CHAPTER 2
Cognitive Impairments in Schizophrenia

1.1 Cognitive Impairments in Schizophrenia: Empirical Perspective

Schizophrenia is nowadays viewed as a general cognitive disorder characterised by relatively stable cognitive impairments (e.g. Rund, 1998; Green & Nuechterlein, 1999). Cognitive impairments are a prominent and very disabling aspect of schizophrenia; in only 20-30% performance on neuropsychological assessment is entirely within the normal range (Holthausen et al; 2002 Harvey & Keefe, 1997). It should be noted here that “normal performance” does not mean that patients do not demonstrate cognitive limitations as compared to their pre-morbid levels of functioning. It may be that these “cognitive clean” patients had very good cognitive functions before onset of the disease. Then, even in the case of considerable deterioration, performance will still fall in the normal range. Moreover, these patients may compensate for their cognitive impairments with higher general intellectual abilities (Holthausen et al., 2002).

Schizophrenia is characterised by a very heterogeneous expression. Neuropsychologists who work with people with schizophrenia know that this is particularly true for the cognitive limitations that accompany the disease. The literature on cognitive functioning in schizophrenia has been reviewed in several papers (e.g. Heinrichs & Zakzanis, 1998, Rund, 1998). Limitations in multiple cognitive domains were found (see paragraph 2.1.1-2.1.8). Although performance from person to person varies strongly, at a group level schizophrenia has a modal profile, that is: characteristic limitations across domains exist (Green, 2006). Studies suggest that some limitations are more severe or more pervasive than others. There is evidence that verbal memory and learning (Saykin et al., 1991) are particularly impaired. Others suggest that limitations in working memory capacity (Goldman-Rakic, 1994) underlie other cognitive deficits. However, no particular cognitive impairment is
unique or specific to schizophrenia (Robbins, 2005). Cognitive impairments appear to be already present at the onset of the illness (Hoff et al., 1999; Bilder et al., 2000) and also in non-psychotic siblings of patients with schizophrenia (Green, 2006). Presumably, the range of cognitive performance in schizophrenia is comparable to the variance within the normal population, while the distribution of patients had shifted downwards. This has been demonstrated with regard to IQ-scores (David et al., 1997).

Cognitive performance remains stable in case of medication changes (Cannon et al., 1994) and cognitive limitations are present in drug-naive first episode patients (Saykin et al., 1994). Thus, cognitive limitations are certainly not just an adverse effect of medication. Some atypical anti-psychotic agents may even produce a mild improvement in cognitive functioning (Woodward et al., 2005).

Three categories of cognitive impairments can be distinguished in schizophrenia (Wykes & Van der Gaag, 2001). Trait deficits are present before the outbreak of schizophrenia and do not (or only mildly) become aggravated during the course of schizophrenia. These deficits are also present in individuals at genetic risk for schizophrenia. Transient state-dependent deficits are strongly associated with symptoms according to DSM IV criteria. Finally, acquired deficits are mildly present before the first episode but aggravate into severe cognitive deficit in the months before and during the first episode and remain subsequently stable after psychosis.

During the past two decades, cognitive limitations have been a very ‘hot topic’ in schizophrenia research. Many attempts have been made to understand the aetiology of schizophrenia from a general cognitive perspective or to predict activity limitations or participation restrictions in daily life from impairments. The increasing interest in cognitive impairments has caused an enormous growth of, in many cases experimental, assessment instruments. Most often neuropsychological tests developed to assess cognitive performance in patients with acquired brain injury or other neurological conditions were adopted, while some test or paradigms were developed to assess people with schizophrenia. Consistency in tests over studies is often lacking. Although performance on various neuropsychological tests of a certain cognitive domain reveal information about the same underlying cognitive function, it is hard to compare the exact extent of a specific impairment when different tests are used. This widespread methodological problem makes the comparison of the results of studies in this area a difficult operation.

