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# The Test2Drive system in driver assessments: relationships between theory, law and practice

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## ABSTRACT

### Purpose
In Poland, traffic psychology is the most thoroughly regulated area of assessment. The Vehicle Drivers Act of 5 January 2011 and the Regulation of the Minister of Health of 8 July 2014 list the variables that must be assessed and the requirements imposed on diagnostic procedures. The Test2Drive system has been developed to provide an integrated tool that meets these guidelines. The system contains 10 tests in the area of cognitive processes, personality and psychomotor fitness. A database of nearly 100,000 recorded assessments is a valuable resource for improving diagnostic tools and conducting research, such as the cited studies exploring the relationship between age and visual attention processes. Analyses based on the database of driver assessments support the verification of hypotheses and research conducted in many areas of applied psychology (human reliability and human error) and academic psychology (psychology of individual differences, changes in fitness with age).

### Research hypothesis
Scientific projects carried out based on the collected materials support the hypothesis that practical applications are not only an inspiration for new research problems, but can also test the correctness of theoretical models. Unsuccessful implementation or the absence of anticipated effects in an experiment can prompt scientists to falsify their research hypotheses.

### Conclusions
An effective policy for managing the rights to assessment results and consents promotes access to data sets whose volume significantly exceeds the number of samples that could be obtained in individual studies. As a result, practice becomes not only an inspiration or a recipient of scientific research, but also a full-fledged laboratory.

**Keywords:** Driver tests, psychomotor fitness, personality, databases, apparatus tests, psychological dysfunctions.

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## INTRODUCTION: LEGAL REGULATIONS VS. PSYCHOLOGICAL PRACTICE

Psychological assessments of drivers have a long tradition. In Poland, psychological assessment laboratories had been established already before World War II. The first laboratory served the railway industry, and facilities for assessing pilots were quickly introduced. At present, driver assessments are regulated by the Act on Vehicle Drivers, adopted in 2011 (Articles 82–90), and the Road Transport Act of 2001 (Articles 39k and 39m). Detailed provisions concerning assessment procedures can be found in the Regulation of the Minister of Health of 8 July 2014. Annex 5 to this Regulation lists the key principles of good practice applicable to the psychological assessment of drivers. Two elements of the proposed methodology deserve special attention. Firstly, psychological tests for drivers must meet the conditions of psychometric quality, i.e. they must be reliable, objective and standardized, as well the conditions of construct validity and, if possible, criterial validity. Secondly, psychologists are required to strictly adhere to the recommendations described in the test manual. Standard and evidence-based methods of personality and intellectual performance testing had been used previously, but manuals for apparatus tests measuring psychomotor fitness and attention were often not available, and psychologists were advised to develop their own test standards in a laboratory. The new regulation contains the relevant guidelines, and it enables psychology professionals to develop sound research methods for examining the areas indicated in the regulation.

However, definitional problems had to be overcome before legal provisions could be implemented into psychological practice. In the cited regulation, the scope of psychological assessments linked with weapon use was copied, and an assessment of psychomotor fitness was added.

The Regulation states that:

> § 4. 1. The scope of psychological assessments in traffic psychology includes:
> 3) assessment and description of the examined person in terms of:
> a) intellectual performance and cognitive processes,
> b) personality, including coping strategies, as well as social maturity,
> c) psychomotor fitness.

The above variables are specified in point II of Annex 5:

> 2. In the field of intellectual performance and cognitive processes, an authorized psychologist selects diagnostic tools and techniques to evaluate perception, attention, understanding of the situation and anticipation.
> 3. In the field of personality assessment, an authorized psychologist selects diagnostic tools and techniques to evaluate social maturity (understanding of norms, self-control, adaptation) and emotional maturity (coping strategies, emotional balance and its impact on the risk of behavioral disorganization).

4. In the field of psychomotor performance assessment, an authorized psychologist selects tests and laboratory instruments to evaluate the speed and adequacy of reactions and hand-eye coordination.

