DDM (Driving Decision Making):
Decision making pattern in graphic driving situations: Relation to personality factors and driving attitudes

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**Abstract:**

Driving is a complex decision making process. Errors in different levels of this processes may lead to risk situations and accident involvement. Studies have pointed out the connection between individual decision making styles, usually measured by self report inventories, and accident involvement. The test presented in this study intends to assess major characteristics of decision making style as appear directly in reaction to specific driving situations, presented in a graphic manner. A structured interview allows to assess basic characteristics of the decisions made by the respondent: inclusiveness of decision, range of factors considered, attention to risk factors, post decision confidence, attention to the behaviour of the other, attention to driving rules etc. Relationships were examined between these measures and: Locus of control in driving, Sensation seeking, major personality traits (derived from the MMPI and the NEO-PI-R and number of accident involvements and driving offences. Findings show good reliability values for the DDM and interesting validity values toward personality factors and attitudes known as related to risky driving. No relation was found between the DDM and accidents involvement or traffic offences. These findings are discussed with regard to development of focused diagnostic tools for psychological assessment of drivers

**Keywords:** Driving, Decision-making, Personality characteristics.
**Introduction:**

The need to identify psychological risk-proness, as well as the basic assumption that our personality affects our driving, has led numerous researchers to study the interaction between psychological personality characteristics and dangerous driving. Many research studies point out the association between personality factors such as: extroversion, excitement-seeking, risk seeking, ab-normative behaviour and the involvement in road accidents and in committing driving violations (Beirness, '93, Elander, West & French '93, Lester, '91).

Despite extensive research, results remain conflicting and of marginal importance (Ranney, '94). This fact is generally attributed to various methodological drawbacks although, in recent years, there is also growing awareness to the fact that personality characteristics are often measured with general inventories, which do not include measures related to the specific targeted behaviour. Attempts to relate general constructs of personality to outside criteria have been more successful when the measures of these constructs were tailored more specifically to the targeted behaviour (Iversen & Rundno, 2001). For example, Rotter’s (1966) locus of control scale which measures the individual’s view of the extent to which he is in control of the results of his actions, was found to be of relatively little association with risky driving, despite the basic assumption that introverted people tend to a more cautious and more controlled behaviour – also while driving. Montag (1987) has adapted the general locus of control scale specifically to driving behaviours, and developed the MDIE (Montag Driving Internality and Externality). Montag & Comery (1987), using these two scales, found more significant correlation between the driving locus of control and the involvement in traffic accidents.

**Decision Making while Driving:**

The concentration on driving decision making style as a major component in driving behaviour emerges from two main reasons:

Firstly – decision making is a very crucial process in the behaviour of driving. In fact, at any moment in driving, we make numerous decisions at different levels: Decisions about routes, lanes, speed, overtaking, winker operation, gearshifting.

Secondly – compared to other cognitive structures, decision making is a comprehensive structure, largely influenced by personality and motivational features and being directly related to driving style.

A low thoroughness in decision-making style measured by a self-report questionnaire, has been shown to correlate with accident risk (French, West, Elanderet & Wilding, '92) and this correlation has been confirmed in a follow up research study (West, Elander & French, '92). Low thoroughness is characterized by a tendency not
to plan ahead, not to approach decision-making in a logical and systematic manner and proneness to make decisions without considering the costs and benefits of the alternative course of action. The measure of thoroughness was found to be correlative to all the measures of driving style as obtained by self-report questionnaire (MDQ). The highest correlation was found between decision-making thoroughness and planning.

This study examines a graphical tool for the evaluation of types of driving decision-making. The decision-making style of a subject is presumed from his reactions to different decision-demanding driving scenarios, presented graphically with a verbal explanation. The subject’s responses are evaluated according to measures of inclusiveness of decision, range of relevant factors considered, degree of items recall (reflects information processing of recalled items), risk perception, ability to cope with recognized risk.

The basic assumption of this study was that the tool would reflect an individual’s style of decision making, its advantage is in that:

a. It uses assessment through behaviour, not through questionnaire,
b. It assesses driving decisions, not general decisions.

