YOUNG DRIVERS AND ROD FATALITIES

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2011

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ABSTRACT

The key objective of this study is to investigate the relation between the automotive accident toll and the age of accident victims and investigate the causes that explain why young people are more likely to die on road accidents.

After to analyze the relation between the number of road fatalities and the group age, and obtaining the results that illustrate the existence of a high percentage of deaths among young people between 18 and 24 years old, we analyse, based on several studies, the factors that explain this situation. There is evidence that some biological and cultural factors explain this high percentage of deaths on road accidents among young people, manly males. We will try to draw some conclusions that will permit to motorize the law enforcement in order to increase the road safety mainly among young people.

Keywords : young people, road safety, biological factors, testosterone, brain.

I

Several studies have shown the existence of a relation between the age and the number of road accidents, deaths and injuries, (Backera and Karph; 1984), (Henrik, Andersson; Petter Lundborg: 2006), (Dejoy, David; 1992), (Lewis, Watson and B., & Tay, R.: 2007).

No desenvolvimento deste estudo estimaremos a probabilidade de morrer e/ou ficar ferido em acidentes de viação por grupo de idade, para o período de 1992-2011.

Em face dos resultados obtidos aplicámos as várias teorias quer da neuroeconomia quer de outros ramos da ciência a fim de explicar as razões porque os indivíduos da classe etária dos 18 aos 24 anos têm uma maior probabilidade de acidentes deviação e suas consequências em mortes e feridos.

Many investigations conducted in the U.S.[2] have uncovered impelling evidence that the age of accident victims is an underlying element in explaining the automotive accident severity rate[3].

With the objective of discerning the incidence of age over the accident fatality rate[4], proponents of such tenet elaborated a study based on an ordinary twenty year-old male driver accompanied by a passenger of the same age and gender. The idea was to determine the corresponding fatality rates *per* accident for drivers and passengers belonging to this particular age group. Subsequently, the fatality risk for 25 year-old drivers was compared to the risk of 20 year-olds then the risk for 30 year-olds to that of 25 year-olds and so on. Logically, the fatality risk for thirty year-old drivers in relation to the risk of twenty year-old drivers was arithmetically obtained by multiplying the rates of both age groups. This procedure was repeated once and again for all other age groups. In this manner, the accident fatality risk of all ages in comparison to twenty year-old drivers was attained without having to resort to individual age comparisons, merely considering large age intervals[5].

By applying the previous method to the purposes aforementioned it was possible to empirically analyze data and elaborate a series of graphs that substantiate the belief that the accident fatality rate increases with age and varies in function of vehicle passenger seats (front and back row seats)[6]. The study made particular reference to front row passengers who either refuse to buckle-up or wish to wear seat belts. Conclusively, the investigation rendered results that indicate the fatality rate increases with age although it decreases

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[2] Backer, S.P; O'Neil, B.; Karph, R.S. – (1984) *The Injury Fact Book.* Lexington: Lexington Books, 1984. Partika, S.C. Restraint use and fatality risk for infants and toddlers. Washington, DC: National Highway Traffic Safety Administration, 1984. Evans, Leonard. *Traffic Safety and the Driver.* New York: Van Nostrand Reinhold, 1991.

- Lewis, I., Watson, B., & Tay, R. (2007). Examining the effectiveness of physical threats in road safety advertising: The role of the third person effect, gender, and age. Transportation Research Part F: Traffic Psychology and Behavior, 10, 48 and 60.

[3] Severity rate is the number of victims, dead and injured, *per* one hundred registered automotive accidents.

[4] Evans, L. – (1988) Risk of fatality from physical trauma versus sex and age. - *Jornal of Trauma*, 1988, No. 28, pp. 368-378.

- Evans, Leonard (2004) **-**Gender And Age Influence On Fatality Risk From The Same Physical Impact Determined Using Two-Car Crashes. - Paper Number 011174. - Peter H. Gerrish Nesa and Associates, Inc.

[5] The margin of error in relation to each age is the reflection of the various steps of the process which uses a certain age as reference, this margin of error increases as we move further away from the age of reference.

[6] We do not have any knowledge of similar data in Portugal that can give us an idea of the accident fatality toll in function of vehicle passenger seats.

with seat belt use. A similar experiment was carried out in relation to the female gender bringing forth an analogous trend in function of age.

1.2.1- ESTIMATED PROBABILITIES: DEAD AND INJURED

Before considering further developments in regards to this subject, we present the reader with the estimated probabilities pertaining to accident fatality and injury *per* age group during the period spanning from 1992 to 2011:

A) ESTIMATED PROBABILITY OF FATAL VICTIMS

Drawing on data made available to us as the tool for our empirical explanation, we were able to obtain estimated probabilities of accident fatality for an individual belonging to a given age group *(i.e. relative reoccurrence rates of accident fatality for a given age group in relation to the total number of causalities)*. Chart 1.2.1.1 below illustrates the yearly percentage rate of accident fatality for an individual of a given age group in relation to total deaths:

Chart 1.2.1.1

Percentage of Accident Fatality for an Individual of a Given Age Group

in relation to total deaths (1992-2011)

Year	Age Group					
	0-17	18-24	25-34	35-49	50-64	65 and above
1992	0.123	0.201	0.178	0.168	0.152	0.166
1993	0.097	0.203	0.175	0.164	0.151	0.191
1994	0.115	0.207	0.183	0.158	0.149	0.174
1995	0.094	0.224	0.171	0.183	0.158	0.159
1996	0.089	0.194	0.166	0.199	0.165	0.178
1997	0.082	0.203	0.183	0.193	0.152	0.175
1998	0.094	0.204	0.183	0.179	0.155	0.178
1999	0.058	0.218	0.200	0.189	0.155	0.171
2000	0.065	0.196	0.192	0.195	0.159	0.184
2001	0.074	0.194	0.182	0.187	0.145	0.192
2002	0.071	0.192	0.182	0.216	0.144	0.180
2003	0.071	0.192	0.182	0.216	0.144	0.180
2004	0.081	0.214	0.199	0.202	0.132	0.168
2005	0.075	0.192	0.190	0.216	0.144	0.178
2006	0.033	0.129	0.209	0.207	0.184	0.222
2007	0.040	0.152	0.192	0.204	0.176	0.231
2008	0.039	0.128	0.187	0.223	0.197	0.223
2009	0.049	0.130	0.176	0.217	0.179	0.244
2010	0.031	0.100	0.206	0.224	0.200	0.238
2011	0.028	0.125	0.167	0.219	0.219	0.242

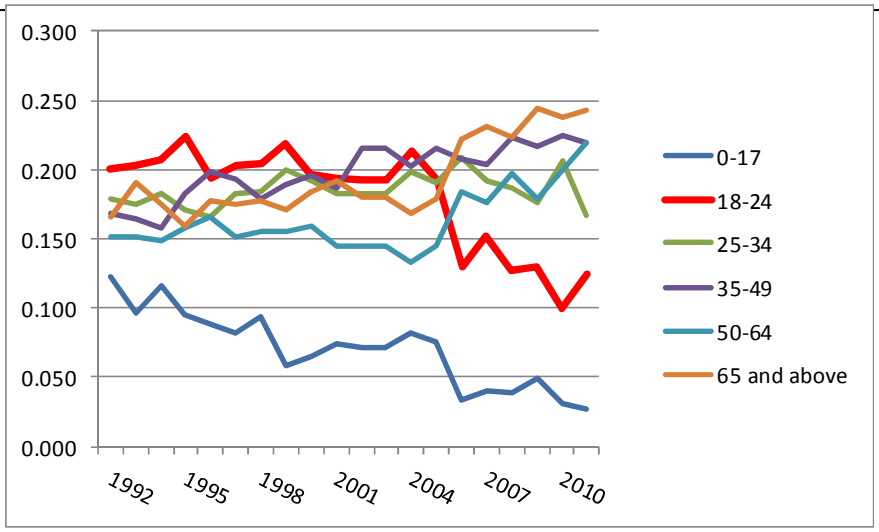
Source: Portuguese Department of Motor Vehicles (*Autoridade Nacional de Segurança Rodoviária* –ANSR) Death Toll 1992-2011. Our estimates.