Therefore, psychological examinations of drivers are the most accurately regulated area of psychological practice, but the concepts addressed by legal regulations are not always clear to psychologists planning diagnostic procedures. Legal regulations are written by lawyers, and they are not easy to conceptualize or operationalize. Assessments of "social and emotional maturity" pose the greatest problem. A person who experiences emotional difficulties and alienation due to trauma is not immature. His or her development proceeded correctly, but traumatic experiences compromised that individual's personality functioning.

Intellectual performance and cognitive processes have similar definitions to those described in the situational awareness model (Endsley, 1995, 2015), but the definition of "understanding" in terms of individual differences, and the definition of individual differences in the "ability to understand situations" remain problematic.

A solution to the above problem was proposed by a team of psychologists associated with the Motor Transport Institute who published the "Methodology of psychological research in the field of traffic psychology" (Ucińska, 2021). The key concepts were defined, ten dysfunctions associated with the variables listed in the Regulation were proposed, references to psychological knowledge were made, and the following observable indicators was postulated:

– Attention deficit disorders (two degrees of severity)
– Impaired understanding or anticipation (two degrees of severity)
– Disorders of social functioning (two degrees of severity)
– Emotional disorders (two degrees of severity)
– Reduced psychomotor performance
– Personality traits increasing the risk of driving under the influence of alcohol

These categories were designed by the authors (the author of this paper also participated in the debate) to build a bridge between psychological and legal terminology. Each dysfunction increases the risk that the tested subject will not be a safe vehicle driver, and it enables psychologists to identify legal provisions that justify this observation. Indicators relating to psychometric tests scores, interviews, and observations were developed for each dysfunction (Ucińska 2015, 2021). Compensation indicators were also proposed for most categories, and the tested subject could be conditionally considered fit to drive if these factors were present. For example, minor attention disorders could be compensated if the subject was characterized by at least average intellectual performance, adequate self-esteem, healthy self-criticism, good self-control and, above all, if the subject has not frequently participated in road accidents that could attest to the presence of a given dysfunction. Groups of respondents (in this case – instructors, examiners, drivers of emergency vehicles) where such dysfunctions were a disqualifying criterion were also described. However, older respondents who are reasonable professional drivers are not disqualified despite reduced attentional capacity, provided that they are safe drivers.

## TEST2DRIVE SYSTEM AS A TEST BATTERY

The Test2Drive system was created in 2014 as a set of psychometric tools for the psychological assessment of drivers, which meet the new legal requirements. The system was developed by a team of psychologists associated with Alta, a company that had been providing IT support for psychologists for more than 20 years, and had co-developed the Vienna Test System and the Multiselect recruitment system for the Polish Police. The Test2Drive system was designed as a tool for assessing the variables required by the new methodology, but above all, it supported the development of tests with proven psychometric quality (i.e. tests that are accurate, reliable, objective, standardized, and accompanied by adequate standards). All test procedures were described in the manual (Tarnowski 2020). The Test2Drive system was also designed to validate conclusions – each tested function should be reflected in the results of at least two independent tests. The project had no external funding, and it was a fully commercial undertaking. Alta is currently implementing the OPTIMIS project to develop a database of psychological tests for other professional groups. The project is supported by the National Center for Research and Development.

Test standardization was an important feature of the Test2Drive project. According to the cited Regulation, all tests have to be conducted in psychological laboratories that meet specific requirements. Therefore, the system has to be installed by users on a computer equipped with a minimum 23-inch touchscreen (on larger screens, the image is scaled and the actual size is always the same). The computers used by the tested subjects should be separated from the computers where the administrative panel is installed and which are operated only by psychologists. The system enables the operator to manage the tests, collect data, and generate all legally required documents. A standardized interview can be completed only from the psychologist's computer (it must be conducted in person). Another important solution is that customers do not have to install a database locally, but can use common resources on the Alta server. Moreover, contracts with customers include a clause on the release of anonymized data for scientific and standardization purposes.