Given the enormous amount of literature on cognitive functioning in schizophrenia, it is far beyond the scope of this thesis to provide an extensive overview here. Instead, the cognitive domains that are affected by schizophrenia and the most frequently used neuropsychological measures will be discussed. A
factor structure of cognitive tests in schizophrenia was provided by the MATRICS committee, a group of prominent neuropsychologists that addresses obstacles that are likely to interfere with the development of pharmacological agents for treating cognition in schizophrenia (Geyer & Heinssen, 2005). As a first step in this process, the MATRICS Neurocognition Committee has identified eight key cognitive domains that represent fundamental dimensions of cognitive deficit in schizophrenia: speed of processing, attention/vigilance, working memory, verbal learning, visual learning, reasoning and problem solving, verbal comprehension, and social cognition. The first seven cognitive domains were derived from thirteen factor analytic studies, and were based on an evaluation of the empirical literature on cognitive performance in patients with schizophrenia (Nuechterlein et al., 2004). Although the emergence of social cognition in schizophrenia research is too recent to have representative measures in factor-analytic studies, this domain was included as a separable domain, also because of the growing body of studies that show impairments in patients with schizophrenia and because of its relevance for clinical trials (Nuechterlein et al., 2005). These cognitive factors represent consensus in the field and are therefore presented as a summary of the literature on cognitive domains that are affected by schizophrenia.

Before the cognitive factors separately are discussed, it is stressed here that—in particular from a clinical viewing point—it is hard to maintain that cognitive domains in schizophrenia are independent and uncorrelated factors. The MATRICS Neurocognition Committee has chosen a pragmatic approach to this problem, as they observe that a clear majority of exploratory factor analytic studies found that cognitive performance variations in schizophrenia were best accounted for by multiple independent or weakly correlated factors. A pitfall of the presentation of cognitive functions as independent domains should be mentioned here: an empirical approach towards cognitive functioning in schizophrenia may easily contribute to a misunderstanding that is widespread in psychiatric research. That is: a test score is often directly and mistakenly related to a function. Walsh stated in 1987: ‘there is a danger in assuming that if a patient fails on a test then the patient has a deficiency in the psychological function stated by the manual to be what a test measures’. According to Keefe (1995) too many researchers in the field of schizophrenia base their research on this assumption, as most studies do not take into account the contribution of elementary and control processes in complex task performance.

Thus, the factors presented by the MATRICS committee represent tests that can be grouped together and not the underlying cognitive functions. Furthermore, the measures that were used in the factor-analyses depends on the preferences of the research teams, they are not necessarily a reflection of the entire range of cognitive
limitations in schizophrenia or the entire range of cognitive tests. The reader should bear this in mind while reading the following paragraphs.

In paragraphs 2.1.1 - 2.1.7 a brief description of the cognitive factors and tests that load on each factor are described. Paragraph 2.1.8 is an exception; this paragraph also encompasses tests that were not described by the MATRICS committee. This is because social cognition was not represented by a factor in the MATRICS study and therefore measures that load on this factor cannot be presented. Therefore in this paragraph a referral will be made to Chapter 3 which includes a review of the literature on tests of social cognition in schizophrenia.

2.1.1 Speed of Processing
Psychomotor slowing is observed frequently in people with schizophrenia. The ‘speed’ factor is measured by relatively simple tasks, often involving perceptual and motor components, and always emphasizing the speed of performance. Typical measures of psychomotor speed that are often used in schizophrenia research and assessment are Trail Making A and B, Digit symbol, Stroop, and Fluency (Nuechterlein et al., 2004).

2.1.2 Attention/vigilance
Individuals with schizophrenia are thought to be hyperdistractable or to lack an attentional filter (Robbins, 2005, Heinrichs & Zakzanis, 1998). According to the latter authors impairments in sustained attention, or the ability to direct and focus cognitive activity on specific stimuli, have been often reported in schizophrenia: people with schizophrenia perform poorly at the detection of a target stimulus over a prolonged period of time. Moreover, selective attention, or the ability to focus on a specific aspect of a scene while ignoring other aspects, and divided attention, or the ability to attend more than one stimuli at a time, are also impaired in schizophrenia (Robbins, 2005; Hagh-Shenas et al., 2002).