The object of this research was to assess the reliability of the suggested tool and its relevance regarding the criteria of accident and traffic offence involvement, as related to general personal traits and to specific driving personality traits. In general it is assumed that a more “negative” decision-making style would be associated with a higher driving risk, as reflected by the connection with personality traits known as contributers to driving risk and involvement in accidents and traffic offences.
METHOD:

Instruments and measures:

As part of their screening process, all subjects went through the basic evaluation battery:

Personality questionnaires:

MMPI (Hebrew version, Montag, 1977): 393 items, 2 choices each, 10 clinical scales. The following scales were introduced to our survey: L (Lie), MA (Mania), PD (Psychopathic Deviation), SI (Social Introversion), Rey (Responsibility)

NEO PI-R (Hebrew version, Montag, 1990; Costa & McCrae, 1985): 240 items, 5 choices each, 5 personality factors, 6 subscales for each scale. All 5 factors were introduced to survey: N (Neuroticism), E (Extroversion), O (Openness), CO (Conscioussness), A (Agreebleness). In addition we have introduced the Imp subscale (impulsivity) from the N scale.


MDIE: Montag Driving Internality and Driving Externality: Two locuses of control scales related to driving: DIS (Driving Internal Locus of Control) DES (Driving External Locus of Control) We also included Montag’s scales of APS-Self Efficacy in Driving and Vio-Permissiveness to driving violations (Montag, 90’ Montag, 92).

DDM: the DDM is introduced by a constructed interview led by the psychologist. The psychologist notes down the subject’s responses in detail. Approximate time requested for the test is 10 minutes.

The tool is composed of two graphic pictures which illustrate different driving situations: The first picture shows a vehicle approaching an intersection with traffic lights, while the green light is blinking. The subject is asked whether he – as the driver of the vehicle – would stop before the intersection or continue. The second picture shows a vehicle approaching a roundabout. The subject is asked whether he could turn right into the roundabout. For each answer, the subject is inquired about the grounds leading to his decision, about risk perception and estimation concerning the decision, post decision assurance, recall and recognition of items from the picture – after
removal of the pictures (reflecting amount of information processing for items recalled).

The subject’s responses are scored as follows:

**Speed:** fastness of response: Immediate - 1    Delayed – 2

**Response:** “quality” of response using a 1-4 scale: 1 for a shallow response that involves very narrow information processes, 4 for detailed response that involves a wide information process

**Grounds:** no. of items taken into consideration with regard to decision. 1-4 scale

**Risk:** risk perception concerning the presented situation; 1-Yes  2- no

**Coping:** perception of ability to cope with the risk

**Assurance:** confidence in decision. 1-4 scale; 1-weak ; 4-high

**Recall:** no. of correct recalls (items that appeared in the picture) 1-6

**No recall:** no. of mistaken recalls (do not appear in the picture)1-6

**Recognition:** no. of items the subject recognizes

Part of the screening process includes also:

**PSYCHOLOGICAL INTERVIEW**

**GENERAL BIOGRAPHICAL QUESTIONNAIRE**

**POLICE RECORD**

**Results:**

Reliability of the DDM:
Factor analysis revealed two main factors:

**Factor 1:** Response - picture 1 + 2
   Grounds - picture 1 + 2
   Recall - picture 1 + 2
   Recognition - picture 1 + 2

The Cronbach’s alpha coefficient was applied to evaluate the internal consistency of the various items: The reliability of factor 1 was 0.73. The items concern range of information processing (narrow to wide) and thus are labeled as factor of:

**Information processing.**

**Factor 2:** Risk
   Coping - picture 1

Internal consistency reliability Cronbach’s alpha was 0.89.
Those items concerning risk perception and coping and thus are labeled as factor of:

**Risk perception.**
The internal consistency of the whole test - Cronbach’s alpha: 0.655; split half reliability (Speerman Brown): 0.62.

We decided to omit a few items found as not related to any of the two main factors and which spoiled the reliability of the test: speed picture 1+2’, recognition picture 2’, recall error picture 1+2. The reliability of the test including those items was: Cronbach’s alpha 0.64.

Table 1 presents the correlations between test items:

Table 1: Correlations between test items

<table>
<thead>
<tr>
<th>Recall error1</th>
<th>Recall1</th>
<th>Grounds1</th>
<th>Response1</th>
<th>Recognition</th>
<th>Recall</th>
<th>Coping</th>
<th>Risk</th>
<th>grounds</th>
<th>response</th>
<th>speed</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Speed</td>
<td>0.17*</td>
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<tr>
<td>Response</td>
<td>0.5**</td>
<td>0.19*</td>
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<td></td>
<td></td>
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<tr>
<td>Grounds</td>
<td>-0.17*</td>
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<td></td>
<td></td>
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<tr>
<td>Risk</td>
<td>0.8**</td>
<td>-0.23**</td>
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<td></td>
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<tr>
<td>Assurance</td>
<td>0.19*</td>
<td>0.29**</td>
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<td></td>
<td></td>
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<tr>
<td>Recall</td>
<td>-0.26**</td>
<td>0.26**</td>
<td>0.35**</td>
<td>0.38**</td>
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<tr>
<td>recognition</td>
<td>0.46**</td>
<td>-0.19*</td>
<td>0.29**</td>
<td>0.31**</td>
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<td>Speed1</td>
<td>0.19*</td>
<td>0.28**</td>
<td>0.17*</td>
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<tr>
<td>response1</td>
<td>0.6**</td>
<td>0.2*</td>
<td>0.28**</td>
<td>0.2*</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Grounds1</td>
<td>0.44**</td>
<td>0.3**</td>
<td>0.3**</td>
<td>0.45**</td>
<td>-0.19*</td>
<td>0.22**</td>
<td>0.19*</td>
<td>Recall1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recall1</td>
<td>-0.32**</td>
<td>0.28**</td>
<td>0.23**</td>
<td>0.28**</td>
<td>0.27**</td>
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<tr>
<td>Recall error1</td>
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<tr>
<td>Recognition1</td>
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</tbody>
</table>

