Bottom-up rehabilitation in schizophrenia
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2. Information processing and schizophrenia.

2.1 Introduction.

The process of rehabilitation includes skills training and education. In order to optimize the results of training, rehabilitation methodology should take into account disabilities as far as they are permanent and impede the learning of skills. In schizophrenia, vulnerability is most frequently expressed in terms of cognitive disturbances. In this chapter the general process of information processing during skills acquisition and cognitive disturbances in schizophrenia are discussed to serve as a theoretical basis for the rehabilitation methodology as formulated in the next chapter.

2.2 A cognitive model for skills acquisition.

Anderson's (1983) model of human cognition provides a general theoretical framework for stagebound skills acquisition. According to this model, learning skills is a process in which, through practice and training, a gradual transition takes place from controlled declarative knowledge to a 'production system' with automatized procedural knowledge. A production system is a programmed, hierarchically organized step-by-step plan which precisely establishes under which conditions the skill can be applied successfully, and according to which successive steps it can be carried out.

Production systems have direct control over behaviour. Therefore, they must be composed gradually and with great care. Any skill performance reflects the functioning of a production system, and a new production system must be established if new skill acquisition is to occur. Only when a new programme is repeatedly effective does it influence behaviour directly. Until then, the available programmes of the repertoire will be used.

Production systems are developed in three successive learning stages. The stages that comprise this learning process are schematically given in figure 2.1.

The first stage in Anderson's model is the declarative stage. At this point no effective production system has been formed for executing a specific task. A task may only be carried out in the presence of external declarative information, which can be used as a guide. So, in this phase the individual is totally dependent on external sources to supply the necessary information describing the behavioural steps involved in performing the skill. At this stage the existing production systems may be employed. However, these are often inadequate for performing the new task. The declarative stage puts an enormous load on the working memory, which is a memory structure in which new information is stored and analyzed, or where old, already formed production systems are activated. Information processing at this stage is totally controlled, requires subjective attention and information processing capacity and it is therefore very strenuous.

Skill performance becomes automatic in the second phase of the learning process, knowledge compilation. As a task is successfully carried out a number of times with the aid of declarative information, the manner in which it is executed is stored in a programme. This process is called proceduralization. After a skill has been proceduralized in a
programme, steps formerly guided by declarative information are linked together. This eliminates the need for external step by step instruction, making capacity available in the working memory and making it possible to execute the task faster. This is called composition. Proceduralization and composition are achieved through repetition of the skill. Due to knowledge compilation the working memory is unloaded, thereby reducing the mental effort required to carry out the skill. Also the chance that old, ineffective production systems will be used is reduced as the gradual transition to internal structure of the new production system takes place.

Figure 2.1: Stages of the learning process (Anderson, 1983).

At the third stage of the learning process, production tuning, the procedural programme is transformed into a definitive automatized production system. Learning is focused on the larger context in which the skill will be used. As there are many ways of carrying out a given skill, the context will determine the correct procedure. Generalization and discrimination are essential in this phase. Generalization brings about a gradual transition from specific skills to general skills with a greater range of application. Conditions for the application of a skill are less strictly formulated and coupled with the specific situation for which the skill has originally been developed. This enables the application of the skill in various situations. Discrimination learning enables the person to identify those situations in which a skill is appropriate for performance. It limits the range
of application of a skill in order to preclude failure. 'Whether' the application of a skill will or will not be successful is precisely stored by this learning mechanism. Discrimination and generalization are only possible if the knowledge about the result of various applications is accumulated by feedback. The feedback mechanism hierarchically structures the diversity of production systems for the performance of skills, which are represented in the memory, by facilitating the application of those skills that have the greatest chance of success, and by inhibiting the application of faulty production systems. Positive reinforcement increases the 'strength' of a production system, facilitating its application. Punishment (the application of aversive stimuli after skill performance) diminishes the 'strength' of a system, inhibiting its application. Reinforcement and punishment can be given by internal and external sources of feedback. Internal feedback is related to one's own values and norms and is for example given by means of self-talk. External feedback is related to judgements and opinions from outside and is for example given by the trainer.