The test system covers three legally required areas: psychomotor fitness, cognitive processes and selected personality traits.

### Psychomotor fitness

Psychomotor fitness (in the Regulation, defined as the speed and adequacy of reaction, hand-eye coordination) is examined by four tests. All tests contain tasks that are performed on an identical board

In the Simple Reaction Time (SIRT) test, the subject's task is to move his/her finger from one field on the screen to another. All stimuli are identical and are presented at pseudo-random intervals. The test measures two components of movement: reaction time (period from stimulus presentation to lifting the finger from the rest field) and motor time (time of movement to the reaction field).

Therefore, the median reaction time, the median motor time and the so-called extended reaction time are evaluated. Extended reaction time is measured by vincentizing the distribution of reaction times (it is the average of 10% longest times). According to research on the intraindividual variability of reaction times, highly dispersed results have greater diagnostic value than the mean value (Schmiedek, Lövdén, Lindenberger, 2009, Vaurio, Simmonds, Mostofsky, 2009).

The Choice Reaction Time (CHORT) test requires differentiated reactions. Depending on the displayed pattern, the subject is asked to touch the appropriate field or refrain from reacting. In addition to reaction times and motor skills, the percentage of correct reactions is also an important variable which indicates the effectiveness of inhibition processes (Verbruggen, Logan, 2008).

The Hand-Eye Coordination (HECOR) and Spatial Anticipation Test (SPANT) tests have been designed to measure hand-eye coordination. In the HECOR test, the subject is asked to press the button under the presented stimulus. The test elaborates on the classic Piórkowski apparatus, where the subject's task is to press buttons indicated by rapidly flashing arrows. In the SPANT test, the subject is asked to touch the field at the indicated intersection of a row and a column. In these tests, the measured variables are reaction time and motor time, and the percentage of correct reactions is additionally measured in the SPANT test. SPANT is the most complex test for measuring psychomotor performance.

## Cognitive processes

Cognitive processes (perception, attention, understanding and anticipation) are operationalized by three more tests.

The pop-up test (PUT) is based on the feature-integration concept proposed by Anne Treisman (Treisman 1999; Treisman, Zhang 2006). The subject's task is to search for a black and vertical triangle (an object defined by a conjunction of features). The test measures mindfulness and the speed of visual search.

The Traffic Related Intelligence Test (TRIT, recently replaced by the simplified TRIT-R) is a logical reasoning test. The subjects are evaluated for their ability to perceive and apply rules, perform mental rotation and spatial inference tasks.

In the Perception-Anticipation of Movement Test (PAMT), the subjects have to estimate the speed and position of moving objects and make decisions at the right time. The test score is the percentage of correctly performed tasks.

## Personality

Personality is the last evaluated area. Despite definitional problems (social and emotional maturity, stress resistance), the Regulation makes a reference to real threats: impulsive individuals, individuals with a high propensity for risk-taking and emotionally unstable individuals are most likely to experience problems as drivers (Cheng, Ng, Lee 2012; Ulleberg, 2001; Ullenberg, Rondmo 2003). While most authors agree that impulsivity and high propensity for risk taking

have negative implications, emotional stability poses a more complex problem. M'Baliar et al. (2018) and Dahlen and White (2006) admittedly confirmed the connection between emotional stability and driver efficiency, but the meta-analysis conducted by Clarke and Robertson (2005) produced rather surprising results and revealed that all the traits from the Big Five model, excluding neuroticism, were linked with the accident rate. In the cited Regulation, emotional instability is not clearly indicating as a disqualifying factor, and psychologists are advised to determine whether emotional imbalance is significantly associated with the real risk of behavioral disorganization (Annex 5). For this reason, the NECOG scale for measuring emotional lability was based on the Broadbent concept (Broadbent, Cooper, Fitzgerald, Parkes 1982) postulating that the level of cognitive failures acts as a link between mental problems and risk-taking behavior. Therefore, the NECOG scale contains questions addressing emotional problems, attention and memory dysfunctions.

