The psychomotor performance

The psychomotor performance is an essential variable with respect to the risk of having an accident, particularly while steering a motor vehicle. The particular kinds of psychomotor functions dealt with in this context are mostly controlled well coordinated movements which are executed after having perceived simple and complex stimulus configurations. Attention and perception are important prerequisites.

With regard to the content as well as with regard to the measurement technique studies hitherto have secured the following dimensions with factoranalytical techniques (Pawlik, 1971):

Simple attention

In the simple attention task as measured by the attention testing apparatus designed by A. Müller temporarily illuminated squares must be detected among various other patterns (Fig. 1).
Divided attention

When, in addition to the just mentioned illuminated squares, a second task demands attention, we speak of *divided attention*. In this attention testing apparatus *colour sequences* must be observed. Out of various sequences the *target triplet blue-yellow-red* must be detected and attended to with a button press.

Simple and complex reaction time

The reaction time deserves our attention in two ways:

- as a simple reaction to a tone stimulus
- as a conditional reaction, e.g. to a specific combination of tones and lights

Gestalt perception

The constructs of speed of closure, speed of perception and flexibility of closure form a further cluster of secured variables. Such aspects are operationalized e.g. with *Cattell’s speed of perception test, the Gottschaldt figures, or the presentation of traffic situations* in which suitable decisions must be taken (Fig. 2).
Related are ambiguous figures oscillating in our perception. The results are indicators of CNS activation (arousal).

Psychomotor coordination

The psychomotor functions require basically a functioning attention and perception. The *psychomotor coordination* is made up of several components:

- *Simple versus complex coordination*. The latter is contained e.g. in the steering of hand-, arm-, and foot-movements which are necessary to react to visual stimuli, and also to some extent to acoustic stimuli (Fig. 3).

- The eye-hand-coordination in combination with speed of reaction, steering ability, and speed of correction (Fig. 4).
It should have become apparent that these variables measuring psychomotor performance are the same variables as the ones being affected by CNS agents.

**Effects of CNS agents on psychomotor performance**

I will limit myself to the three main families of drugs used in psychiatry:

- the minor tranquilizers,
- the antidepressants, and
- the neuroleptics also known as 'major tranquilizers'

**Minor tranquilizers**

The minor tranquilizers show 3 main effects:

- anxiolytic
- hypnotic
- sedative-anticonvulsive or muscle relaxing
Due to these effects tranquilizers are also called anxiolytics and sedatives.

From this spectrum of effects it becomes clear that beyond a certain dose the cognitive-psychomotor performance of healthy subjects will be impaired. However, studies with healthy subjects show that:

- at a low dose few 'relevant' negative side-effects' are observable (Fig. 5),

**benzodiazepines and psychomotor performance**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>bromazepam 3 mg</td>
<td>hardly any</td>
</tr>
<tr>
<td>diazepam 2 - 5 mg</td>
<td>&quot;relevant&quot;</td>
</tr>
<tr>
<td>chlordiazepoxid 10 mg</td>
<td>impairment</td>
</tr>
</tbody>
</table>

- those 'minor tranquilizers' with predominantly hypnotic-sedative effect impair performance more than those with predominantly anxiolytic effect.

Detailed indications were observed recently in a study at our institute (Gerhard, Hobi, Kocher, Koenig, 1991). The relaxing effect of a single oral dose of the phytopharmacon Valverde relaxation dragees was examined in a single dose double-blind trial against 3 mg bromazepam and placebo in groups of 20 healthy male volunteers for each treatment. (Valverde is an extract of four plants: valerian, balm, passion-flower, and pestilence, all of which have a reputation of being tranquilizing agents with spasmyolytic effect.) We expected that the relaxing-tranquilizing effect of bromazepam as well as of Valverde would be perceived subjectively. A potentially existing impairment of performance due to Valverde was assumed to be milder than an impairment due to bromazepam.
However, the extended and sophisticated test-battery could not detect any impairment in performance for either of the two drugs in comparison to placebo. Only the effect of the fatiguing three hour testing could be observed in the subjective well-being - a reduction of vitality and vigilance - for all three groups alike. Both verum groups showed an additional reduction of anxiety and arousal. The results are in agreement with the ones obtained by Saario (1976) who detected decrements in performance only beyond 6mg bromazepam. Other authors - and this should not be withheld - even observed that under these doses autonomously labile and emotionally irritated persons show an improved performance (Austin and Lettieri, 1976; Janke, 1964; Clyde, 1981; Hobi, 1985). This means that observations gained from healthy subjects cannot be transferred linearly to patients who, for medical reasons, are prescribed such drugs at low to medium dose for a limited period of time.

In this context I would like to point at a study which in no way was able to substantiate the often heard deficits of concentration and memory after surgery and anesthesia (Dierks-Ventling, Gerhard, Hobi, 1989). Inspite of the routine gamut of medication before, during and after surgery, the 27 patients merely showed in the subjective mood a weak post-surgery hint of difficulties in concentration and memory. An experimental metric objectivation of a corresponding behavioral impairment failed, again inspite of an extended test-battery (Fig. 6).

