## Special Study Summary Report Analysis of Advanced Driver Assistance Systems (ADAS) Automatic Emergency Braking (AEB); City (CAEB); High-Speed (HAEB) Results of Comparison of Nissan Without AEB/HAEB Against Toyota with AEB/HAEB David B. Brown and Praveena Penmetsa

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# **1.0 Introduction**

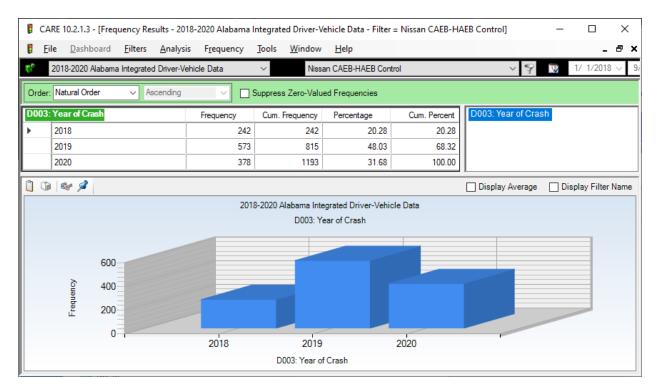
This document presents the results of an ADAS evaluation of both city and high speed Automatic Emergency Braking (AEB). With AEB brakes are automatically applied to reduce crash severity and to warn the driver in some cases to prevent the crash altogether. The particular comparisons that we made involved Toyotas for which AEB was in effect for both CAEB and HAEB. These were compared to Nissans that were selected to have neither of the AEB capabilities.

The use of the terms test and control could be confusing, and we will not use them here. The tables have two columns labeled "Subset" and two labeled "Other." The Nissans are in the Subset Frequency and Subset Percent columns in the table. We usually put the "inferior" subset (like DUI, Distracted Driving, etc.) in this position so that the results make more sense. The "Other" columns in this study are the Toyotas, which are being evaluated to see if they are superior to the Nissans.

The following CARE results are given to provide further background for the analysis that will be given in Section 2:

- 1.1 Years of Crash for Nissans (Non-AEB) these are the calendar years that the Nissan crashes took place.
- 1.2 Cross-tabulation, where the columns are the model years of the Nissans, and the rows are the calendar years in which these crashes took place.
- 1.3 Years of Crash for Toyotas (AEB) these are the calendar years that the Toyota crashes took place.
- 1.4 Cross-tabulation, where the columns are the model years of the Toyotas, and the rows are the calendar years in which these crashes took place.
- 1.5 This is a comparison using IMPACT of the Nissan years of crash (in the Subset columns and having red bars in the chart) against the Toyota years of crash (in the Other columns and having blue bars in the chart).
- 1.6 This is the same comparison as above except that the attribute being compared is the model year as opposed to the year of the crash.

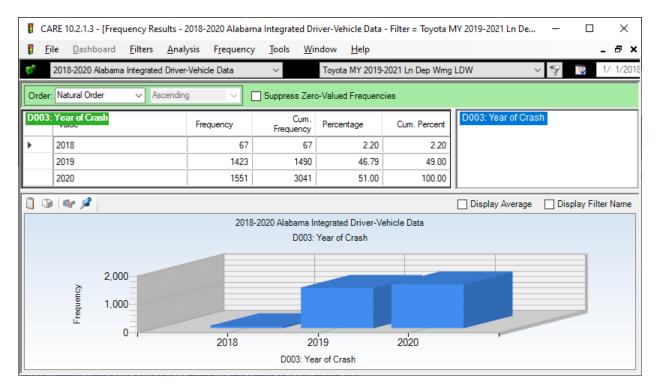
### 1.1 Years of Crash for Nissans (Non-AEB)