The most prominent test loading on this factor are derived from the Continuous Performance Test (CPT). The Continuous Performance Test was originally developed by Rosvold et al. (1956) and was later refined for assessment of individuals with schizophrenia by Cornblatt and Keilp (1988). Other tasks loading on this factor are dichotic listening tasks (shadowing one’s own voice), the forced Span of Apprehension task (target detection in a array of targets), and a Backward Masking task (target identification in early perceptual processing) (Nuechterlein et al, 2004).
2.1.3 Working Memory

Working memory is viewed as as a system for keeping representations of objects and words temporarily in consciousness, also involving mental manipulations of this information. Impairments in working memory are a robust finding in schizophrenia (e.g. Goldman-Rakic, 1994). A related concept is prospective memory which concerns the ability to remember to perform planned actions in the future/ to keep information online over a longer period of time. Also prospective memory is impaired in schizophrenia: patients perform worse than controls on tasks involving on time-, place-, and event-related verbal memory (Shum et al., 2004).

Tests loading on the Working Memory factor are the subtests Arithmetic, Digit Span, Letter-Number Sequencing, and Mental Control of the WAIS and WMS. Other tasks that load on the working memory factor are n-back tasks and spatial working memory tasks (Nuechterlein et al., 2004).

2.1.4 Verbal learning

Verbal learning can be divided into three separate phases: encoding (the ability to store new information, retention (the ability to consolidate information), and retrieval/ recognition (the ability to remember information after a delay). Verbal learning deficits are a consistent and stable finding in schizophrenia research. Especially encoding and free recall of verbal material are impaired, while recognition and cued recall are relatively spared (Aleman et al., 1999).

Typical measures loading on a verbal learning factor are immediate and delayed recall of word lists that exceed working memory capacity (e.g. Rey Auditory Verbal Learning Test, California Verbal Learning Test, and the 15 Words Test in the Netherlands) and immediate and delayed recall of paragraph-length story information (e.g. WSM III Logical memory I and II). Other less familiar tasks that load on this factor are paired associate learning and recall of digit sequences (Nuechterlein et al., 2004).

2.1.5 Visual learning

Impairment in non-verbal learning in schizophrenia is found to be comparable in magnitude to verbal memory impairment (Aleman, 1999), although the deficit appears to be less robust than verbal memory deficits across studies (Heinrichs & Zakzanis, 1998).

Visual learning is typically measured by tests assessing the immediate and delayed recognition of faces, immediate and delayed recall of family scenes memory for non-familiar figures and reproduction of line drawings (Nuechterlein et al., 2004).
2.1.6 Reasoning and Problem Solving
Planning is consistently impaired in schizophrenia (Heinrichs and Zakzanis, 1998). Cognitive tests loading on this factor are sorting cards by an abstract principle (Wisconsin Card Sorting Test), nonverbal reasoning to complete a sequence of visual patterns (Matrix Reasoning) or to construct a visual pattern (Block Design), moving around disks between pegs in the smallest number of steps to achieve a specific order (Tower of London), and similar verbal and non-verbal problem solving tasks (Nuechterlein et al., 2004).

2.1.7 Verbal Comprehension
This factor encompasses general verbal ability and is found to reveal a stable impairment, largely independent of the course of schizophrenia. Examples of tests that load on this factor are the WAIS III subtests Vocabulary, Similarities, and Information (Nuechterlein et al., 2004).

2.1.8 Social Cognition
During the past years, social cognition has emerged as an important aspect of cognitive functioning in schizophrenia. This concept will be extensively discussed in Chapter 3.

2.2 Cognitive Impairments in Schizophrenia: a theoretical framework
Schizophrenia is a dynamic and heterogeneous disorder. The heterogeneity concerns the degree of the cognitive impairments as well as the pattern of performance (Shallice et al., 1991). Thus, to fully understand the cognitive impairments of an individual with schizophrenia, not only the degree but also the pattern of performance (or the cognitive profile) should be taken into account.

It is hard to disentangle the effects of impairments in different cognitive domains, as cognitive functions that emerge as separate factors appear to be interconnected closely in individual assessment. Activity limitations and participation restrictions in daily life can not easily be explained by separate cognitive factors, as aspects of cognitive functioning are closely intertwined and therefore the whole is often more than, or at least different from, the sum of its parts.

For example, memory cannot be entirely isolated from attention, as information that escapes attention will not be remembered. In working memory, the close association between attention and information is particularly prominent, as working memory is concerned with attention and co-ordination as well as with storage. A related example is the association between speed and memory. The subjective
organisation of material during the acquisition phase takes time. Slow processing in working memory will result in impaired encoding and subsequently in less efficient organisation of material. In its turn this will affect consolidation and retrieval (Van Zomeren and Brouwer, 1993).

