier, two researchers (e.g., authors) independently coded participants' descriptions of their most recent crashes with the aim being to: (a) compare the samples' interpretation of culpability with the independent reviewers, and (b) identify the frequency of culpability in the sample. In total, 193 participants reported being involved in a crash in their lifetime (77.51% of the sample). There was a high level of consensus between the sample respondents' and the independent raters' categorisation of culpability (90.27%) with 180 descriptions being categorised the same. Examples of coding are provided in Table 3. The small number of ambiguous responses, after consideration, were all deemed to be the fault of the respondent (self) and coded accordingly. In these cases, although other factors may have also been at play, the drivers' actions (or inactions) were deemed to have contributed to the crash.

Table 3. *Examples of coding 'Culpability'*

Coding Categorisation	Survey response
Culpable	*Aqua planed into a bank.*
	I was distracted and rear ended a car that stopped suddenly in front of me.
Not culpable	*Rear ended by car while stopped at traffic lights.*
	T-boned at an intersection by a p-plater who disregarded a give way sign.
Ambiguous (coded as culpable)	*I did a u-turn and a driver crashed into the side of me.*
	A child ran in front of my car on a wet road. Swerved to avoid & crashed into parked car.

Predicting crashes, offences and culpability

To better understand the relationship between self-reported crashes/offences and driving behaviours (as measured by the DBQ), a series of logistic regression analyses were undertaken. Models were created assessing the contribution of participants' gender, recent driving exposure (e.g., hours spent driving per week), the modified DBQ factors (e.g., errors, highway code violations and aggressive violations) and driving history (incurring demerit points loss, crash involvement) and crash

culpability. To address small cell sizes present in some categories, weekly kilometres driven was re-coded into five categories, being: less than 50 km per week; 50-100 km per week; 101-200km per week; 201-500km per week; and over 500km per week. Similarly, hours driven per week was re-coded into four divisions; less than five hours per week; 6-10 hours per week, 11-20 hours per week; and 21 or more hours per week.

Predicting lifetime crashes

The first logistic regression aimed to determine the contributions of gender, hours driven per week, the DBQ factors and number of self-reported traffic offences in the past 12 months to the prediction of being in a crash in the driver's lifetime. This dependent variable was dichotomised with 193 coded as crash involved and 53 with no crash history. The number of hours driven per week and gender were entered in the first step to examine, as well as control for, their influence before the inclusion of the DBQ factors. The model at step one was a significant predictor of the outcome variable (χ^2(4) = 18.920, p = .001), with, 11.2% of the variance accounted for and 77.3% of the sample was correctly classified. At step one, gender was found to be a predictor (wald = 5.09, p = .024) with men 2.25 times more likely than women to have been involved in a crash in their lifetime. In addition respondents who reported driving between 11 and 20 hours per week (wald = 4.54, p = .033) were 2.98 times more likely than those who drove five hours or less per week to report being involved in a crash in their lifetime. At step two, the model remained significant (χ^2(7) = 20.018, p = .006), however the addition of the three DBQ factors did not make a significant contribution to the prediction of crashes. Step two accounted for .6 % of the variance. Gender and respondents driving between 11 and 20 hours per week remained significant at step two.

Predicting crashes in last three years

Another logistic regression was conducted to examine the contribution of age, gender, hours driven per week and the DBQ factors to the prediction of whether or not respondents had been involved in an accident in the past three years. Again a dichotomous variable was created which recorded the 70 (28.1%) drivers who had reported a crash in the last three years and the 179 (71.9%) who had no crash in this period. The model at step one was not a significant predictor of the outcome variable (χ^2(4) = 7.277, p = .122). However significance was found in regard to those drivers who drove over 21 hours per week (wald = 5.752, p = .016), with this group 5.62 times more likely than who drove less than 5 hours per week to report involvement in a crash in the past three years. The second step involved the inclusion of the three DBQ factors. While at step two the model was not significant (χ^2(7) = 9.585, p = .213), the item noted above remained significant but the addition of the DBQ scales did not contribute to the prediction of crashes in the past three years.