### 1.2 Model Year (Columns) by Year of Crash (Rows) for Nissans (Non-AEB)

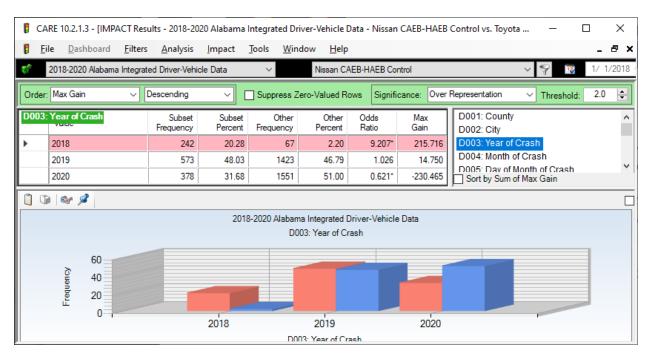
CARE 10.2.1	3 - [Crosstab Result	s - 2018-2020 Alabar	ma Integrated Driv	er-Vehicle Data - Filt	ter = Nissan CAEB-HAEB Co	ntrol] —	
🖡 <u>F</u> ile <u>D</u> as	hboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	low <u>H</u> elp			_ 8 :
2018-202	) Alabama Integrated [	Driver-Vehicle Data	~	Nissan CAEB-HAEB	Control	~ 9	1/ 1/20
Suppress Zero \	/alues: Rows and Co	umns 🗸 Select	Cells: 🔳 🖷 🛞	9	Column: Mod	el Year ; Row: Ye	ar of Crash 🛛 🖓
	2018	2019	2020	TOTAL			
2018	239	3	0	242			
2019	338	235	0	573			
2020	185	179	14	378			
TOTAL	762	417	14	1193			
		-		-			

# 1.3 Years of Crash for Toyotas (AEB)



## 1.4 Model Year (Columns) by Year of Crash (Rows) for Toyotas (AEB)

CARE 10.2.1	.3 - [Crosstab Result	s - 2018-2020 Alabaı	ma Integrated Driv	er-Vehicle Data - Fil	lter = Toyota MY 2019-2021 Ln Dep 🗆 🗙
🖡 <u>F</u> ile <u>D</u> as	hboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rossta	b <u>T</u> ools <u>W</u> ind	dow <u>H</u> elp	_ & ×
2018-202	0 Alabama Integrated [	Driver-Vehicle Data	~	Toyota MY 2019-20	021 Ln Dep Wmg LDW -> 💡 😨 1/ 1/201
Suppress Zero	Values: Rows and Co	lumns 🗸 Select	Cells: 🔳 🔹 %	9	Column: Model Year ; Row: Year of Crash 🔃
	2019	2020	2021	TOTAL	
2018	67	0	0	67	
2019	1289	134	0	1423	
2020	961	588	2	1551	
TOTAL	2317	722	2	3041	
		-			



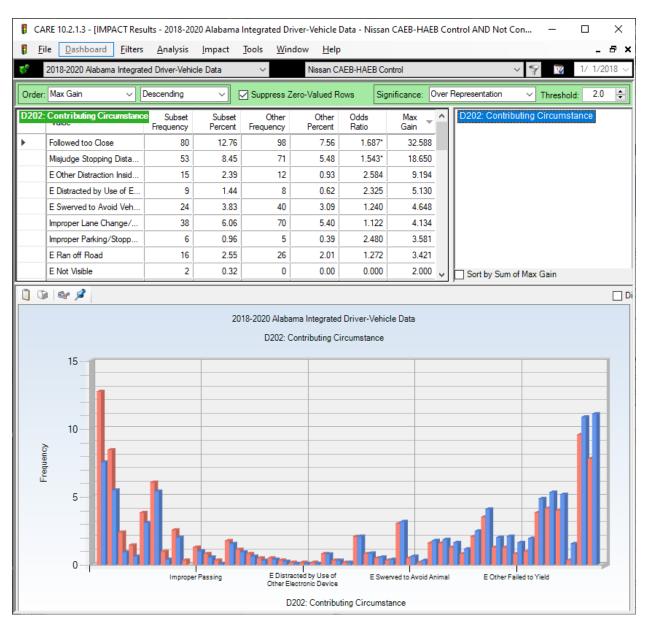
## 1.5 D003 Year of the Crash IMPACT (Subset=Red Bars=Nissan)