The above examples quite well illustrate how difficult, if not impossible, it is to describe cognitive functions in terms of uncorrelated domains. This holds especially true when we try to understand and influence complex behaviour in daily life situations, where multiple cognitive functions are involved. To grasp the full range of impairments and its consequences for daily life in schizophrenia, we should stress the importance of the integrated character of cognitive functions, instead of describing them as separable factors. That is, although an empirical approach may be helpful as a summary of cognitive impairments in schizophrenia, cognitive dysfunctioning in a broader sense may be better understood in terms of a dynamic model of cognitive functioning that illustrates the interplay of cognitive functions that underlie complex behaviour. Furthermore, a cognitive model that reflects the interdependence of processes that underlie complex behaviour will help us better to choose targets for cognitive rehabilitation.

### 2.3 Cognitive models of schizophrenia

A number of a cognitive models of schizophrenia has been proposed during the past two decades. Usually, these cognitive models consider cognitive impairments as common pathway to schizophrenia. Consensus on which theory should be considered the “gold standard” is lacking. In the following paragraphs a number of dominant cognitive models of schizophrenia will be presented. First, two influential models that link specific cognitive impairments to symptoms of schizophrenia will be discussed briefly. Subsequently, we examine cognitive theories that link mental schema theory to schizophrenia.

#### 2.3.1 Frith (1992)

Christopher Frith (1992) links anomalous experiences in schizophrenia to impaired information processing. He has proposed a model that explains symptoms of schizophrenia from three types of cognitive impairments. According to Frith, an impairment in willed action underlies the behavioural signs of schizophrenia. Patients can perform routine actions elicited by environmental stimuli, but have difficulty in producing spontaneous behaviour. This leads to the negative symptoms of schizophrenia. The absence of willed behaviour will also lead to the repetition of recent actions (perseverations) and responses to irrelevant stimuli.
The second cognitive process is self-monitoring: in Frith’s view disrupted self-monitoring accounts for most of the positive symptoms of schizophrenia. In case of a willed movement, pre-reflective self-awareness includes a sense of agency (a sense of being the initiator of a movement, action or thought) and a sense of ownership (a sense that it is I who am experiencing the movement or thought). In case of an involuntary movement, there is a distinction between the sense of agency and the sense of ownership; the sense of agency is lacking. This is also the case in involuntary cognitive processes. A individual does acknowledge that he is the one who is thinking, but feels that the thought are not wilfully generated. In delusions of control, certain auditory hallucinations and thought insertion in schizophrenia a sense of agency is lacking. Finally, paranoid delusions and delusions of reference occur because the patient has made wrong inferences about intentions of other people. For example, patients with delusions of reference may believe incorrectly that others are trying to communicate with them.

2.3.2 Garety et al. (2007)
Garety et al. propose a cognitive model of psychosis that link the genotype of the disease to its phenotype by cognitive impairments. According to Garety a “biopsychosocial vulnerability” (e.g. genes, perinatal stress) renders an individual liable to the effects of stress on subcortical dopamine transmission. As dopamine plays a role in marking stimuli as relevant (Berrien & Roberton, 1998), hyperactivity of subcortical dopamine leads to a release of dopamine independent of cue and context. Thus, redundant stimuli may be perceived as very important to an individual. This perceptual distortion does not necessarily lead to a full-blown psychosis. Transition to psychosis is dependent on the subsequent appraisal of the experience (e.g. labelling voices as threatening and omnipotent or explaining the salience of stimuli in a delusional way) and the presence of negative affective reactions. Appraisal of disturbing experiences in the development of psychosis is influenced by specific cognitive styles. For example, people with psychosis tend to jump to conclusions, they gather less information than controls to draw a conclusion. Finally, psychosis will be maintained by a number of factors. First, negative schematic beliefs about the self and perceiving others as bad or threatening contribute to the persistence of a psychosis. Other factors that will play a role in the persistence are again appraisal and reasoning processes and also emotional reactions of the environment.

