visual acuity have been presented together with evaluation of visual signs seen by older people. Other visual functions such as useful visual field size, for example, should also be investigated in a similar quantitative way for a better visibility of traffic signs for older drivers.

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The Assessment of Fitness to Drive in the Elderly

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H.H. Warnink, The assessment of fitness to drive in the elderly, Gerontechnology 2002; 1(4): 299 - 303. In the assessment of fitness to drive, especially in the elderly, a medical examination and a practical driving test in daily traffic are indispensable. Many kinds of physical insufficiency and ineffectiveness can be compensated with technical adaptations in the car. Field of vision deficits can be compensated by eye and head scanning movements. There is no age bar to the holding of a driving licence. With compensatory strategies, the older driver can be a safe or even safer driver than a younger one.

Keywords: car adaptations, driving test, physical handicaps, vision disorders

Also the Dutch society has a rising quantity of aging people[1]. The number of car drivers beyond the age of 65 is increasing as well, because driving assures an active and independent life style. However, with increasing age, sensory, perceptual, cognitive, and motor functions that are relevant for car driving will decline in efficiency, particularly in the 75+ age group[2-4]. Decline in ability and fitness to drive does not necessarily mean stopping driving, but recognition of decline should lead to an acceptance of the situation, positive adjustment, and ultimately less worry. There is no age bar to the holding of a driving licence. Changes with age vary from one person to another, with no necessary correspondence between biological age and age in years[5]. Old age has its infirmities, but older drivers are judged without discrimination in the Netherlands. Only 2 to 3% of the 70+ drivers are assessed as unfit to drive at the time of renewing their licence!

In the current Dutch system, the road-users bear a lot of responsibility. To obtain/renew a drivers licence for passenger cars the applicant only needs to complete a medical statement ('personal declaration'). The form

contains questions reviewing the presence of epilepsy, impairments of balance, mental disorders or disorders of the nervous system, drug or alcohol dependency, diseases like diabetes, hypertension, or kidney disorders, limb deformities or amputations, eye diseases and vision problems, the use of medication, and other conditions which may influence the fitness to drive a car. One has to respond the questionnaire truthfully as declared by law (Road Traffic Act), but proving criminal intention is very hard. If one or more questions are answered affirmatively, a general practitioner (GP) must countersign it, indicating the nature and gravity of the complaint. This GP needs to be independent (i.e., not the family doctor) in order to respect the relationship of confidentiality between family doctor and patient.

For all drivers over 70 years of age, an additional general medical examination is required every 5 years, together with a 'personal declaration'. In a number of cases, when the medical information or examination shows it is necessary, the medical adviser of the CBR (the Dutch drivers licensing authority) may require the applicant to undergo further examination by a medical specialist. On the basis of this information, the theoretical fitness to drive can usually be determined. In any circumstance of a functional disability that may influence the handling of a motorized vehicle, the medical adviser will order a practical assessment of fitness to drive, carried out by technical adaptation specialists of the CBR who also have broad experience as road-test examiners. The medical examination and the assessment by the department of adaptations can not take place unless the person concerned has reported himself voluntarily to the CBR by sending a 'personal declaration', because in the Netherlands there is no duty for owners of a driving licence to report physical or mental disorders relevant to traffic safety or, more to the point, traffic 'unsafety'. These assessment procedures are quite comparable to those of other countries[6].

The medical department and the department of adaptations are confronted with many wheelchair users, people with disorders of the nervous system, the muscular system, the bones and the joints—sometimes very complicated diseases causing complete or partial paralyses. Other people have a variety of eye problems such as reduced visual acuity and/or visual field defects. For nearly all of these individuals, there is in principle a solution. All persons with physical handicaps or severe eye problems have one thing in common: they come to report to CBR with doubt and fear, as elsewhere in the society they very often have met a lack of understanding and do not want to be dependent anymore. We define adaptations as 'stipulating the requirements the motor vehicle has to meet in order to allow the (disabled) driver to steer and control it safety'. In order to assess this correctly, a driving test in daily traffic is often necessary. This driving test is explicitly stated in the regulations[7-9]. Many restricting stipulations can be outlined for the vehicle, but only one for the person, who 'shall wear corrective lenses' if without these his or her vision is inadequate. With restricting stipulations in place, the person with a functional disorder can lead life like an able-bodied driver.

There are hundreds of possible car adaptations. A few examples.

1. The control handle ('steering knob'), which is used when steering with one hand, even with maximal power steering is not very effective for people with disorders of hand-wrist function; however, this device can be used in cases of coordination disorders in the arm which result in inconsistent steering behaviour when both hands are used. This adaptation is often provided in cases of upper spinal cord lesion or certain types of rheumatism. The steering knob has the disadvantage that while driving, the hand has to be kept for a long time at the same spot on the steering wheel, which can be very tiresome. Also, the steering knob

can become caught in the sleeve of the driver, which obviously can have negative consequences. Therefore, this adaptation is not frequently applied in the Netherlands unless there are no other solutions at hand.