### 1.6 D208 Model Year IMPACT

P	CARE	10.2.1.3 - [	IMPACT Re	sults - 2018-20	)20 Alabam	a Integrated	Driver-Vehic	le Data - Nis	san CAEB-HAE	B Control AND Not M 🗆 🗙
ľ	<u>F</u> ile	<u>D</u> ashboa	ard <u>F</u> ilter	s <u>A</u> nalysis	<u>I</u> mpact	<u>T</u> ools <u>W</u>	<u>/</u> indow <u>H</u> e	elp		_ & ×
¢	20	18-2020 Ala	bama Integra	ated Driver-Vehi	cle Data	~	Nissan	CAEB-HAEB	Control	✓ ♥ 〒 1/ 1/2018
Or	der: M	ax Gain	~	Descending	~	Suppres	s Zero-Valued	Rows Sig	nificance: Ove	er Representation V Threshold: 2.0
D2		odel Year		Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max ^ Gain	D208: Model Year
	20	)17		0	0.00	0	0.00	0.000	0.000	
	20	)18		762	63.87	0	0.00	0.000	762.000	
	20	)19		417	34.95	2317	76.19	0.459*	-491.971	
	20	)20		14	1.17	722	23.74	0.049	-269.244	
	20	)21		0	0.00	2	0.07	0.000	0.000 🗸	Sort by Sum of Max Gain
0		sy 🖉								
					20	18-2020 Alab	ama Integrate	ed Driver-Veh	icle Data	
							D208: Model	Year		
		Frequency	100 50							
		<u> </u>			2018	3	2019	)	2020	-
							D208- Mode	al Yaar		

# 2.0 IMPACT Analysis Comparing Nissans (non-AEB) with Toyotas (AEB)

Because the comparisons here are being made using the Driver-Vehicle Dataset within CARE, the numbers produced are in vehicles and not crashes. However, they were only vehicles that were involved in crashes. In order to emphasize this point, the term "<u>Vehicle-Crashes</u>" will be used in discussing these results.



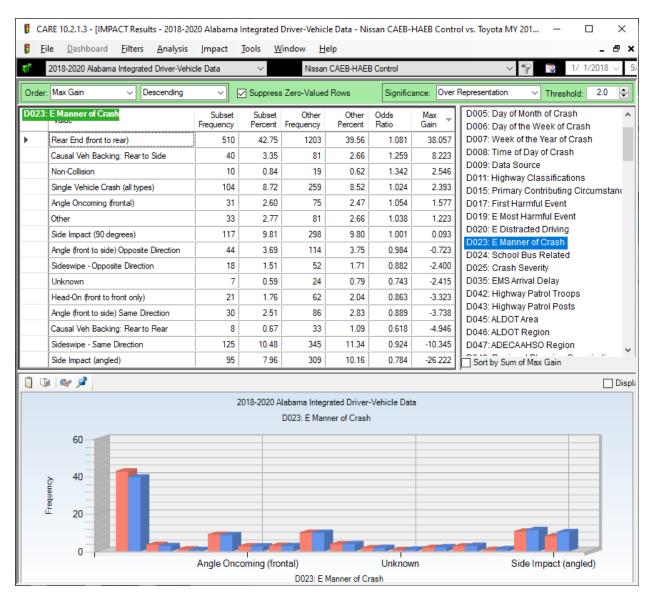
#### **D202** Contributing Circumstances

For the analysis above, 566 were removed where the reporting officer entered "Not Applicable" indicating that this attribute was in their opinions not applicable to the particular unit for which the report applied. The major results are:

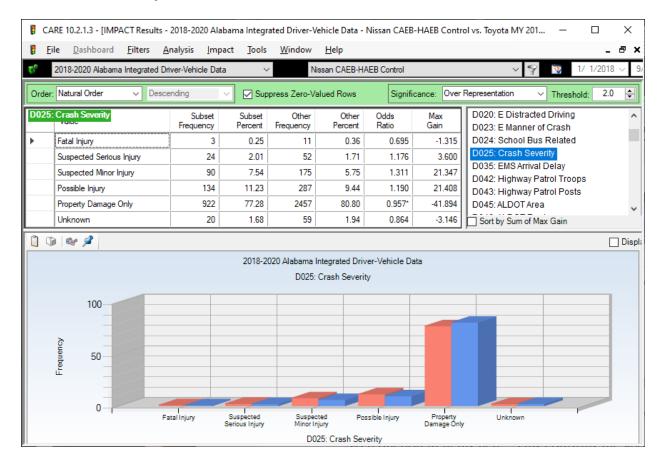
- The Following Too Close proportion was reduced almost 70% (Odds Ration 1.687 = 68.7% reduction). This amounted to over 32 vehicle-crashes (Max Gain = 32.588).
- Misjudged Stopping Distance proportion was reduced 54.3%, saving over 18 vehiclecrashes (18.650 Max Gain).
- The total number of vehicle-crashes reduced for which either Following Too Close or Misjudged Stopping Distance compared to this expected number was over 50 vehicles.

The tables are ordered by highest Max Gain at the top – the Max Gain is the maximum vehiclecrashes that would be reduced if <u>all</u> of the higher percent in the Subset Percent column was reduced to the (lower) value in the Other Percent column.

#### **D023 Manner of Crash**



None of the attribute outcome items were removed in the display above. This finding confirms the results from D202. Interesting the sum of the two factors reduced was about 50 vehicles above, here the rear-end crashes are reduced by a little over 38 (38.057).



### **D025** Crash Severity

This is not ordered by Max Gain – we believe it makes more sense to put the worst severity at the top.

- Fatal Injury Numbers are too low to do any meaningful statistical test, and fatalities are not necessarily related to AEB e.g., they could be caused by not being properly restrained. See PCC above for the Toyotas that had 52 DUIs of which typically half would not be wearing seatbelts. There are too many variables to nail this down from the data given above.
- Suspected Serious Injury This is a proxy for potential fatalities in the future. Its proportion was reduced about 18%.
- Suspected Minor Injury could also serve as a proxy for fatalities, but not as definitive as the serious injury category. This proportion was reduced over 31%, and the number of vehicle-crashes affected was over 21.
- Possible Injury this one is not as definitive, but it is good to see it reduced as well about 21 vehicle-crash cases that had this injury.

• Property Damage Only – this result was significant, showing that the collection of the injury reductions above was significant. There were about 42 crashes with no injuries.

D328 Driver	Injury	Туре
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CAI		-	CT Resu			-	ed Driver-Ve <u>W</u> indow	hicle Data - N <u>H</u> elp	Vissan CAEB	-HAEB Contro	ol vs. Toyota MY 201 — [	_ & ×
	2018-2020 /		_	/		~	_	san CAEB-HA	EB Control		✓ ♀ 〒 1/1	
Order:	Natural Ord	er	~ [	Descending	9 ×	Suppr	ess Zero-Val	ued Rows	Signifi	cance: Over	Representation V Threshold:	2.0
D328:	Driver Injur	у Туре			Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain	D321: Driver Seating Position D322: Driver Victim/Occ Type	^
•	Fatal Injury				2	0.17	3	0.10	1.699	0.823	D323: Driver Safety Equipment	
	Serious Inju	ry			16	1.34	31	1.02	1.316	3.839	D324: Driver Airbag Status	
	Minor Injury				53	4.44	105	3.45	1.287	11.808	D325: Driver Age D327: Driver Ejection Status	
	Not Visible I	out Com	plains of	Pain	68	5.70	180	5.92	0.963	-2.615	D328: Driver Injury Type	
	E Unknown	Injury			8	0.67	12	0.39	1.699	3.292	D329: Driver First Aid By	~
	Driver was	Not a Vio	ctim		1046	87.68	2710	89.12	0.984	-17.147	Sort by Sum of Max Gain	
0	📋 🕼 🞯 🖉											
						2018-202		tegrated Drive iver Injury Typ		ata		
	10	0										7
	Frequency 5	0										
		0		Fatal Inj	ury Se	l erious Injury	Minor Inju		Visible but lains of Pain	E Unknown Inju	ry Driver was Not a Victim	
	D328: Driver Injury Type											