2.3.3 Schema theory
The models of Frith and Garety are very elegant conceptualisations of the link between cognitive impairments and symptom categories in schizophrenia. Unfortunately they
do not link cognitive impairments directly to activities in daily life. For this purpose
cognitive models of schizophrenia based on schema theory will be examined in the
remaining part of this Chapter.

For a full understanding of these models a general model of information
processing that is based on Neisser’s (1976) schema theory will be presented first.
According to the mental schema theory schema’s are specialised subsystems or
structure of knowledge stored in long-term memory that associate perception with
action and allow for rapid unconscious information processing. Schemata underlie all
aspects of human knowledge and skills, as daily routines are represented internally as
schemata (Reason, 1990). The model encompasses both stimulus-driven automatic
information processing and consciously controlled information processing. As it
links cognitive functioning to goal directed behaviour, it is helpful in understanding
cognitive impairments that hamper functioning in daily life.

The theory makes the assumption that perceptions and actions are specified by
a set of cognitive schemata that are triggered by contextual information. Additionally
it specifies how supervisory attentional control (executive functions) are involved in
the selection and adaptation of schemata.

Norman and Shallice distinguish three adaptive mechanisms that regulate the
use of schemata in response to both environmental and intrinsic triggers: Contention
Scheduling, Lateral Modulation, and the Supervisory Attentional System (SAS).
Contention Scheduling (CS) is an automatic conflict-solving process based on trigger
strength that is used when two competing schemas are activated at the same time. In
the case there is conflict between the actions specified by the schemas, the schema
triggered strongest is facilitated and the less strongly triggered one is inhibited.
Lateral Modulation (LM) concerns the influence of currently active schemata on the
concurrent and future trigger of other schemata by lateral inhibition of incompatible
and lateral facilitation of compatible schemata. CS and LM control routine or semi-
automatic actions, for example driving in experienced drivers.
The SAS is a mechanism involving conscious executive control, and has a directing
function and controls behaviour in non-routine or emotionly charged situations.
The SAS is needed when no well-learned schemata are available, for example when
learning how to drive a car or driving an unfamiliar route. SAS influences behaviour
indirectly by modulating the effects of CS and LS.

Brouwer (Brouwer and Schmidt, 2002) has elaborated on this model and made
more explicit several factors that are implicitly embedded in the original model:
motivation, knowledge of obtaining goals, effort, planning, and a monitoring system
that precedes the actual manipulation of schemata (see Figure 1)
Figure I  Brouwer’s elaboration of Norman and Shallice’s model

The upper part of the figure (above the line) represents control processes (SAC), while the lower part (below the line) represents automatic processes (Lateral Modulation and Contention Scheduling). Schemata are implicit memory structures containing behaviour codes that can be activated in response to environmental stimuli or in response to bodily sensations (e.g. hunger, gut feelings). The Monitor System refers to screening of the stimulus situation with regard to its emotional consequences and compatibility with current goals. When situations are well-known or expected, actions are routinely carried out by using the automatic processes below the line. When situations are as expected and are not arousing a strong emotion, actions are routinely carried out by the automatic processes below the line. When situations are unexpected and/ or arousing a strong emotion (gut feeling), conscious control of behaviour by the Supervisory Attentional System is activated. Thus, the monitoring system encompasses aspect of social cognition, by screening the (social) environment and the interpretation of the screened stimuli. Besides information from contextual cues, the Monitor also receives information about the motivational representation of goals, that is, information on knowledge of obtaining goals and the emotional value of these goals. Based on this information an estimation of the effort needed to plan and execute behaviour is made. The planning itself takes place after this estimation. Here, the declarative knowledge on how to obtain goals is used. This information is
stored in long-term declarative memory. The product of this planning process, or the actual plan, is stored and updated in working memory. The contents of the working memory consist of knowledge of a sequence of schemata necessary for the execution of a plan. Cues to activate certain schemata at certain points in time are stored in Working Memory. Cue selection is mediated by prospective memory.

Aspects of the model have been linked to anatomical structures (Brouwer & Schmidt, 2002). The orbitofrontal cortex is involved in self-monitoring, motivation can be linked to the anterior cingulate and ventromedial parts of the prefrontal cortex, and working memory and planning is associated with activation of the dorsolateral prefrontal cortex.