In 20 years it was found that the percentage of fatalities in relation to the total number of deaths in the age group 18-24 began to decline from the year 2005 until 2011. The reason for this is perhaps the dwindling birth rate in Portugal particularly from 2005 onwards which has its effects on the 18-24 age group since there are fewer drivers in this age bracket. Let´s not forget that Portugal is currently embroiled in what is arguably the biggest financial crisis in its history, situation that has heavily influenced its natality rate. Thus, as drivers of this age group grow older the lower the percentage of deaths in this age group, as can be seen in the following graph:

Graph 1.2.1.1

Percentage of Accident Fatality for an Individual of a Given Age Group

in relation to total deaths (1992-2011)



As illustrated in the figure above, the demographic and population structure has great influence on traffic safety. As the population structure of Portugal changes with fewer youngsters belonging to the general population and considering that the probability of accident fatality for young drivers is higher than that of older drivers - as we shall see - we begin to witness a decreasing trend in both the accident fatality and injury tolls in the country, *ceteris paribus*.

We proceed to review the probabilities of accident fatality according to age group population. To accomplish such task we considered the census data provided in the following chart which summarizes mainland Portuguese population broken down by age group[7]:

Chart 1.2.1.2

Portuguese Population (Mainland) per Age Group

[7] Only mainland Portuguese population was considered since the data pertaining to automotive accident casualties and injuries in the autonomous regions (Azores and Madeira) was excluded from the statistical data obtained.

Year	Age Group						
	0-17	18-24	25-34	35-49	50-64	65 and above	Total
1992	2,218,670	1,072,280	1,366,730	1,830,490	1,564,140	1,285,150	9,337,460
1993	2,162,240	1,093,420	1,380,850	1,852,430	1,561,470	1,347,230	9,397,640
1994	2,113,310	1,107,700	1,395,100	1,871,430	1,564,940	1,362,530	9,415,010
1995	2,051,650	1,108,170	1,410,140	1,885,590	1,570,100	1,396,330	9,421,980
1996	2,012,790	1,096,520	1,430,170	1,904,770	1,570,080	1,419,120	9,433,450
1997	1,980,450	1,078,880	1,454,190	1,924,100	1,576,640	1,439,980	9,454,240
1998	1,952,220	1,059,100	1,475,750	1,935,470	1,593,560	1,457,970	9,474,070
1999	1,955,503	1,060,881	1,478,231	1,938,724	1,596,239	1,460,421	9,489,999
2000	1,955,509	1,060,884	1,478,236	1,938,730	1,596,245	1,460,426	9,490,030
2001	1,898,000	1,043,900	1,518,400	1,992,900	1,613,300	1,423,500	9,490,000
2002	1,987,558	1,093,157	1,590,046	2,086,936	1,689,424	1,490,669	9,937,790
2003	1,985,488	1,092,019	1,588,391	2,084,763	1,687,665	1,489,116	9,927,442
2004	1,985,488	1,092,019	1,588,391	2,084,763	1,687,665	1,489,116	9,927,442
2005	2,008,753	1,104,814	1,607,002	2,109,190	1,707,440	1,506,564	10,043,763
2006	1,874,456	863,571	1,557,919	2,216,897	1,830,985	1,766,145	10,109,973
2007	1,864,456	837,474	1,545,920	2,233,846	1,857,840	1,787,344	10,126,880
2008	1,853,503	815,848	1,525,802	2,249,052	1,879,453	1,811,651	10,135,309
2009	1,840,029	799,746	1,496,383	2,270,634	1,899,821	1,838,327	10,144,940
2010	1,801,315	766,994	1,360,863	2,245,227	1,941,015	1,941,966	10,057,380
2011	1,782,452	760,642	1,306,173	2,250,841	1,953,023	1,975,103	10,028,234

Source: Portuguese Institute of Statistics (*INE*). Lisbon. Annual Stats 1992-2011. Adapted.

The subsequent chart presents us with the results gathered in reference to the estimated probabilities:

Chart 1.2.1.3

Estimated Probability of Accident Fatality for an Individual of a Given Age Group In Relation to the Corresponding Total Population of that Same Age Group

Year	Age Group					
	0-17	18-24	25-34	35-49	50-64	65 and above
1992	0.00013	0.00045	0.00031	0.00022	0.00023	0.00031
1993	0.00009	0.00039	0.00026	0.00018	0.00020	0.00029
1994	0.00011	0.00036	0.00025	0.00016	0.00018	0.00025
1995	0.00010	0.00042	0.00025	0.00020	0.00021	0.00024
1996	0.00009	0.00037	0.00024	0.00022	0.00022	0.00026
1997	0.00008	0.00037	0.00024	0.00019	0.00019	0.00024
1998	0.00009	0.00036	0.00023	0.00017	0.00018	0.00023
1999	0.00005	0.00036	0.00024	0.00017	0.00017	0.00021
2000	0.00005	0.00030	0.00021	0.00016	0.00016	0.00020
2001	0.00006	0.00027	0.00018	0.00014	0.00013	0.00020
2002	0.00005	0.00026	0.00017	0.00015	0.00013	0.00018
2003	0.00005	0.00024	0.00016	0.00014	0.00012	0.00016
2004	0.00005	0.00023	0.00015	0.00012	0.00009	0.00013
2005	0.00004	0.00019	0.00013	0.00011	0.00009	0.00013
2006	0.00002	0.00016	0.00014	0.00010	0.00011	0.00013
2007	0.00002	0.00020	0.00013	0.00010	0.00010	0.00014
2008	0.00002	0.00015	0.00012	0.00010	0.00010	0.00012
2009	0.00002	0.00015	0.00011	0.00009	0.00009	0.00012
2010	0.00002	0.00012	0.00014	0.00009	0.00010	0.00011
2011	0.00001	0.00014	0.00011	0.00008	0.00010	0.00011

Source: Portuguese Department of Motor Vehicles (*Autoridade Nacional de Segurança Rodoviária* – ANSR) 1992-2011. Our estimates.

The highest annual estimated probability of accident fatality for an individual of a given age group in relation to its corresponding total population prominently belongs to the 18-24 age group. However, the results point towards a slight decrease in trend from 1995 onward. To a lesser extent the 65 and above age group has sporadically swapped places with the 25-34 age bracket for the second highest rate.

The fatality rate per million inhabitants between the ages of 20 and 24 was 135 in 2011[8], while the remaining 88 deaths registered in that year belonged to other age groups. If we consider that the probability of a male person dying in road accidents is much higher than that of women then we can assume that the fatality rate per million inhabitants for men between the ages of 20 and 24 will be much higher.