* Significance at level p< 0.05
**Significance at level p< 0.01

As we can see in Table 1 we have found significant correlations in the expected direction among test items. It was found, for example, that a wider and more elaborated response in both pictures (response, response1) is correlated with more grounds mentioned (grounds, grounds1) , with more items recalled from both pictures (recall, recall1) and with better risk perception (risk) and risk coping (coping) . It should be noted that a positive significant correlation was found between the two driving pictures (r=0.4, p<0.01).
Validity of the DDM:
In relation to specific personality factors: Driving attitudes:

In an effort to test the extent to which specific personality factors related to driving behaviour could predict the performance in the DDM, a stepwise regression procedure was used. The predicted variables were the total score of the DDM, the score of factor 1 and of factor 2. The predictors were Driving Locus of Control (DES, DIS), perceived self efficacy in driving (APS) and permissiveness to driving violations (VIO).

It was found that from the driving attitudes mentioned above, Perceived self efficacy in driving (APS) is the only predictor for the general score of the test (beta = 0.182; p<0.05). It was also found that External driving locus of control (DES) is the only predictor for factor 1 - Range of information processing (beta = -0.19, p<0.05) and Internal locus of control (DIS) predicted factor 2 of the test: Risk perception (beta = -0.19, p<0.05).

We also examined the correlations between each of the driving attitudes and the various tests’ items. The findings are presented in Table 2:

Table 2: Correlations between test’s items and Driving attitudes

<table>
<thead>
<tr>
<th>Score Pict. 2</th>
<th>Factor 2</th>
<th>Factor 1</th>
<th>Total score</th>
<th>COPING</th>
<th>RESPONSE</th>
<th>GROUNDS1</th>
<th>RESPONSE1</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.18*</td>
<td>-0.19*</td>
<td></td>
<td></td>
<td>-0.198*</td>
<td>-0.235**</td>
<td>DES</td>
<td></td>
</tr>
<tr>
<td>-0.13*</td>
<td></td>
<td>-0.212*</td>
<td></td>
<td></td>
<td></td>
<td>DIS</td>
<td></td>
</tr>
<tr>
<td>0.23*</td>
<td>0.179*</td>
<td>0.182*</td>
<td></td>
<td>0.232**</td>
<td>0.21*</td>
<td>APS</td>
<td></td>
</tr>
</tbody>
</table>

p<0.05*
p<0.01**

As we can see in Table 2, the relations found between items supported the expected direction: We found significant negative correlations between test’s items (factor1, response1, score of picture2, grounds1) and External driving locus of control; the higher External locus of control the narrower the Information processing.

In addition, we found significant negative correlations between Internal driving locus of control (DIS) and the score of factor 2 and Coping; the higher Internal driving locus of control the better are risk perception and risk coping. Finally, we found significant positive correlations between test’s items which concern a range of
information processing (response, response1, grounds, score of factor 1, score of picture 2, total score of the test) and Perceived self efficacy in driving, that is, the higher perceived self efficiency in driving the wider and more elaborated the information processing.

**Relation to Personality factors:**
In an effort to test the extent to which personality factors could predict the performance in DDM, a stepwise regression procedure was used. The predicted variables were the total score of the test and each of the two factors. The predictor variables were the following personality factors derived from the MMPI, the NEO-PIR and the SSS: Disinhibition (DS), Boredom susceptibility (BS), Aggressiveness (AGG), TAS, Sensation seeking (ES), Risk taking (CAI), Impulsiveness (Imp), Neuroticism (N), Externality (E), Openness (O), Agreeableness (A), Consciousness (CO), Lie scale (L), Psychopathic Deviation (PD), Mania (MA), Social Introversion (SI), Social responsibility (Rey).