Predicting offences incurred in last three years

A logistic regression was conducted to examine the contribution of age, gender, hours driven per week and the DBQ factors to the prediction of incurring demerit points or fines in the past three years. A dichotomous variable was created categorising whether or not respondents had received a fine or demerit points in the last three years, with 162 respondents (65.1%) reporting no offences while 87 (34.9%) reported incurring one or more fines or demerit points in the last three years. The model at step one was not a significant predictor of the outcome variable (χ^2(9) = 12.889, p = .168). The second step involved the inclusion of the three DBQ factors. While at step two the model was also not significant (χ^2(12) = 19.761, p = .072), the three item *highway code violations* factor was found to be significant (wald = 4.421, p = .036). In the overall model, after controlling for age, gender, weekly driving hours, for every unit increase in their *highway code violations* score, respondents were 1.75 times more likely to have been detected committing a traffic offence in the last three years.

Predicting Culpable Crashes

In order to investigate the extent to which driver culpability improved the predictive efficacy of the driving variables, a dichotomous variable was created containing drivers who had been coded as being at fault in their most recent crash (n = 88) versus those drivers who reported never being involved in a crash in their lifetime (n = 56). Respondents whose most recent crash was deemed to be caused by someone else were excluded from this variable. The contribution of age, gender, hours driven per week to the prediction of whether or not respondents were at fault in their most recent crash was examined at step one with the DBQ factors again included in the model at step two.

The logistic regression at step one found the model was a significant predictor of the outcome variable ($\chi^2(9) = 25.440$, $p = .003$), with 22.3% of the variance was accounted for and 70.2% of the sample correctly classified. Both age (wald = 5.60, $p = .018$) and gender (wald = 6.253, $p = .012$) were found to be significant predictors. For every yearly increase in age, a driver is 1.05 times more likely to be considered at fault in their most recent crash, while women are 2.97 times less likely than men to be considered at fault in their most recent crash. At step two, no significant contribution was made by the addition of the DBQ scores to the prediction of culpability. Corresponding between group analyses (e.g., ANOVAs) that utilised the DBQ factors also failed to find significant effects between the: (a) culpable drivers and those who hadn't been in a crash and (b) culpable drivers and those who hadn't been in a crash or were not culpable (e.g., sample combined).

Discussion

The present study aimed to: (a) examine the psychometric properties of the DBQ with a sample of Australian drivers; (b) explore whether participant's own assessment of crash culpability was similar to independent raters; and (c) investigate whether the predictive ability of the DBQ to identify self-reported crash involvement increases when culpability is coded.

Firstly, DBQ reliability coefficients were found to be relatively robust and similar to earlier Australian research (Davey et al, 2007; Freeman et al, 2009; Sullman et al, 2002). The reliability of the scale appears acceptable despite making minor alterations to the DBQ to reflect Australian driving conditions, which again provides support for the tool to be modified to accommodate different cultures and driving environments. Examination of the overall mean scores with the original DBQ factors revealed similar scores, and *highway code violations* were again reported to be the most frequent driving behaviour exhibited. This finding is consistent with previous research that has found speeding to be the most frequently reported aberrant driving behaviour on public roads (Lajunen et al, 2003; Parker et al, 2003) and also is in line with official traffic infringement histories for the surveyed regions which showed speeding to be the most common form of traffic violation (Watson, Armstrong, Watson, Livingstone & Wilson, 2011).

Secondly, factor analytic techniques were implemented to assist with the interpretation of the scale scores. The current study identified three factors that were quite ambiguous: (a) *highway code violations* with *aggressive violations,* (b) *errors* and (c) *highway code violations* (3 items). Nine items cross-loaded on different factor scales, with one item *Miss 'Stop' or 'Give Way' signs* cross-loading on all three factors. In terms of face validity, many items, including the cross loading items could be reasonably associated with more than one grouping of behaviour types. However this may equally apply to items that did not cross-load. In the current sample, the DBQ was not particularly precise in determining distinct factors, although this is similar with some previous DBQ research that has reported crossing loadings and mixed factors (Davey et al, 2007; Freeman et al, 2009). More specifically, *highway code violations* and *aggressive violations* tended to cross load. This may be considered to be expected, as behaviours regarded as *highway violations* may also be classified as aberrant or aggressive, or at least, may originate from emotions associated with frustration (Freeman et al., 2014). In contrast, driving errors was the clearest factor to interpret which is again consistent with previous research (Davey et al., 2007; Freeman et al., 2014).