Studies in neuroscience explain the reduced risk-averse behavior in relation to young drivers, as pointed out by Glendon and Ian:

> *"Young drivers are much more likely than older drivers to be influenced by their peers (Gardner & Steinberg, 2005; Simons-Morton, rner, & Singer, 2005; Steinberg, 2008b). Gardner and Steinberg found higher levels of risk taking, greater focus on benefits than potential costs of risk taking, and*

[8] Source: ANSR, Report (2011).

riskier decisions by adolescents when in peer groups than when alone. Steinberg reported FMRI data indicating that although brain regions activated in a driving task associated with cognitive control and reasoning (e.g., prefrontal and parietal association cortices) were active irrespective of driving condition, additional brain regions were activated (medial frontal cortex and left ventral striatum - primarily the accumbens, left superior temporal sulcus, and left medial temporal structures) when peers were present. This socioemotional network led to more risky driving behavior, indicating that peer presence enhanced rewards from potentially risky driving behavior." (Glendon, A. Ian, 2011:118) [9]

Young people seek to express their behavior through identity, norms and social categories, seeking an ideal of who they should be and how they should act while their peers, perhaps some of them, are regarded as the people they wish to follow (Akerlof, George A.; Kranton, Rachel E., 2010)[10]. We know that driving, especially for young people, is a *good* that provides pleasure by itself and that it is a means to reveal their identity, especially for young men. According to prospect theory behaviors are situation-dependent, meaning that changes in states of reference alter behavior. Samuel Bowels states:

"Thus, the value individuals place on states depends on the relationship of the state to the status quo (or possibly some other reference state, such as an aspiration level or the states enjoyed by peers).". (Bowles, Samuel,2004)[11]

As for the 0-17 age group their probabilities are diminutive since this age cluster is mostly constituted by young children and adolescents who usually travel in back seats of vehicles under the care and vigilance of adults.

Comparatively the U.S. registers similar estimated accident fatality probabilities in spite of different age intervals and a higher population[12]:

Chart 1.2.1.4

[9] Glendon, A. Ian – (2011) Neuroscience and Young Drivers *in* Handbook of Traffic Psychology, p. 118.- Elsevier, San Diego, USA.

[10] Akerlof, George A.; Kranton, Rachel E. (2010) - Identity Economics how our identities shape our work, wages, and well-being, p. 11. Princeton University Press, Princeton and Oxford.

[11] Bowles, Samuel (2004) – Microeconomics behavior, institutions, and evolution *Samuel Bowles.* - Russell Sage Foundation, Princeton University Press.

[12] Note: U.S population is nearly 30 times higher than that of Portugal. Legal driving age in the U.S. is 16 whereas in Portugal the legal licensing age is 18 and only exceptionally 16 years of age (e.g. emancipated minors).

Estimated Probability of Accident Fatality for an Individual of a Given Age Group in Relation to the Corresponding Total Population of that Same Age Group (U.S.A.)

Year	0-15	16-24	25-34	35-54	55-64	Over 65
1994	0.000056	0.000308	0.000183	0.000139	0.000131	0.000209
1995	0.000054	0.000309	0.000193	0.000144	0.000139	0.000208
1996	0.000053	0.000305	0.000189	0.000144	0.000141	0.000209
1997	0.000051	0.000292	0.000186	0.000143	0.000144	0.000215
1998	0.000048	0.000285	0.000179	0.000145	0.000141	0.000211
1999	0.000047	0.000289	0.000180	0.000144	0.000138	0.000205
2000	0.000045	0.000291	0.000183	0.000146	0.000137	0.000191
2001	0.000040	0.000292	0.000171	0.000148	0.000135	0.000192
2002	0.000039	0.000293	0.000172	0.000146	0.000132	0.000186
2003	0.000040	0.000279	0.000168	0.000147	0.000134	0.000185
2004	0.000040	0.000276	0.000171	0.000144	0.000131	0.000179
2005	0.000036	0.000274	0.000176	0.000148	0.000138	0.000177
2006	0.000033	0.000272	0.000177	0.000145	0.000132	0.000161
2007	0.000031	0.000258	0.000167	0.000140	0.000125	0.000157

Source: NHTSA (Traffic Safety Facts Final Reports 1994-2007), FARS (Fatality Analysis Reporting System), GES (General Estimates System) and U.S. Census Bureau. Adapted

B) ESTIMATED PROBABILITY OF INJURED VICTIMS

Just as in the previous subsection we carried out a similar analysis in regards to injured victims. Chart 1.2.1.5 sets the milieu for our investigation as it traces the trend of accident injury *per* age group in relation to total number of accident injured victims:

Chart 1.2.1.5

Percentage of Accident Fatality for an Individual of a Given Age Group in relation to total injured (1992-2011)

Year	Age Group					
	0-17	18-24	25-34	35-49	50-64	65 and above
1992	0.167	0.274	0.202	0.168	0.115	0.073
1993	0.166	0.274	0.199	0.164	0.118	0.079
1994	0.164	0.274	0.195	0.166	0.117	0.083
1995	0.153	0.270	0.198	0.174	0.122	0.083
1996	0.141	0.260	0.206	0.182	0.124	0.087
1997	0.142	0.258	0.203	0.184	0.124	0.088
1998	0.146	0.249	0.202	0.185	0.126	0.091
1999	0.106	0.248	0.221	0.199	0.128	0.097
2000	0.109	0.257	0.214	0.199	0.127	0.095
2001	0.111	0.235	0.223	0.202	0.128	0.101
2002	0.103	0.232	0.229	0.207	0.130	0.100
2003	0.103	0.232	0.229	0.207	0.130	0.100
2004	0.103	0.232	0.229	0.207	0.130	0.100
2005	0.103	0.232	0.229	0.207	0.129	0.100
2006	0.101	0.172	0.218	0.224	0.144	0.118
2007	0.104	0.164	0.214	0.229	0.149	0.125
2008	0.098	0.164	0.216	0.231	0.153	0.124
2009	0.095	0.162	0.206	0.236	0.159	0.129
2010	0.090	0.158	0.207	0.238	0.164	0.130
2011	0.091	0.152	0.197	0.246	0.165	0.138

Source: ANSR. Annual Stats 1992-2011. Adapted.

The results obtained reveal that individuals between the ages of 18 and 24 are more likely to get injured in a car crash. However, a sharp percentage decline has been verified over the last couple of years specifically from 2000 onward in relation to these individuals. The probability rates of the 25-34 age group also stand out due to constant percentage increases from 2000 until 2005. Another age group recording high percentage increases since 2005 and until 2011 has been the 35-49 age group mostly because of the low birth rate and the aging of younger drivers. The 65 and above age group comes in last with low injury probability albeit some signs of percentage increase are clearly visible.

We estimated the probability of accident injury per age group in relation to its corresponding population. The following chart illustrates such probabilities:

Chart 1.2.1.7

Estimated Accident Injury Probability in relation to Age Group Population

Year	Age Group					
	0-17	18-24	25-34	35-49	50-64	65 and above
1992	0.00544	0.01844	0.01064	0.00660	0.00531	0.00412
1993	0.00522	0.01704	0.00979	0.00602	0.00512	0.00399
1994	0.00491	0.01568	0.00882	0.00563	0.00474	0.00387
1995	0.00499	0.01630	0.00940	0.00619	0.00523	0.00399
1996	0.00475	0.01616	0.00981	0.00648	0.00536	0.00419
1997	0.00488	0.01626	0.00947	0.00648	0.00535	0.00417
1998	0.00494	0.01556	0.00906	0.00630	0.00523	0.00414
1999	0.00341	0.01475	0.00942	0.00646	0.00507	0.00418
2000	0.00329	0.01435	0.00860	0.00608	0.00471	0.00385
2001	0.00328	0.01265	0.00827	0.00570	0.00446	0.00397
2002	0.00276	0.01124	0.00763	0.00526	0.00407	0.00354
2003	0.00285	0.01159	0.00787	0.00542	0.00420	0.00365
2004	0.00268	0.01091	0.00741	0.00510	0.00395	0.00344
2005	0.00251	0.01022	0.00693	0.00478	0.00369	0.00322
2006	0.00255	0.00941	0.00659	0.00477	0.00372	0.00316
2007	0.00258	0.00909	0.00642	0.00474	0.00373	0.00323
2008	0.00233	0.00885	0.00621	0.00450	0.00358	0.00302
2009	0.00239	0.00942	0.00638	0.00483	0.00389	0.00326
2010	0.00233	0.00959	0.00709	0.00495	0.00393	0.00311
2011	0.00216	0.00842	0.00635	0.00461	0.00355	0.00294

Source: ANSR. Annual Stats 1992-2011. Adapted.