Social maladjustment is measured by the Personality Maladjustment (PEMAL) scale. The test also features a subscale for measuring Impulsivity and Dysfunctional behaviors and beliefs related to road safety.

The Stress Coping Scale (SCOPE) examines stress coping strategies. It contains scales for measuring exposure to stress (to verify the level of discomfort and exposure to difficult situations) in subjects with a Task-Oriented Coping Style (a high score indicates that a stressful situation is regarded as a problem that needs to be solved), Avoidance Coping Style (procrastination-related indicator) and Permissive Attitude Towards Alcohol (the extent to which stimulants are acceptable for coping with stress). The results play only an auxiliary role in assessments of personality functioning.

Psychometric testing is supplemented by a standardized interview creator. The questions have been designed to elicit critical information for diagnosing psychological problems. The set of seventeen questions addresses health issues (head injury, loss of consciousness, hospitalization, psychiatric treatment, relatives' suggestions regarding memory disorders, regular use of medication) driving problems (revocation of driver's license, accident, tickets) or other life problems (problems at work and in the family, insomnia, alcohol or drug abuse, criminal record, life-threatening situations). If the answer is "yes" to any question, the system displays a window where detailed information can be entered. The interview discloses one of the greatest limitations of the system as a source of scientific data – the system has been designed to facilitate the psychologist's, rather than the researcher's work. Interviews involving 64,580 subjects have not been completed, and the researcher probably relied on his own diagnostic scenario. Of the remaining 30,129 respondents, 20,092 did not answer any questions in the affirmative. In the most extreme case, 12 events were indicated, but in general, the scientific reliability of this part of the questionnaire is significantly limited.

The initial psychometric assessment of the accuracy and reliability of the scales was repeated several times as the number of the surveyed subjects in the database increased. A test manual presenting the theoretical framework and the results of psychometric analyses was developed. The manual includes a guide to psychological diagnosis involving the Test2Drive system. Ukrainian and Russian

language versions were developed (including complete language adaptation and standardization processes), and the system was translated into English and Spanish (Test2Drive is increasingly used in assessments of professional drivers in Mexico).

## DATABASE AND RESEARCH PERSPECTIVES

The contracts concluded with clients feature legal clauses that enable the distributor to use anonymized data for scientific purposes. Due to rigorous testing conditions (described in the Regulation) and the fact that measurements have to be standardized, the results can be regarded as outcomes that have been obtained under standard conditions. A database of 94,907 assessments (as of August 2021) involving a highly diverse population is available for research purposes.

**Table 1.**

**Groups included in the Test2Drive database**

| Group | N | Percentage |
|---|---|---|
| Occupational medicine | 24 618 | 26.0% |
| Professional drivers | 22 406 | 23.7% |
| Instructors and examiners | 764 | 0.8% |
| Emergency vehicle drivers | 1 972 | 2.1% |
| Drivers with more than 24 penalty points | 912 | 1.0% |
| Perpetrators of serious accidents | 266 | 0.3% |
| Driving under the influence of alcohol | 3 620 | 3.8% |
| Drivers referred for medical reasons | 506 | 0.5% |
| Drivers referred for psychological reasons | 64 | 0.1% |
| Candidates and students of auto mechanic schools | 5 925 | 6.3% |
| Russian-speaking professional drivers | 3 035 | 3.2% |
| Ukrainian-speaking professional drivers | 4 333 | 4.6% |
| Research groups and athletes | 2 038 | 2.2% |
| Other | 21 628 | 22.8% |

Women account for 12.5% and men for 87.5% of the respondents. The age range of the respondents (included in the analyses) is 18–94 years (after eliminating dubious data and minors surveyed for scientific purposes). The mean age

is 37 years. Most respondents (47.3%) have secondary education, and 132 subjects are PhD holders.