<table>
<thead>
<tr>
<th>medication (N = 27)</th>
</tr>
</thead>
</table>
| **before surgery:** midazolam 15 mg  
diazepam 5 - 10 mg |
| **during surgery:** a.o.  
initially { thiopentale 200 - 250 mg  
alcuronium 10 mg }  
continuously halothane or enflurane  
at the end { atropine  
neostigmine } |
| **after surgery:** individually { flurazepam  
mefenamine acid  
paracetamol } |

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I included this example to highlight the complexity of the problem. No doubt that unequivocal temporary decline in cognitive-psychomotor performance can be observed in healthy subjects treated with 5 mg diazepam, 6 mg bromazepam or higher dose. The same holds true for hypnotics with a long half-life like e.g. nitrazepam in the sense of a hang-over the next morning. Also, I believe it is important to emphasize that in single cases, after the use of benzodiazepines (diazepam and flunitrazepam), massive situational losses of memory and psychomotor functions have been described. I refer to the respective studies and overviews (Fig. 7). They confirm that a denial of potential harm would not be appropriate. Nevertheless we need a differentiated appraisal, that is a complex, individual appraisal which takes into account all these situational and personality factors.

<table>
<thead>
<tr>
<th>STUDIES</th>
</tr>
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<tbody>
<tr>
<td>Saario, 1976</td>
</tr>
<tr>
<td>Hobi &amp; Kielholz, 1981</td>
</tr>
<tr>
<td>Harrison et al., 1986</td>
</tr>
<tr>
<td>Volkerts et al., 1987</td>
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<tr>
<th>OVERVIEWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>O'Hanlon &amp; de Gier, 1986</td>
</tr>
<tr>
<td>Hobi, 1992</td>
</tr>
</tbody>
</table>

Antidepressants

The aspect of the interaction between medication and illness has to be emphasized for this pharmacological category even more than for minor tranquilizers. The antidepressants have the following main effects (Fig. 8):
main effects of antidepressants

**motor activation:**
e.g. desimipramine

**brightening of mood:**
e.g. imipramine

**motor inhibition:**
e.g. amitriptyline

Studies with healthy subjects show these effects also with respect to cognitive-psychomotor performance (Fig. 9).

ANTIDEPRESSANTS AND THEIR EFFECT ON PSYCHOMOTOR FUNCTIONS OR VARIABLES OF FITNESS FOR DRIVING IN HEALTHY SUBJECTS

It can be seen that strongly sedating substances show a clearly stronger impairment than mood-brightening and activating compounds. But even with
amitriptyline, whose sedative effect has been shown repeatedly by several studies, the sedation - after an initial phase - increasingly gives way to a mood-brightening effect.

On the other hand, patients treated with these compounds show the following deficits (Fig. 10):

**psychopathological dimensions of depression**

<table>
<thead>
<tr>
<th>emotion:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ inner vacancy</td>
</tr>
<tr>
<td>▶ low-spirited</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cognition:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ negative cognitive schemata</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>motor functions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ retarded / agitated</td>
</tr>
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</table>

However, it is a fact, that properly administered antidepressants on patients can improve the cognitive-psychomotor performance to an extent that the patients, even on a relatively high dose, reach a sufficient psychomotor fitness. And this *not in spite of* but *because of* the antidepressant therapy which is therefore considered a *conditio sine qua non*.

**Neuroleptics**

The main effect of neuroleptics is clearly *anti-psychotic*, e.g. of haloperidol or pimozide. Possibly, as side-effects, sedation and sleep-induction should be named, e.g. with fluanison, floropipamide, and chlorpromazine.

Wherever studies on healthy subjects are made, it is necessary to use a low dosage. However, a dosage that is unrealistically low for the treatment of schizophrenia, as a rule shows impairments of the psychomotor functions. This is particularly true in the case of sedative neuroleptics.
The basic symptomatology of schizophrenia makes it evident that cognitive-psychomotor deficits are inherent in the acute phases, as part of the illness. Some of these impairing psychopathological symptoms are listed on the next slide (Fig. 11).

**psychopathological dimensions**

(a.o. in schizophrenia)

<table>
<thead>
<tr>
<th>formal thought disorders:</th>
</tr>
</thead>
<tbody>
<tr>
<td>► absent-mindedness</td>
</tr>
<tr>
<td>► inhibition of thinking</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>delusional mood:</th>
</tr>
</thead>
<tbody>
<tr>
<td>► subjectivistic interpretation</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>affect:</th>
</tr>
</thead>
<tbody>
<tr>
<td>► ambivalence</td>
</tr>
<tr>
<td>► ambitendency</td>
</tr>
</tbody>
</table>

After the fading of the acute phase, the basic or underlying symptoms of schizophrenia deserve closer attention. They do not respond to neuroleptic treatment as well as the more spectacular symptoms. Therefore both the individual course and the cognitive-psychomotor fitness need to be assessed in each patient anew and repeatedly during the duration of the illness.

**Summary**

Using CNS-active substances we can draw the following conclusions:

- depending on their dosage and their action-spectrum psychopharmaca can measurably impair psychomotor performance.

- depending on dose and personality even a positive effect - an improvement of psychomotor performance - can be seen at times.
• in this complex field we should arrive at judgements only after multidimensional and multimethod assessments. The compound and its effect is only one dimension; the psychomotor functions are another. Further important interacting aspects to be included are dimensions like state and trait components of personality, biosignals in the context of the activation or arousal state. Only with such an expansion of the approach can we expect to arrive at conclusions suiting the individual patient. This holds particularly true when in a single case the more complex appraisal of the driving ability is at stake. The psychomotor abilities are only one aspect, one part of a triad: medication, personality, and driving ability (Fig. 12).

To end a citation by Nelson et al, 1987, p. 227:

"... important was the finding that drug treated psychic distress was not a significant risk factor. A net beneficial effect from the drug therapy is a plausible explanation for this finding."
References


Pawlik, K. (1971) Dimension der Verhaltens, Bern, Huber Verlag