Using the data provided in the previous chart several conclusions can be drawn. Individuals between the ages of 18 and 24 have a greater probability of automotive accident injury when compared to other age groups which in turn has severe implications on society. In fact, if we keep in mind the average life expectancy, permanent disability resulting from serious accident injury will affect the quality of life during a much longer period of time, inflicting higher social costs.

In addition, this situation leads us to place a broad array of inquiries concerning the lifestyle and day-to-day habits of individuals who belong to the 18-24 age cluster. For example: Do 18 year olds portray identical behavior as 24 year olds? How do social factors affect the driving conduct of 18-24 year olds especially those related with family, community, employment, schooling, dropout rate, relationships with friends, self-esteem, the need of transportation, peer pressure, fitting in a social group *(i.e. ownership of a car as a social symbol)*?

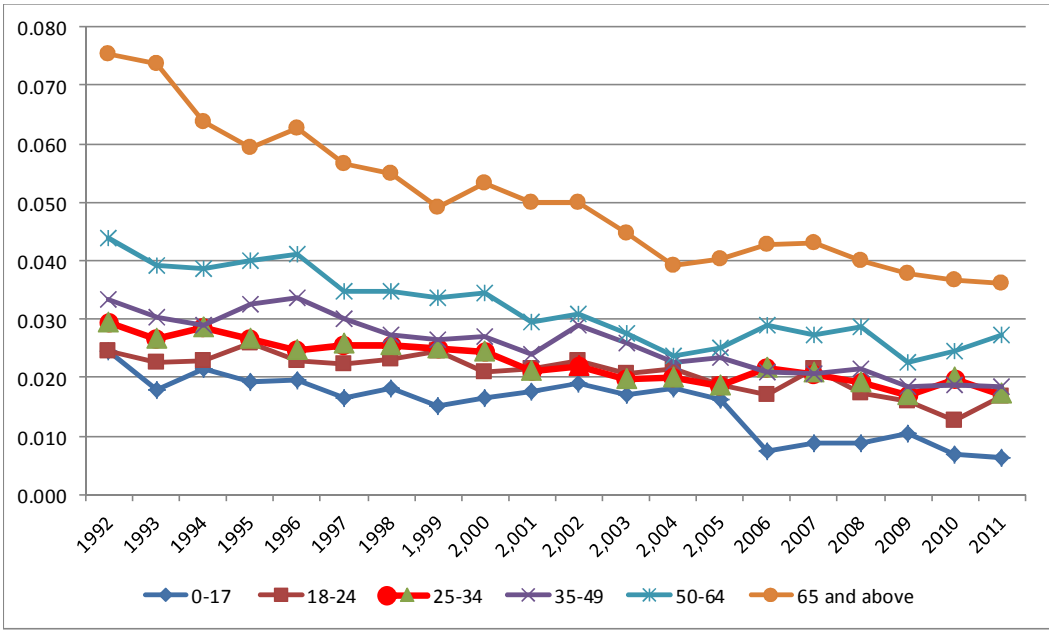
On this logic, although the influence of social factors may not seem apparent we still consider these youngsters to be a part of a generation whose maturity, interests, values and priorities vary significantly in function of age and life experience. Further, they are individuals whose behavior reflects personal

concepts of sociability, independence and social responsibility. They choose to accept rules of conduct that denote their preferences, concerns and quotidian circumstances. In this perspective and bearing these considerations in mind, road safety research should specifically focus on young adult drivers because they are more likely to suffer the consequences of automotive accidents. Yet other questions arise: Should the severity of sanctions be bolstered or should there be more restrictions based on driver age (e.g. graduated licensing programs)? Should alternative strategies be adopted for instance the betterment of driver education, rehabilitative courses and postlicensing control for young drivers in local high schools?

Graph 1.2.1.1 compares the accident fatality rate to that of accident injured victims *per* age group:

Graph 1.2.1.1

Fatal Victims in Relation to Injured Victims *per* Age Group



Source: ANSR. Annual Stats 1992-2011. Adapted. (*Vide*: Appendix 4)

From the graph above we see that 65 and above age group registers a relatively high percentage perhaps due to causes of physical and psychological nature inherent to its members. In what concerns other age groups, individuals between the ages of 50 and 64 occupy the second position while the ensuing age intervals follow and inverse order in relation to age.

1.2.2- INJURY RESULTING IN PERMANENT DISABILITY *PER* AGE GROUP

For the purpose of investigating the influence of age over the seriousness of automotive accident injuries resulting in permanent disability (PD) we comprised a sample of 1,113 injury cases between 1997 and 1999:

Chart.1.2.2.1

Permanently Disabled Victims *per* Age Group (Sample 1,113 Cases)							
	0-17	**18-24**	**25-34**	**35-49**	**50-64**	**65 and Above**	**Total**
PD up to 50%	79	372	306	57	100	80	994
PD 51%-100% or PFD	2	18	18	23	32	26	119
Total	81	390	324	80	132	106	1.113

Source: Portuguese Insurance Companies

Data above alludes to the fact that 89.31% of accident injury cases resulting in (PD) fit into the first group *(i.e. disability inferior to 50%)* while the remaining 10.69% incorporate the second group, disability greater than 50%. Once again the 18-24 age cluster recorded the highest numbers succeeded by the 25-35 age group when it came to injuries that result in permanent disability inferior to 50%. At the other end of the spectrum, the 18-24 and the 25-34 age groups register identical values in respect to (PD) greater than 50% although inferior to those verified in other age intervals. Empirical evidence suggests that accident injury resulting from car crashes with identical impact tends to be more severe with age.

1.2.3- FATAL DRIVERS AND THE TIME OF EXPOSURE TO ACCIDENT RISK

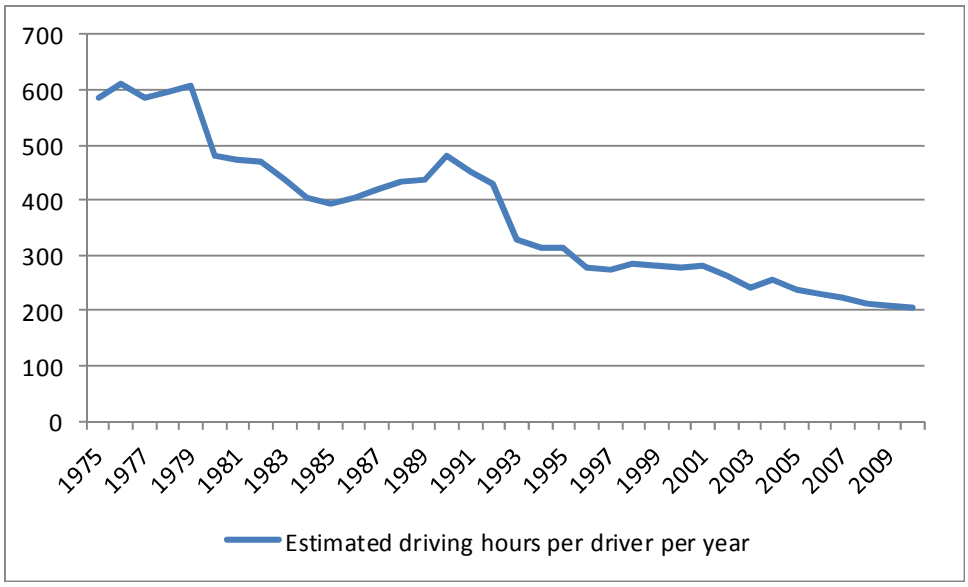
As with all risky activities automotive driving naturally involves risk even if exercised with optimal care. Such risk varies in function of a myriad of factors, for instance; driver and vehicle characteristics, road environment, age of drivers and so on. However, the time of exposure to accident risk *(i.e. time spent driving and the intensity of the activity)* is truly a determinant factor when assessing accident probability. Using the available statistical data, we set out to study the trend in driver fatality toll *per* unit of time spent driving or in more technical terms, the *temporal -accident risk exposure rate*.