This is another injury comparison for the driver only. Generally, it supports D025 findings given above.

CARE 1	10.2.1.3 - [IMPACT Results - 2018-2020	Alabama Ir	ntegrated D	river-Vehio	:le Data - N	lissan CAE	B-HAEB Co	ontrol vs. Toyota MY 🗕 🗆 🗙		
🖡 <u>F</u> ile	Dashboard Filters Analysis I	mpact <u>T</u>	ools <u>W</u> i	ndow <u>H</u>	lelp			_ @ ×		
2018	8-2020 Alabama Integrated Driver-Vehicle	Data	$\sim$	Nissar	n CAEB-HAI	EB Control		✓  ✓  72 1/ 1/2018 ∨		
Order: Ma	x Gain V Descending	~ 2	] Suppress	Zero-Value	d Rows	Significa	nce: Over	Representation V Threshold: 2.0 🜩		
D101: Uni	it Type	Subset requency	Subset Percent	Other requency	Other Percent	Odds Ratio	Max Gain 👻	D058: Number Injured (Non-Fatal) in thi: A D059: Number Injured (Includes Fatalitie		
Pick	k-Up (Four-Tire Light Truck)	448	37.55	418	13.75	2.732*	284.016	D060: Number Killed in this Vehicle		
EC	Cargo Van (10000 lbs or Less)	71	5.95	0	0.00	0.000	71.000	D075: This Unit was Causal Unit		
EN	/ini-van	36	3.02	41	1.35	2.238*	19.915	D101: Unit Type D102: Non-Motorist Indicator		
EP	Passenger Van	10	0.84	0	0.00	0.000	10.000	D103: Commercial Motor Vehicle Indicat		
EO	Other Passenger Vehicle	2	0.17	0	0.00	0.000	2.000	D107: Driver Raw Age		
ES	ingle-Unit Truck (2-Axle/6-Tire)	1	0.08	0	0.00	0.000	1.000	D108: Driver Race		
EO	Other Light Truck (10000 lbs or Less)	1	0.08	0	0.00	0.000	1.000	D109: Driver Gender D110: Driver Residence Distance		
Sta	tion Wagon	2	0.17	6	0.20	0.850	-0.354	D111: Driver License State		
Pas	ssenger Car	605	50.71	1944	63.93	0.793*	-157.641	D112: Driver First License Class		
► ES	Sport Utility Vehicle (SUV)	17	1.42	630	20.72	0.069	-230.152	Sort by Sum of Max Gain		
	sy 🖉									
	2018-2020 Alabama Integrated Dri	ver-Vehicle	Data - Filte	er = Nissan D101: Un		B Control v	s. Toyota M	Y 2019-2021 Ln Dep Wrng LDW		
	80									
	60									
Frequency	40									
	20									
	0 E Cargo Van (1000 Ibs or Less)	20 E	E Passenger \	/an	E Single-Unit (2-Axle/6-1	t Truck Tire)	Station	Wagon E Sport Utility Vehicle (SUV)		
	D101: Unit Type									

Some disparity, but that should not matter for the types of crashes we are considering. Differences are not in AEB performance – these are strictly the types of vehicles that occurred in the sampling.