Anderson's model is a stage model of information processing. It emphasizes a sequential series of processing stages in which the output from one stage is fed to a subsequent stage for further processing. The information becomes more automatized with each step. Such a model leads to a search for the lowest dysfunctional stage of processing. An assumption is that a defect at an early stage has a pervasive character because it can disrupt processing at later stages (Saccuzzo & Braff, 1981). Therefore, according to a stage model, rehabilitation aimed at the restoration of general functioning, should take into account cognitive disturbances which can possibly impede the learning process. In the next section, cognitive disturbances which are manifest in schizophrenia are identified and related to Anderson's model.

In schizophrenia cognitive disturbances are related to the stage of the illness and are dependent on individual characteristics (Van den Bosch, 1994). Considering that the present study deals with chronic patients who mainly suffer from negative symptoms and are indicated for long stay wards, the focus will be on cognitive disturbances found in this group of patients.

2.3 Cognitive disturbances in chronic schizophrenia.

Shiffrin and Schneider (1977) distinguished between automatic and controlled information processing, the first being fast and requiring little capacity, the second being strenuous and requiring subjective attention and therefore more capacity. In everyday life, complex controlled information processing, for example driving skills, can be automatized by practice. The more automatized a skill becomes the less mental effort it requires. In general the idea on energetical insufficiency as an important disturbance in schizophrenia is very popular today. This idea fits Anderson's model in which gradual automatization of production systems to effectively perform a skill, is the central concept.

In chronic schizophrenia cognitive disturbances are mainly found in controlled processing and to a lesser degree in automatic processing of information (e.g. Nuechterlein & Dawson, 1984b; Saccuzzo, 1986). Thus, most disturbances are expected to be found at the declarative stage of Anderson's model. As stated before, information processing in this stage is controlled and requires strenuous information processing. Slow processing of information and limited channel capacity of sensory storage has often been found in
Schizophrenic patients (e.g. Saccuzzo, 1986; Harvey, 1987). This appears to be especially the case in chronic schizophrenic patients and in schizophrenic patients who already had a schizotypical personality before onset of the illness. Some authors (e.g. Saccuzzo & Braff, 1986) consider limited information processing capacity to be a vulnerability marker in schizophrenia.

Since controlled information processing is a prerequisite to skills acquisition, attention is a first necessity to develop a new production system. To select the right declarative information, the focus of attention should be on the right source. In order to complete the skill it is also necessary to sustain attention. Some authors suppose that disturbances in sustained attention represent a stable vulnerability indicator (e.g. Nuechterlein et al., 1990). Schizophrenics tend to fail to respond to target stimuli during a sustained attention task (e.g. Cornblatt et al., 1988; 1989). Remitted patients, as well as a quarter of the children born to schizophrenic mothers show disturbances in sustained attention (Erlenmeyer-Kimling & Cornblatt, 1978). Besides disturbances in sustained attention, disturbances are also found in the capacity of attention (Nuechterlein et al., 1990) and in the selectivity of attention (Abramczyk et al., 1983). Selectivity of attention is the ability to focus on one source of information and to actively inhibit responses to information from other sources.

Perception of the right external declarative information is also necessary in order to develop a production system. Concerning perception, organization, categorizing and arrangement of interpersonal and emotional expression, in schizophrenia disturbances are found in the 'gestalt formation' of impressions (e.g. Wells & Leventhal, 1984; Van der Gaag & Haenen, 1990). Reich and Cutting (1982) found schizophrenic patients to use a bottom-up strategy of perception; the observation starts with details and matter-of-facts and ends with a theme. In contrast, normals use a top-down strategy, starting with a theme and verifying this with evidence from details.

Concerning auditory perception, disturbances are found in localizing the origin of sounds (Balogh & Leventhal, 1982), the use of syntax (Gerver, 1967) and identification of the tone of voice and the emotion expressed in it (Bazhin et al., 1978).

Remembering the declarative information or recalling already existing production systems is essential for the next stages of the learning process. In schizophrenia recognition memory is intact, but recall memory is deficient (Goldberg et al., 1989). Also deficient recency and primacy effects are found (Manschreck et al., 1991).