Albeit, average speeds differ considerably in accordance to location (urban or suburban areas) we considered mean velocity to be 60km/hr since available

stats made such differentiation unfeasible. However, such hindrance does not affect our findings which we found to be very accurate in relative terms. The following graph conveys the trend in time spent driving per driver:

Graph 1.2.3.1

Estimated Time of Exposure to Accident Risk (Hours) *per* Driver (1975-2010)



Source data: ANSR (Fuel Consumption). Adapted. See Appendex 5

Let's suppose that the quantum of total driving time represents exposure to accident risk and that as more time is allocated towards the practice of this risky activity the greater total accident risk will be, *ceteris paribus*. In the figure above, we observe that average estimated driving mobility (per driver) diminished over the duration of the period under examination which consequently brings about a decrease in accident risk per driver and a reduction in the accident fatality toll thereof.

An explanation for the decreasing trend in the temporal-accident risk exposure rate per driver resides in a profound change in the structure of licensed drivers witnessed over the past couple decades. As more women and younger drivers gain access to the activity along with an increase in the number of vehicles per household, shorter routes will be travelled resulting in a reduction in accident risk exposure per driver. Statistical data has also pointed out the female drivers, on average, use more caution when driving.

1.2.4 - WHY THE PROBABILITY OF ACCIDENT FATALITY AND INJURY AND THE BEHAVIOR OF YOUNG PEOPLE - IN PARTICULAR MALES ARE HIGHER?

New scientific findings are altering our perspective on how we perceive adolescent and young adult behavior. Today, research performed on the adolescent and young adult brain suggests that the human brain is still developing during adolescent years, with changes that continue into the early 20´s **(Giedd. J. N.; 2004)[13].**

Maturation of the prefrontal cortex in the brain (PFC) is not complete until near the age of 25. This brain region gives an individual the capacity to exercise "good judgment" when presented with difficult life situations since it is the part of the brain that governs the control mechanisms **(Giedd. J. N.; 2004)**[14]. The PFC prompts a more careful deliberative analysis that triggers secondary emotional responses (secondary induction) that help guide advantageous decision-making **(Levin, Irwin P. *et al,* 2012)[15].** Thus, in accordance to these studies - inter alia (**Denson, *Thomas F. et al*,2012**)[16]- young people will have lesser ability to control their impulses causing them to be more risk-lovers or takers, especially when driving a vehicle. This behavior is known as *myopia* in terms of time preference, where individuals exhibit positive time preference **(Loewenstein, George,1987)**[17] in relation to pleasure in the present (short-term) rather than in the future (long-term). When coupled with the development of part of the brain that commands self-control, it can explain much of the behavior of male young drivers on the road.

In economics this behavior is known as "'*bounded willpower' or 'insufficient self-command'*" **(Sen , Amartya,2009:176)[18],** what is sometimes called the "weakness of will", that Aristotle called *akrasia*(**Aristotle – Rhetoric; Aristotle -**

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[13] Giedd. J. N. (2004). Structural magnetic resonance imaging of the adolescent brain. *Annals of the New York Academy of Sciences*, 1021, pp. 77-85.

[14] Idem.

[15] Levin, Irwin P. *et al* (2012) - A Neuropsychological Approach to Understanding Risk-Taking for Potential Gains and Losses.

[16]Denson, Thomas F.; Richard Ronay; William von Hippel;, Mark M. Schira1 (2012) - Endogenous testosterone and cortisol modulate neural responses during induced anger control. - Psychology Press, an imprint of the Taylor & Francis Group, an Informa business (Australia).

[17] Loewenstein, George (1987) - Anticipation and the Valuation of Delayed Consumption - The Economic Journal, 97: 666–684, reproduced *in* Exotic Preferences Behavioral. Economics and Human Motivation, by Loewenstein , pp. 385-410, Oxford University Press (2007).

[18] Sen , Amartya (2009) – The Idea of Justice - The Belknap Press of Harvard University Press, p.176.

Nicomachean Ethics)[19] [20] that occurs when we do wrong knowingly, typically as a result of some passion such as anger or pleasure.

As reported by Thaler and Sustein, people's state of arousal varies over time and the degree of arousal influences decision-making. The authors consider two extreme points: hot and cold. The decisions in a cold state are different from those in a hot state. The cold state is more related with the reflexive system of thinking and the cold state is more associated with the automatic system of thinking.

The context influences the level of arousal and, consequently, the cold and hot states determine decision-making. The desires and behaviors of individuals will be altered when they are under the influence of arousal. Related with these states – cold and hot – are the classical case of Ulysses and the sirens. The songs of the sirens, as a metaphor, can be understood as the influence that emotions and feelings have in the decisions of individuals, which vary with the context in which they are, according to the state of arousal, hot or cold. As reported by Loewenstein:

> *"Affect has the capacity to transform us, as human beings, profoundly; in different affective states, it is almost as if we are different people. Affect influences virtually every aspect of human functioning: perception, attention, inference, learning, memory, goal choice, physiology, reflexes, self-concept, and so on….People who are in "hot" states tend to underappreciate the extent to which their preferences and behavioral inclinations are influenced by their affective state; they typically believe that they are behaving more dispassionately than they actually are "* **(Loewenstein, George,2005:S49**)[21]

Understanding the internal mechanics and the hot-cold states of individuals, namely young people, allow us to develop processes in all areas, including automotive driving, in order to reduce the number of deaths and injuries on the road by applying measures that lead to changes in the behavior of young people, particularly young males.

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[19] Aristotle - Rhetoric, *in "The Complete Aristotle", p. 2309.- //ebooks.adelaide.edu.au/a/Aristotle ."You may get your pleasure on the spot and the pain later, or the gain on the spot and the loss later. That is what appeals to weak-willed persons—and weakness of will may be shown with regard to all the objects of desire.".*

[20] Aristotle - Nicomachean Ethics, Book VII, 3.

[21] Loewenstein, George (2005) – Hot-Cold Empathy Gaps and Medical Decision Making – Health Psychology, 2005. Vol. 24, No.4 (Suppl.) S49-S56, p.S49.

The young in certain contexts, tend to act on their own short-term affect-driven preferences. Young drivers perceive risk differently than adults (**Glendon, A. Ian, 2011)**[22], their subjective level of risk (perceived risk) is usually lower than objective risk. The greater the gap between subjective risk and objective risk the greater the deviation from optimal care and, in consequence, the outcome (and the process) will be inefficient and the economic and social costs of accidents will not be minimized.