2. The accelerator can be placed to left of the brake pedal in case the right leg is no longer there or does not function. As cars for disabled persons may also be used by an able-bodied partner who might consider the accelerator as the clutch pedal, extensive safety measures are taken by assembling folding pedals. The disabled driver folds the pedals when leaving the car, and the able-bodied driver attends to the position of the pedals when taking the seat.
3. The 'sectional accelerator' is a ring under the steering wheel which is pulled with the fingers in order to accelerate. Apart from the sectional accelerator, the so-called 'adapted hand brake' also has been constructed, as drivers who need these adaptations cannot move the lower part of the body due to a spinal cord lesion or advanced disuse of the legs. With respect to acceleration, it is easier for the driver to use a 'ring accelerator' constructed upon the steering wheel, operated with both thumbs to allow for smooth steering.
4. People with an upper spinal cord lesion, multiple sclerosis, or an affliction in which one half of the body functions better than the other half, can steer with the well-functioning arm while the less-functioning arm can use an accelerator/brake slide. As the name indicates, this adaptation consists of a slide, fixed on the door, which can be moved forward (acceleration) and backward (brake) by means of a bar or a splint. Handling this accelerator/brake slide in principle requires no active hand-wrist function. On this slide a 'wrist-splint' can be assembled so that the active shoulder and elbow operate the accelerator/brake slide.
5. When steering problems occur in the context of very low speeds, it sometimes helps to bring the underarm in a horizontal position so that hand, arm and elbow pursue a steady course while steering, with power originating from the strongest part of the shoulder. Turning the wheel in a horizontal or vertical position can offer a potential solution, based upon the outcome of the essential individual assessment. If steering in one of these ways is not possible, joy-stick steering can be considered.
6. Hydraulic joy-stick steering, as applied in the electric wheelchair, has proven safe and has been officially approved. In the adapted learning car, a long safety handle is pressed in order to operate the joy-stick functions. When this handle is released, such as in emergency situations, taking over the controls with the usual steering wheel becomes possible. Returning to joy-stick control can be problematic, however, as the car's wheels must be aligned in a straight position in order to safely re-engage the joy stick.
7. People in whom neither arm functions, or who lack both arms, can use foot controls, providing they have normal strength and function in both legs. The shoe of the driver can be fixed on the 'feet-steering' wheel.
8. It can also occur that a person with coordination disorder, despite having power in both feet, cannot aim very well. In this case, a combination accelerator/brake shoe, in which the foot is more or less fixed on the 'modified' pedal, offers an ideal solution.
9. Persons which Bechterew disease in which a complete deformation and stiffening of the spinal column have occurred so that the head cannot be turned al all, nevertheless have 360° view with a special combination of mirrors in the car. Use of this system of mirrors requires substantial practice.
10. When the feet do not function but there is active hip function, a knee accelerator (left or right, inwards or outwards) can

possibly be operated, as well as a 'knee brake system'. These kinds of adaptations are often used in cases of muscular dystrophy.

These are only some examples of the almost unlimited range of possibilities for technical adaptations in a car[10-11]. Of course, many of these compensations are also applicable to younger disabled people. Technical adaptations in the car were invented and developed in the United Kingdom after the second world war. Other countries such as the Netherlands soon followed suit. There now are about 100 car-adaptation industries in Europe. The market for these adaptations is roughly 2% of all passenger cars. In the Netherlands, the department of social affairs often pays the costs, even in very expensive cases (e.g., joy-stick steering, composing 2 - 3% of all adapted cars in Europe) when absolutely indicated. There is no additional liability, because disabled persons have proven to be good drivers with adaptations in the car. Some insurance companies ask higher premiums, however.

Assessment of the practical fitness to drive also takes place in cases of seriously reduced vision: namely, low visual acuity and/or field of vision defects. Well known in the elderly are diabetic retinopathy, glaucoma, and strokes. The European and national directives are very flexible as to reduced visual acuity. For passenger car drivers they require a binocular visual acuity, with corrective lenses if necessary, of at least 0,5 when using both eyes together[7-9]. As to visual field disorders, the directives historically have been very strict[12-13], such that homonymous hemianopia (HH)—loss of one hemi-field—was an absolute excluding factor. (Homonymous visual field disorders represent the most frequent visual deficits after posterior brain injury[14]. In 1974, a man was described with right-sided HH[15]. The handicap was investigated with a simulation experiment in the laboratory and with a real traffic task in a instrumented car. The conclusion was drawn that he showed great compensation for his defect. Until the disorder was detected, he drove about 250.000 km yearly without any accidents! In order to instigate a change in the European and national directives, research by the CBR was started amongst 63 persons with serious visual field defects (in particular HH). The procedure was to test the visual field carefully, and in this way 5 to 10° sparing of the macular field on the hemianopic side often was found. Furthermore, applicants were checked for any concomitant disorders (e.g., in neurophthalmic cases by a neurologist). If not, they had to undergo a practical driving test, usually in their own car on a public road, for approximately one hour in different traffic conditions. Medical approval was given to people who thus had proven that they could function as an adequate driver[13,16-19]. The results were that the 2nd European directive (1991), implemented by all member states in 1996, offers more possibilities for drivers with field of vision disorders—a success for The Netherlands and Belgium, who advocated this. The revised directive stipulates for drivers of passenger cars:
'Driving licences shall not be issued or renewed if, during the medical examination, it is shown that the horizontal field of vision is less than 120°, apart from exceptional cases duly justified by a favourable medical opinion and a positive practical test'. In the Netherlands there now are over 300 drivers with right- or left-sided HH. It does not seem to matter on which side the HH occurs, given the fact that in The Netherlands drivers have to give priority to traffic from the right on an equal road crossing and that with right-hand driving one has to scan oncoming traffic on the left side when overtaking a car. With adequate compensation mechanisms, including more scanning eye and head movements, these persons drive as well as most other drivers[12].

It is clear that by means of above mentioned assessment of fitness to drive in daily traffic and the car adaptations which are sometimes extensive, not only may the physical disorder

be compensated , but the joy of living that accompanies this enlargement of the radius of action can scarcely be expressed.

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