Disturbances at the declarative stage may hinder the further development of production systems. Therefore, disturbances in the phase of knowledge compilation are associated with the disturbances mentioned above. Schmand (1991) found that lack of mental effort or energetical dysfunctions measured by time on task effects are associated with disturbances in procedural learning.

As stated before, concerning generalization and discrimination it is well known that patients with schizophrenia, and to some extent other psychiatric patients, have great difficulty in performing new appropriate skills outside the context in which they were learned. In Anderson's model, generalization failures result from faulty or incomplete knowledge compilation. It is possible that at the declarative stage the learning process has been partially or totally interrupted by overloading the working memory, and receives insufficient or no continuation. Environmental cues which would normally be signals to perform the skill are not compiled, so those cues do not produce automatic task
performance. The range of application of a (possibly) effective skill is then limited, and specific cues to the training environment may be compiled, so only those cues develop automatic control over performance. Similarly, compilation of inappropriate cues limits discrimination. When discriminating cues are absent or inappropriate, the individual has not fully learned 'when' 'what' must be done. When faced with a choice of various ways to carry out a task, he uses a 'trial and error' approach and skill performance may seem to occur randomly. Also, disturbed social perception can lead to incorrect behaviour characteristics being selected for the judgement of behaviour. This can, in turn, lead to serious impediments in learning skills (Cowan et al., 1989; Corrigan & Green, 1993).

Disturbances in discrimination also limit the possibilities for improving skills through the use of feedback which is essential in the last learning phase. This may lead to perseverations, which is found to be a common disturbance in schizophrenia (Franke et al., 1992).

In summary, in schizophrenia, cognitive disturbances can be identified in every stage of Anderson's model, but especially at the declarative stage. Disturbances at this stage of controlled and strenuous information processing, contribute to disturbances in knowledge compilation and production tuning and may impede the process of skills acquisition and consequently may limit general behaviour. In order to determine whether cognitive disturbances do affect everyday life of schizophrenic patients, the association of cognitive disturbances and symptoms will be described in the next section.

2.4 Cognitive disturbances and symptoms.

To identify the specificity of cognitive disturbances in schizophrenia the association to symptoms has been investigated many times. Many studies show a correlation between negative symptoms and cognitive disturbances (e.g. Andreasen et al., 1990; Schmand, 1991). However, reduced information processing capacity is not specific for schizophrenia. A reduced processing capacity was also found in manic patients (Strauss et al., 1987). Also, the phenomenon of abnormalities in controlled processing and in a lesser degree in automatic processing, is not specific for schizophrenia as it was also found in major depression (Tariot & Weingartner, 1986) and dementia (Jorm, 1986).

Recently, factor analysis of symptoms of schizophrenia repeatedly resulted in three symptom factors (e.g. Buchanan & Carpenter, 1994); (1) reality distortion, including hallucinations and delusions, (2) disorganisation including inappropriate affect, poverty of content of speech, incoherence of speech, thought disorder and bizarre behaviour and (3) psychomotor poverty including poverty of speech, anhedonia and affective flattening. The first factor has no association with cognitive disturbances, the third factor is associated with disturbances which are characterized by reduced processing speed and capacity and the second factor is most strongly related to disturbances, especially distractibility and poor performance on the language, memory, attentional and planning functions.

Given this state of affairs, it may be concluded that cognitive disturbances are related to the quality of life of schizophrenic patients. Illustrative supports for this conclusion, are the findings that social perception explains more variance of global competence than symptoms do (Appelo et al., 1992), and the fact that memory problems are related to global levels of functioning (Goldberg et al., 1993). However, this and other
data are primarily correlational and do not demonstrate a causal relationship between cognitive disturbances, symptoms and poor behaviour. Still, it is widely assumed that these disturbances are at least in part responsible for the profound disruptions in general social behaviour and role functioning that typify (at least a subgroup of) patients with schizophrenia (Bellack, 1992). Consequently, to accomplish skills acquisition, rehabilitation methodology should at least take these disturbances into account. For this reason, before shifting the focus to the question in chapter 4 whether cognitive disturbances can be remediated, such a methodology will be formulated in the following chapter.