It was found that from all the above personality factors the only predictor to the score of factor 1 is Impulsiveness (Imp) (beta = -0.226; p<0.05).

We also examined the correlations between personality factors and test items. It was found that from all personality variables Social Introversion was marked in a negative relation to the performance in the DDM. That is, higher level of Social Introversion is correlated with poorer performance in the DDM.

<table>
<thead>
<tr>
<th>RECALL</th>
<th>Factor 1</th>
<th>Score pic 2</th>
<th>Score pic 1</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.184*</td>
<td>-0.18*</td>
<td>-0.177*</td>
<td>-0.2*</td>
<td>-0.2*</td>
</tr>
</tbody>
</table>

*p <0.05

We also found negative correlation between Mania (MA) and Response (r= -0.205; p<0.05) and positive correlation between Openness (O) and Grounds 1 (r= 0.21; p<0.05) and score of picture 2 (r= 0.177; p<0.05).

**Relation to Demographic Variables:**
In order to examine the extent to which demographic variables could predict performance on the DDM, a stepwise regression procedure was used. The predicted variables were a general score of the test and scores of each of the two factors. The predictor variables were: age, education, experience, license, number of kilometers and hours driven per day. It was found that from all the demographic variables, the only one which predicted the score of factor 1 was education (beta= 0.188; p<0.05).

In addition we examined the correlations between each of the demographic variables and test items. Education was marked from all the demographic variables and was positively related with performance on the DDM.
We also found a significant positive correlation between grounds1 and driving hours per day (r= 0.174; p<0.05).

Relation to the criteria of Driving Accidents and Violations:
We used the stepwise regression procedure in order to examine the extent to which performance on DDM could predict number of accidents and violations. Test items were the predictors. The DDM did not predict accidents and violations and no significant correlations were found between measures of the DDM and accidents and violations.

Prediction of Accidents and Violations: On the relation between Personality and Risk in Driving

In order to examine which of the variables analysed in this study could predict the criteria of driving accidents and violations, we used the stepwise regression procedure. We found that the only variables which predicted driving violations were Social Introversion (beta= 0.367; p<0.01) and number of kilometers driven per day (beta= 0.241, p<0.01). Involvement in accidents was predicted only by Social Introversion (beta= 0.278; p<0.01) and Lie scale (L) (beta= - 0.289; p<0.01). L and PD were the only mediating factors between SI and accidents.

On the relation between Social Introversion and other personality factors:
In order to understand better the findings regarding the negative relation of Social Introversion with performance on the DDM and the positive relation with accidents and violations involvement, we examined the relation between Social Introversion and other personality factors. Table 3 presents the significant correlations we found:

<table>
<thead>
<tr>
<th>RECOGNITION</th>
<th>GROUNDS</th>
<th>Factor 1</th>
<th>Picture 1</th>
<th>Picture 2</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2*</td>
<td>0.214*</td>
<td>0.19*</td>
<td>0.18*</td>
<td>0.17*</td>
<td>Education</td>
</tr>
<tr>
<td>* p&lt;0.05</td>
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</table>
As can be seen in Table 3 and as expected, there are negative significant correlations between Introversion and personality measures of excitement seeking, risk tendencies and adventureness (CAI, TAS, ES). That is, the more introvert a person is the less he will tend to be involved in risky and adventurous experiences. In addition, as expected, we found an inverse relation between Social Introversion and Extroversion (E) and between Social Introversion and Openness (O).

SI was found to relate to ‘negative’ personality measures such as Psychopathia (PD), Impulsiveness (Imp) and Neuroticism (N). That is, the higher the social introversion the higher the psychopathia, neuroticism and impulsiveness. In addition we found social introversion to correlate negatively with more ‘positive’ personality measures such as: Agreebleness (A), Consciousness (Co). That is, higher social introversion is related to poorer interpersonal capacities and poorer coping abilities. Also noteworthy is the positive relation found between Social Introversion and External driving locus of control (DES). That is, higher introversion is related to higher external driving locus of control.
**Discussion:**

The basic assumption in this study was that the driving decision making pattern, which is the outcome of interaction between personality and cognitive factors, may be linked to driving risk proneness. In this study we chose to examine the direct reactions of individuals to graphic driving situations presented to them and to evaluate these reactions in terms of: Inclusiveness of decision, grounds leading to decision making, range of attention to relevant details, recall of items, risk perception, coping with risk.

The examination of the reliability of the DDM revealed quite satisfactory expected relations between the various measures of the test and showed promising evidence for the use of the DDM as a measure of driving decision making pattern.