We can also integrate the *time discount rate* into this analysis and apply it to young drivers, mainly males. This *time discount rate* is not constant but hyperbolic **(Frederick, Shane; George Loewenstein; Ted O` Donoghue (2002 [2004])**[23]. It is often used to convey the idea that a person has a declining rate of time preference. In this sense, internal factors associated with the development of a young person can lead to a high positive *hyperbolic discount rate*, producing a preference in young individuals for short-term pleasure (*time preference* **(Frederick, Shane; *et al* (2002 [2004]:64)***[24]*), thereby inducing them to take on high risk when driving with the negative consequences that our study has shown as well as other research conducted on this subject.

Such conduct by young drivers (displaying high risk proclivity) which may appear to violate the rationality axioms of neoclassical economics, constituting *anomalies* (**Loewenstein, George; Richard Thaler, 1989)** [25] for this theory, in reality should be understood as a normal pattern of human behavior. In fact, these anomalies must be considered as regularities **(Frey, Bruno S.; Alois Stutzer, 2007)** [26] and as part of normal human behavior in accordance to biological, cultural and external factors.

Bearing in mind that the "anomalies" considered by neoclassical theory are indeed normal behaviors - as behavioral economics, psychology and neuroeconomics have shown - one should not regard these anomalies as

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[22] Glendon, A. Ian (2011) - Neuroscience and Young Drivers, *in* Handbook of Traffic Psychology -. ELSEVIER. "*Hence, although young drivers can "see" the same things (including obvious hazards) as adults, they cannot always perceive risks appropriately because they have yet to fully develop higher level cognitive interpretive functions".* p.112.

[23] Frederick, Shane; George Loewenstein; Ted O` Donoghue (2002 [2004]) -Time Discounting and Time Preference: A Critical Review." *Journal of Economic Literature* 40 (June): 351–401, republished *in* Advances in Behavioral Economics, pp. 162-222 – Princeton University Press-2004.

[24] *Idem,* p. 64.

[25] Loewenstein, George; Richard Thaler (1989) – Anomalies Intertemporal Choice – Journal of Economic Perspectives –Vol. 3, No. 4 – pp. 181-193.

[26] Frey, Bruno S.; Alois Stutzer (2007) - The Economics and Psychology: Developments and Issues. *in Economics and Psychology,* p. 4 - CESifo Seminar Series.

violations of rationality **(Elvik, Rune, 2004)** [27], but rather try to comprehend what factors - biological, cultural and others - determine these behaviors in order to develop the means that lead to the minimization of negative results, including high risk driving. The traditional theory of rational choice considers that a great part of the behavior of young drivers violates rational choice as advocated for over a century by economic neoclassical theory which is the underpinning of rational choice theory.

Many of the problems associated with the view of neoclassical economics results from Cartesian dualism **(Descartes, René, 1637:22-23)** [28] and Newtonian physics, which compares individuals to Newtonian atoms and, moreover, perceives rationality as devoid of feelings and emotions.

The vision of *homo economicus* **(Thaler, Richard H., 2000)** [29] limits the understanding of the complex system of motivations of the individual, where emotions and feelings are factors that determine the decisions under risk (all decisions are associated with some level of risk **(Wilde, Gerald J.S. (2001:1**)[30]. It is not only reason that determines the behavior, as has been understood by neoclassical theories. Economic theory was largely derived from rational, consequentialist assumptions about decision-making. Standard economic theory assumes that people choose between alternative courses of action based on the desirability or "utility" of their consequences **(Loewenstein, George; Scott Rick, 2004)**.[31]

The "status quo bias" **(Kahneman, Daniel; Jack L. Knetsch; Richard H Thaler, 1991)** [32] suggests that individuals have preference for present rather than future situations, and because the level of cognitive interpretative functions is less developed in younger individuals there is a natural tendency for young

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[27] Elvik, Rune (2004) - Why some road safety problems are more difficult to solve than others, p.15. - Institute of Transport Economics. Oslo, Norway,

[28] Descartes, René (1637) - *Discourse on the Method of Rightly Conducting the Reason, and Seeking Truth in the Sciences* :- This Electronic Book Is a Publication of the Pennsylvania State University's Electronic Classics Series, Jim Manis Faculty Editor, pp. 22-23.

[29] Thaler, Richard H. (2000) - From Homo Economicus to Homo Sapiens - *Journal of Economic Perspectives—Volume 14, Number 1—Winter 2000—Pages 133–141.*

[30] Wilde, Gerald J.S. (2001)- *Target Risk2.* Toronto-Ontario: PDE Publications, 2001, p. 1.

[31] Loewenstein, George; Scott Rick (2004) - Emotion in economics (The challenge of emotions for economic theory) - *Letters Proceedings: Biological Sciences*, 4, 177-179. (Proc. R. Soc. Lond. B; Suppl.,

DOI 10.1098/.

[32] Kahneman, Daniel; Jack L. Knetsch; Richard H Thaler (1991) - Anomalies The Endowment Effect, Loss Aversion, and Status Quo Bias - *Journal of Economic Perspectives*- Volume 5, No. 1- Winter 1991- pp. 193-206.

people to prefer the present to the future when obtaining satisfaction from driving.

To understand the behavior of young people it is also necessary to take into account peer pressure as well as all intersubjectivity **(Davis, John, 2002)** [33] comprising relations of alterity that are external factors that influence their behavior.

Rune Elvik (2004:10-15) [34] poses the question that some road safety problems are harder to solve than others, explaining that biological factors contribute towards young drivers being more risk-loving, namely because the level of testosterone influences the level of risk taking.

Rona and Von Hippel reported that physical risk taking by young men increases in the presence of an attractive female, and "*that this increase in risk taking is caused in part by elevated testosterone levels of men who performed in front of the attractive female.*" **(Ronay, Richard; William von Hippel, 2009)** [35] The increase in the level of testosterone combined with a low level of cortisol reduces fear – increasing the level of risk – reduces focus attention on rewards and reduces sensitivity to losses **(Van Honk, Jack *et al*, 2005)** [36] which is associated with decreased aversion to risk **(Carney, Dana R.; Mason, Malia F. -)** [37].

Other studies **(Mehta, Pranjal H.; Robert A. Josephs, 2010)**[38] **(Josephs, Robert A. et al (2006)**[39] show that threats to status cause more testosterone production and thus increase risk propensity. So, when young people, especially males, are with their peers or driving with their girlfriends they tend to reveal their status. When such status is threatened they are led to reveal

[33] Davis, John (2002) - Collective intentionality and individual behavior *in* "Intersubjectivity in Economics", pp.11-27 - Rutledge.

[34] Elvik, Rune (2004) – Why some road safety problems are more difficult to solve than others, p.15. - Institute of Transport Economics. Oslo, Norway, referring Evans, L. (2006) *in* "Innate sex differences supported by untypical traffic fatalities. Chance", 19 (1), 10-15.

[35] Ronay, Richard; William von Hippel, (2009) - Power, Testosterone, and Risk-Taking -Journal of Behavioral Decision Making, J. Behav. Dec. Making, (2009)

[36] Van Honk, Jack *et al* (2005) - Testosterone Reduces Unconscious Fear but Not Consciously Experienced Anxiety: Implications for the Disorders of Fear and Anxiety - BIOL PSYCHIATRY. 2005;58:218–225. 2005 Society of Biological Psychiatry.

[37] Carney, Dana R.; Mason, Malia F. (-) - Moral Decisions and Testosterone - Columbia University.