Despite the described limitations and the fact that the quality of the material has to be verified each time, the database can be used for scientific research in many areas. Tarnowski and Szostok (2018) relied on this resource to analyze visual attention processes as a function of age. They examined a database of 17,652 drivers available at the time, including the results of the PUT test, to reveal that attention processes deteriorate past the age of 30, but the percentage of errors remains relatively stable until the age of 50, whereas both parameters deteriorate significantly past the age of 70. The current database can be used to validate these findings –85.4% of 70- to 79-year-olds are characterized by relatively satisfactory attention performance, and 84.0% by satisfactory visual search speed. In the 80+ group, these indicators are 82.4% and 55.9%, respectively. These results are based on data relating to 265 "silver" drivers. Thus, more than half of 80-year-olds are safe drivers, provided that are critical of their abilities and remain in good overall health.

The Test2Drive system has been used in several research studies in the field of psychology (Małkiewicz 2020, Czapska 2015, Olejniczak-Serowiec, Rutkowska 2018) and sports psychology (Paśko et al. 2021, Bonnet, G., Debanne, T., Laffaye, G. 2020). However, none of these studies harnessed the capabilities offered by the full database.

Further research is needed to address problems such as lifelong changes in cognitive and executive performance, gender related differences (a statistically significant difference of 5 milliseconds in reaction time provokes a methodological discussion), the typology of road accident perpetrators, and many others.

## THE RELATIONSHIP BETWEEN THEORY AND PRACTICE

Nearly 30 years ago, Potts (1993) criticized the classic model of implementation research and proposed the "Industry-as-laboratory" approach. Potts focused mainly on computer science projects, but his findings are still relevant for social sciences.

In the classic "Research then implementation" model, a problem is identified by the market, industry or other social actors, and it is then solved by a scientific institution. This process first requires complementary basic research, followed by research and development, as well as industrial and pre-implementation research, before subsequent levels of technological readiness are achieved. Later, the solution can be presented to the contracting authority. However, at the time, practitioners were already gathering experience and attempting to clarify or reformulate the problem. As a result, the proposed solutions could address problems that no longer exist. Potts described this situation as a "model for the transfer of results". He argued that scientists approach a problem which is defined by anecdotal and unsystematized knowledge, then acquire scientific knowledge through successive approximations, and finally propose a sophisticated solution. In the meantime,

the problem evolves without the researchers' knowledge – organizations have to resolve current issues, and they do not have access to knowledge that could be useful, but remains confined within a scientific institution. As a result, the offered solution can be sophisticated, but it no longer addresses the current situation.

Potts proposed the "industry-as-laboratory" model as an alternative approach. In this model, researchers contact the industrial partner after completing each stage of the research, transfer the gathered knowledge, obtain information about changing market conditions and, consequently, formulate a problem that has been updated not only based on research results, but also based on the new experiences communicated by the practitioners. From the point of view of scientific methodology, this marks a significant shift in focus: theory is no longer validated exclusively in the laboratory. The model is validated under external conditions, and it accounts for complex conditions that are easily omitted in the laboratory. The failure to implement the model in the social reality as well as negative experimental results provide equally compelling evidence for the model's falsification.

The Test2Drive system has been validated scientifically, and the reliability and accuracy of the variables have been established by correlation with other tests and external data. Thus, the system can be said to possess theoretical accuracy. However, the quality of the tests as well as the reliability of the underlying theoretical models can be ascertained only based on their practical applicability, decision-making accuracy and ability to identify potential problems. Interpretation rules have to be clarified, new indicators and tests have to be developed, and the theoretical perspective has to be modified to fulfill the diagnostic needs of psychologists and traffic psychologists. Hopefully, the reliability of theoretical models and the quality of psychometric tools are perceived by psychology professionals as values that are worth striving for.

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