The reliability examination has identified two main factors:

**Range of information processing:** The ability to reach a well-founded, broad decision.

**Risk perception:** The ability to identify a relevant risk factor and the ability to cope with this risk.

There is of course an interaction between these two factors, since it is evident that a person’s ability to take into consideration a large range of details, may allow him a better chance at risk perception. Yet, the fact that risk perception was identified as an independent factor leads us to special consideration of this factor; that is, in any general detailed information process, it is important to be able to identify relevant details as risk details.

Many studies have examined the relation between the ability of risk perception and accident proneness. A delayed reaction to risk in a driving simulator has been found to be related to higher driving accident involvement of subjects, beyond the influence of basic reaction time (Quimbly & Waits, 81; Quimbly et al, 86). Other studies have found that less experienced or younger drivers tend to underestimate risk situations presented to them in photos, films or in actual driving (Ganton & Wilde, 71; Sivac et al, 89; Bragg & Finn, 82).

It was found in this study that persons with higher education tend to better performance in driving decisions. It is obvious that proper decision making and reaction are based on a suitable cognitive ability. Reason et al (1990) found that persons with high cognitive ability better succeeded in avoiding negative outcomes of risk situations (and avoiding accidents) due to a higher level of information processing. It was found that drivers with many driving offences and no accidents were characterized by better information processing patterns compared to drivers with many offences and many accidents. Similarly, we found in our study that positive and more efficient driving decision making style is related to personality factors of
perceived control and influence on conduct outcomes and perceived self efficiency in driving.

We found that impulsive persons tend, in general, to less adequate driving decisions. This finding corresponds with the results of West et al (1992), that persons with low thoroughness in decision making style tend to lack of planning, a less systematic and logical decision making and a tendency to make decisions without adequate consideration of possible outcomes.

Another interesting finding is the relation between Social Introversion and driving decision making style as well as involvement in accidents and driving violations. We found that persons with higher Social introversion tend to a more narrow and simplistic decision making process, tend to be more involved in driving accidents and in executing driving violations.

The scale of Social introversion reflects a general pattern of social maladjustment and emotional distress. This scale includes measures of shyness, social discomfort, stress, anxiety, lack of confidence and cognitive problems (attention, decision making, judgment). Nevertheless, we are dealing with a heterogenic and complex scale. The relation between social introversion and other personality factors as found in this study indicated that persons with higher social introversion tend to be more impulsive, more neurotic, with less coping and interpersonal abilities and a tendency to perception of lower control over situations and outcomes of their behaviour. Social introversion was also found with a negative relation to characteristics of excitement and risk seeking. It appears that the relation of Social introversion to driving risk - as reflected in a problematic driving decision making style and in involvement in accidents and violations, does not derive from `active` risk tendency but rather from passive tendency, emotional distress and lack of adequate coping ability.

While most studies in the domain of personality and driving deal with `active` tendencies relevant to driving risk as experience seeking and impulsiveness, this research points out the importance of identifying `passive` tendencies. Further research should be conducted in order to provide better understanding of this risk profile.

This research’s findings indicate the need to address in a pluralistic manner a better understanding of the relation between personality and driving.

This present work presents only a pilot study for examining a new evaluation tool of driving decision making style. We found that the DDM is a reliable tool and valid in relation to personality criteria known as relevant to driving risk. A few limitations of the tool should be considered: The possible bias of education on performance, the narrowness of the tool (which is composed only from two situations), the poverty of items in factor 2 which was found in factor analysis, the possible coding limitations. Coping with these limitations may lead to higher reliability rates of the tool. In
addition, it is important to use larger samples which may allow examination of unique sub-populations.

Finally, we should consider the fact that DDM was not found as predictor for driving violation and accidents.

This lack of relation may reflect the limitations of the DDM; yet, it is possible that decision making pattern is only part of a more generalized pattern of lack of coping abilities and therefore does not stand by itself as predictor for risky driving. What it does stand for is a cognitive behavioristic symptom of a more generalized syndrome. More research is needed for better understanding this syndrome and its relation to driving.

There is also the question of the reliability of accidents as criteria in research. Many recent researchers address the lack of reliability of driving accident criteria (Elander et al., 1993; Lajunen, 2000; Iversen & Rundmo, 2001). A driving accident is a rare event which involves varied variables that are hard to be tracked. Moreover, there is growing awareness that report sources for driving accidents are not reliable. There is certainly no doubt that one of the most important goals that stands ahead of us in the research of driving psychology and in the domain of safety research in general, is a better definition of reliable criteria for prediction.
References:

- Beirness, D.J. (1993). Do we really drive as we live? The role of personality factors in road crashes. Alcohol, Drugs and Driving, 9, 129-143.