[38] Mehta, Pranjal H.; Robert A. Josephs (2010) - Testosterone and cortisol jointly regulate dominance: Evidence for a dual-hormone hypothesis - journal homepage: www.elsevier.com/ locate/yhbeh.

[39] Josephs, Robert A.; Jennifer Guinn Sellers; Matthew L. Newman; Pranjal H. Mehta (2006) - The Mismatch Effect: When Testosterone and Status Are at Odds - Journal of Personality and Social Psychology Copyright 2006 by the American Psychological Association 2006, Vol. 90, No. 6, 999–1013.

dominance and risk taking. This is one of the physiological and behavioral factors that can help explain higher accident fatality and injury rates among young males.

Given that the capacity for reflection and self-control in young people is not fully developed until about the age of 25, *visceral factors* should also be considered as playing an important role in their behavior. Visceral factors influence behavior more directly, as stated by Loewenstein:

> "*virtually all visceral factors can influence behavior without conscious cognitive mediation"* **(Loewenstein, Georg, 2004:694)** [40].

In the same vein, Peterson:

> *"because the reward and loss systems influence thought and lie beneath awareness, they often direct behavior automatically through subtle emotional influences on judgment, thinking, and behavior*[41]*… the emotion of excitement indicates that one has identified an opportunity. Excitement propels increased risk seeking and exploratory behavior.* **(Peterson, Richard L. , 2007:26, 37)** [42] (our emphasis).

We can also refer that the way of life of young people, the alteration of sleep, mainly on weekends, will affect the level of risk **(Groeger, J. A. , 2006)** [43].

In order to understand the behavior of young drivers we should also consider what is known in behavioral economics as *procedural utility*. It has been convincingly demonstrated that people do not only value outcomes but also the way by which they are reached.[44] Therefore, young drivers can often lead to high risk levels since driving pleasure devalues the results of their behavior.

According to several studies[45] there are two systems[46] of thinking, one that is intuitive and automatic (Automatic System) and the other reflective and rational

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[40] Loewenstein, Georg (2004) - Out of Control: Visceral Influences on Behavior, *in* Advances in Behavioral Economics (2004), p. 694. – Princeton University Press.

[41] Peterson, Richard L. (2007) - Inside the Investor's Brain - John Wiley & Sons, p. 26.

[42] Idem, p. 37.

[43] Groeger, J. A. (2006) - Youthfulness, inexperience and sleep loss: The problems young drivers face and those they pose for us - Injury Prevention, 12, i19 – i 24

[44] Frey, Bruno F.; Alois Stutzer (2007) - Economics and Psychology: Developments and Issues., *in* Economics and Psychology A Promising New Cross- Disciplinary Field, p. 7 - The MIT Press.

[45] Thaler, Richard H.; Cass R. Sunstein (2007) – Nudge. Improving Decisions About Health, Wealth, and Happiness- Yale University Press.

[46] Camerer, Colin; George Loewenstein; Drazen Prelec (2005) - Neuroeconomics: How Neuroscience

Can Inform Economics, p. 16 - *Journal of Economic Literature Vol. XLIII (March 2005), pp. 9–64*

(Reflective System), and whose characteristics are summarized in the following chart:

Chart 1.2.4.1

Cognitive systems

Two cognitive systems	
Automatic System	Reflective System
Uncontrolled	Controlled
Effortless	Effortful
Associative	Deductive
Fast	Slow
Unconscious	Self-aware
Skilled	Rule-following

Source: Thaler, Richard H.; Cass R. Sunstein (2007) – Nudge Improving Decisions About Health, Wealth, and Happiness[47]- Yale University Press, p. 20.

If we consider that some functions of the human brain related to self-control and reflection, are only complete at around 25 years old, we can deduce that young drivers mainly use the functions related to the automatic system, which can be potentiated by visceral factors, as mentioned earlier, developing high risk proclivity on young people, explaining, at least in part, the high number of deaths and injuries of young male drivers in road accidents. According to Zweig[48] cited by Donald T. Wargo[49] *et al*, the size of the reward is processed by the automatic system, unconsciously, while the probabilities must be processed in the rational brain, the reflective system, which may mean that young male drivers tend to make their decisions underpinned in their emotions and feelings without the control that is developed by the reflection system.

Consequently, in view of the advances in scientific knowledge about human behavior, road safety policy should take into account greater risk propensity among young males, which is evidenced by the analysis on the probabilities of dying or getting injured in road traffic accidents, leading to the need for greater oversight and intervention in road safety.

[47] See also: Kahneman, Daniel (2011) – Thinking Fast and Slow – Farrar, Straus and Giroux. (Kahneman calls system I (Fast) and system II) (Slower)), pp. 20-21.

[48] Zweig, J. (2007) -Your Money and Your Brain: How the New Science of Neuroeconomics Can Help Make You Rich - New York: Simon and Schuster.

[49] Wargo, Donald T.; Norman A. Baglini; Katherine A. Nelson (2010) - Dopamine, expected utility and decision- making in the firm, *in* Neuroeconomics and the Firm, p.166.- Edward Elgar Publishing, Inc..

"Therefore, interventions to reduce road traffic injuries among the young must take into account the evolving complexity of brain –behavior - social context interactions from birth to young adulthood."[50]

Since the consequences of traffic accidents in relation to young people are very austere for society, seeing that individuals aged 18 to 24 are more likely to die or get injured in road accidents, we quote Rune Elvik on the importance of adopting systemic measures by society - including policy makers,

"*The greater its magnitude, since a major problem may require major investments or major changes in road user behaviour in order to be solved,"*[51´].

According to what was analyzed we can conclude that change can be brought about by interventions that effectively alter young people´s perception values of risk, namely increasing the probability of law enforcement and at a more general and profound level, investing in cultural, ethical and moral values, which alter the internal sanctions for violations of rules, increasing the global sanction and, consequently changing the behavior of individuals. For safety, behavioral change in relation to automotive driving shall be more important than technological measures and policies. In this vein we cite Dieter Klebelsberg,

"*a dangerous road does not imply that certain constructional – i. e. , non-individual – properties of the road are dangerous in themselves, but that on this road an unusual amount of dangerous behavior is to be observed; thus, the road only becomes dangerous or safe through behavior*."[52]

Considering the interaction of multiple factors as determinants of accidents, which form a complex and dynamic system, we must act in an integrated manner in order to obtain effective results and, thus, minimize the social cost of accidents. We must consider not only the underlying factors but also the role played by the different players and the efforts of institutions in increasing accident prevention since crashes along with their consequences are a multidimensional problem that requires a broad view and understanding of the

[50] Huang, Patty; Flaura Koplin Winston (2011) - Young Drivers, *in Handbook of Traffic Psychology.* - ELSEVIER, p. 315.

[51] Elvik, Rune (2004) - Why some road safety problems are more difficult to solve than others - Institute of Transport Economics. Oslo, Norway, p. 12.