Finally, a central component of the current study was to investigate the extent that the DBQ could predict aberrant driving outcomes, particularly after taking into account self-reported culpability. Within the current sample, gender was a significant predictor of lifetime crashes, offences in the past three years and of culpability. Similar to previous DBQ-based research (Davey et al, 2007; Freeman et al, 2009), exposure to the road were also predictive. More specifically, weekly hours driven was found to be a significant predictor of both lifetime crashes and crashes in the past three years. However, both before and after the contribution of culpability, the DBQ was generally poor in terms of predictive capacity. In effect, and in line with previous DBQ studies, exposure to the road is more effective at predicting crashes than any of the DBQ factors (Davey et al., 2007; Freeman et al., 2009; Wishart, Freeman, Davey, Rowland, et al., 2012). The sole contribution of a DBQ element was that of *highway code violations* to the prediction of offences incurred in the past three years. This finding adds support to the argument that the DBQ is not an effective tool by which to predict self-reported incidents, particularly crashes (af Wåhlberg, Dorn & Freeman, 2012). While previous research has identified an association between *errors* and crash involvement (Blockey & Hartley, 1995; DeLucia et al., 2003; Freeman et al., 2009, Wishart, Freeman, Davey, Rowland, et al., 2012) the predictive capacity of *errors* has also been queried (Scott-Parker, Watson & King, 2010; Stephens & Groeger, 2009). It is also noted that while there is general acceptance that aggressive driving behaviours do contribute to an increased crash risk, establishing a proven link between measurements of this behaviour and actual crash involvement can be problematic (AAA Foundation for Traffic Safety 2009; Deffenbacher, 2009; Soole, Lennon, Watson, & Bingham, 2011).

Coding for (and including) culpability in the regression models did not improve the predictive efficacy of the DBQ. While there appeared to be a high level of consensus between the sample's and raters' interpretation/understanding of culpability, including the variable in subsequent analyses did not improve detection of at-fault drivers. There may be a number of reasons for this finding. Firstly, the small sample size of the study limits statistical power, particularly those reporting a recent crash. Although, larger sample sizes that have utilised the DBQ have not automatically facilitated an increase in predictive findings (Freeman et al., 2014). Secondly, a range of other methodological limitations associated with self-report data (e.g., social desirability responding, memory recall bias and other method effects) can also negate predictive efficacy. Thirdly, the generalisability of the findings may also be limited to the extent that the sample was not representative of the wider driving population. While an acceptable variety of respondents participated in the study, it is noted that the sample was self-selecting, drawing primarily on urban professionals and students. As a result, rural drivers are likely to be underrepresented in the sample. Lastly, it is acknowledged that the prediction of crashes and culpability for crashes utilises self-reported data drawn from crash involvement over the respondent's lifetime. As the DBQ questions in the current survey examine recent driving behaviours (e.g., 6 months), they may not reflect driving behaviours as they existed at the time of some of the earlier crashes.

Taken together, future studies that include larger sample sizes may illuminate the actual contribution of culpability analyses to identify drivers involved in at-fault crashes. This could include either self-reported or independently rated culpability categorisation, although given the above mentioned problems with self-report data, combining such data sources with official records may improve the robustness of any findings. As noted above, there is currently no accepted and validated definition of responsibility of accidents with traffic research, as well as a method to undertake necessary categorisations (af Wåhlberg, 2009). Despite this, there appears some intuitive sense in considering the issue of culpability in order to improve the accuracy of predictive models, although the exact level of such contribution is yet to be determined. The present study indicated that respondents' assessments of culpability are similar to that of independent raters, which increases the validity of this data source. However, there is almost a total lack of discussion in the literature regarding the appropriate interpretation and value of considering culpability (af Wåhlberg, 2009). This may yet prove to be an oversight given the increasing research focus being directed

towards understanding the causes of crashes, and the limited ability of current tools to predict such events.

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