[52] Klebelsberg, Dieter (1994) – Is Risk Compensation a Personality Trait, and Attitude or a Behavior?, *In* "Challenges to Accident Prevention. The Issue of Risk Compensation Behavior", p. 51. – STYX Publications, Groningen, The Netherlands.

causes, consequences and solutions. On this subject, we provide the reader with the following figure which portrays an integrated view on accidents and outlines the named theory "Risk – Motivation Theory", proposed by Rudiger Trimpop[53]:

Chart 1.2.4.1

Risk Motivation Theory

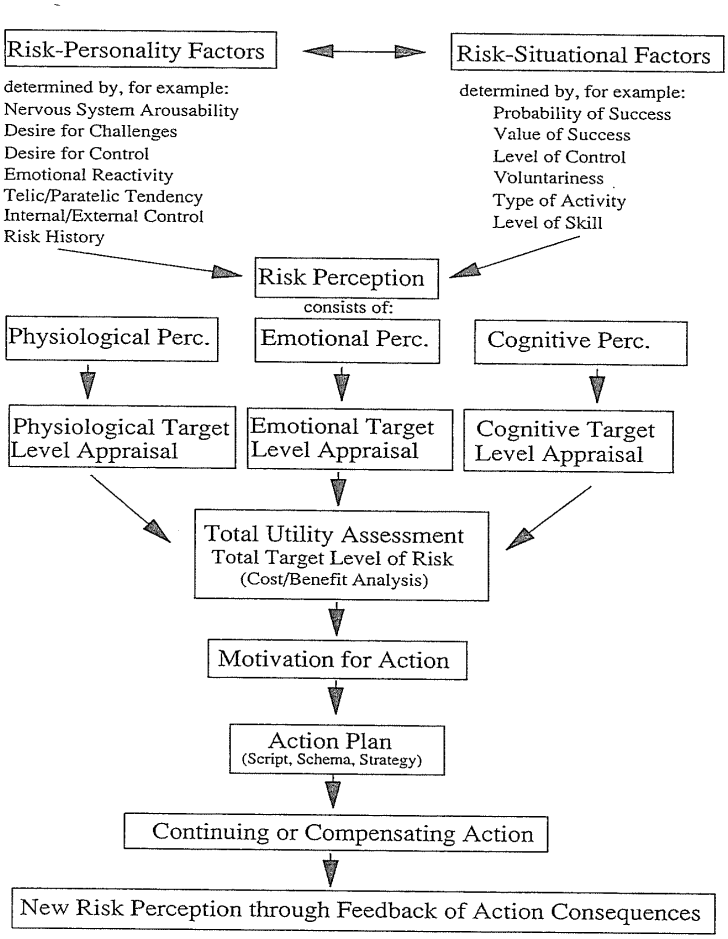

Figure 1: Risk Motivation Theory (RMT)
(Perception-Appraisal-Motivation-Compensating Action-Feedback Model)

Source: Rudiger Trimpop- Risk Compensation and the Interaction of Personality and Situational Variables, *in* "Challenges to Accident Prevention. The Issue of Risk Compensation Behavior", p.142. – STYX Publications, Groningen, The Netherlands.

This theory encompasses the cognitive, emotional and psychological dimensions and can be related to what we analyzed above in relation to the diverse factors that tend to explain the behavior of young people when driving.

On a final note, the demographic structure of population has a great impact on traffic safety. As young road users represent high accident risk basically

[53] Trimpop, Rudiger (1994) - Risk Compensation and the Interaction of Personality and Situational Variables, *in* "Challenges to Accident Prevention. The Issue of Risk Compensation Behavior" – STYX Publications, Groningen, The Netherlands.

worldwide, and considering that the proportion of young people on the general population has decreased, especially in Portugal due to a low birth rate, there should be fewer casualties in the near future in relation to younger drivers.

1.2.5 - CONCLUSIONS

The analyses conducted above allow us to extract the following conclusions:

- Age is one of the risk factors of road traffic deaths and injuries;
- In what concerns accident fatality, the probability of death for an individual belonging to 18-24 age interval in relation to the total number of accident deaths is usually the highest amongst all other ages;
- Further, estimated accident fatality probability for the contemporaries of the 18-24 age cluster in relation to its total corresponding age group population drew attention since it recorded the highest percentage values amongst all other ages;
- With respect to the accident injury toll, results were conclusive in suggesting that individuals between the ages of 18 and 24 are susceptible to a higher probability of accident injury when compared to total number of crash injuries.
- The probability rates of the 25-34 age group was also prominent due to constant percentage increases from 2000 until 2005;
- Another age group recording high percentage increases since 2005 and until 2011 was the 35-49 age group mostly because of the low birth rate and the aging of younger drivers.
- Evidence from the rate comparison of fatalities to injuries shows that the 65 and above age group cataloged the highest percentage values mostly due to reasons of physiological and physical nature. Moreover, since this particular age group constitutes the bulk of registered run-down pedestrians it becomes obvious why it has registered the highest percentage ratios of accident fatalities to accident injuries. Thus, in order to abate such causalities more investment on strategies that persuade divers to adopt optimal levels of driving care should be adopted - especially in urban and high density areas.
- Among the myriad of feasible measures more *speed bumps* are required in certain inner-city streets and roads impelling drivers to reduce speed even if

their level of *desired risk (target risk)* [54] is greater than objective risk. Perhaps, consequential damages caused by speed bumps to vehicles when driving at inadequate speeds may serve as stimuli for drivers, thus demanding higher levels of driving care.

- Other strategies can also encourage efficiency and therefore reduce personal damages such as increasing the *expected sanction*[55] which can be achieved by the dint of effective radars on roads and highways. As further analyzed in section 3.6 of chapter III, the most effective policy destined towards behavioral changes in risk –loving drivers is to increase the probability of law enforcement.

- From extensive empirical study above we also conclude that individuals comprehended between the ages of 18 and 24 followed by the 25-34 age group are more vulnerable to automotive accident death and injury. Evidence supporting once more the need to develop road safety measures aimed specifically towards this portion of the population inculcating valuable information and moral values that ultimately induce drivers to control risk factors, to alter levels of desired risk and to modify automotive driving behavior.

- A long term policy would be to investment on driver education and information dissemination regarding objective risk inherent to automotive driving. In fact, individuals who belong to this particular age bracket are in great part risk-takers suggesting that an increase of law enforcement, carried out by numerous methods of intervention, is an adequate measure towards reducing the harm caused by reckless driving and low levels of driving care.

- Along with other risky behaviors, excessive speed is a form of arousal for young and old drivers alike who seek pleasure and the approval of their peers. If more social activities and beneficial programs were to be accessible to youngsters coinciding with their personal interests then reckless risky driving behavior would dissipate ultimately contributing towards a reduction in automotive accident fatality and injury;

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[54] Level of *desired risk (target risk)* is the optimal level of risk that the individual is willing to incur where expected costs and benefits are maximized in accordance to the person's perception. Vide: Section 1.4 of Chapter I.

[55] See: Section 3.6 of Chapter III.

- Usually, the majority of drivers especially those between the ages of 18-24 are *risk-under-estimators* with levels of *subjective risk (perceived risk)* much inferior to the *real and objective probability* of accident involvement. As a result, drivers generate a level of *objective risk* superior to optimal which consequently originates greater accident risk;

- Concerns must be raised by policy-makers regarding the risk-taking behavior of young people, namely males, where the results obtained herein have strongly stressed the need to take a more broad-based, systematic and social-determinant approach to the behavior of young drivers.

- We also analyzed certain factors related to young male drivers and their propensity towards risk. Biological factors must be taken into account when implementing policy measures. Among these biological factors we highlighted the incompleteness of the prefrontal cortex in the brain (PFC) which fully develops at about the age of 25[56]. As previously stated the PFC is the part of the brain that governs the control mechanisms and integrates the reflexive system.

- Young people are on average risk-takers especially in activities that provide them with immediate pleasure. Their hyperbolic time preference discount rate is higher and they are also more influenced by visceral factors - whose effects are less controlled due to their cerebral maturation- leading them to frequently use their automatic system of thinking rather than their reflective one.

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[56] Idem.

infants and toddlers. Washington, DC: National Highway Traffic Safety Administration, 1984. Evans, Leonard. *Traffic Safety and the Driver.* New York: Van Nostrand Reinhold, 1991.

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