2.3.4 Schema-based theories of schizophrenia

Mental schema theory is a useful framework for understanding the association between cognitive impairments and goal-directed behavior in daily life. Mental schema theory has been elaborated in two theories of schizophrenia.

Hemsley (1993, 2005a, 2005b) connects mental schema theory with learning theory. According to Hemsley theory the influence of previously stored memories (the context) on the selection of mental schemata is weakened in schizophrenia. Normally, perception is guided by expectancies or “response biases” based on an interaction between presented stimuli and stored information of regularities in previous input.

However, Hemsley states that (2005a, p. 979): “The “schiz” or split in schizophrenia is between current sensory input and contextually appropriate stored material”. In other words, it is thought that a disturbance in the processing of context information is central to schizophrenia, and the rapid and unconscious anticipation of stimuli is impaired because of this disturbance. This will lead in turn to a failure to integrate stored material with current sensory input. To illustrate how subsequent stimuli are predicted on the basis of the context, Hemsley uses principles derived directly from learning theory. To make a prediction of information regarding the current motor program, stored information with regard to past regularities in the association of two stimuli (Stimulus-Stimulus association), and stored information with regard to past regularities in the association of past responses to subsequent stimuli events (Response-Stimulus associations) is used. Because the response bias that is normally caused by prior experience is diminished in schizophrenia, past regularities do not regulate/ determine performance as it does in healthy individuals.

Two important cognitive processes are supported by the operation of the context-module: working memory (keeping instructions online) and inhibitory
processing (inhibiting automated responses). Both processes are known to be impaired in schizophrenia. If there is a delay in stimulus presentation and response, the context module supports working memory to maintain information over time. In the case of response competition, the context can play an role in inhibiting redundant information.

According to Hemsley’s model context information can be processed in schizophrenia, but its rapid and automated processing is disturbed, this makes conscious control necessary. Indeed, people with schizophrenia profit less from contextual information in experimental tasks (eg. Da Silva & Hemsley, 1973; Servan-Schreiber et al., 1996), while they outperform healthy individuals in tasks were contextual information hampers performance (Hemsley, 2005b). Since the influence of the context is diminished, attention will be paid to irrelevant and incidental details. These details may be perceived as very important to the patient. The patients tries to understand why he pays attention to a stimulus; the cognitive explanation of the perceived significance of a stimulus is thought the be a feature of delusional thinking.

Another feature of delusional thinking, an abnormal view of the relationship between events, is also captured by Hemsley’s model. Because of the lack of contextual information, associations are made on the basis of one incidental observation. Reduced contextual influences may lead to the association of stimuli that incidentally co-occur and can thus be related to thought disorder in schizophrenia (Knight and Silverstein, 1998; Kuperberg et al., 1998), but may be also involved in the aetiology of hallucinations (Ward, et al., 1999) and negative symptoms (Hemsley, 2005a). The latter two theories are at a speculative stage and have not yet been empirically studied.

Van den Bosch (1995) argues in a similar vein that the influence of mental schemata (or “common sense”) is reduced in people with schizophrenia, because patients are unable to understand how other people feel or think, they do not hold the constant set of beliefs about the world as healthy individuals do, and their judgement about the likelihood of events is impaired. This leads to a failure of automatic information processing. Thus, pre-attentive contextual controls functions are disturbed during an acute psychotic state. Therefore, during a psychotic episode stimuli enter consciousness without information about the context. Irrelevant stimuli may be perceived as being very significant to an individual. A psychosis is operationally defined as a failure to use contextual information here. The contextual deficit leads to cognitive fragmentation and causes a subjective overload of information that may lead to the perceptual disorganisation, hallucinations and incoherence (cognitive disorganisation syndrome). Delusions can be understood as top-down compensatory
control mechanisms that are used to explain the subjective significance of a stimulus (reality distortion syndrome). This effortful cognitive processing causes an energetic deficit. Patients tend to cope with this lack of energetic resources by apathy and withdrawal: the negative symptoms of schizophrenia (psychomotor poverty syndrome).

2.3.5 Integrating cognitive theories of schizophrenia into Brouwer’s model: implications for daily life

Brouwer’s model based on the cognitive schema theory may also be helpful to link functional cognitive impairments in schizophrenia to impaired daily functioning. The model encompasses elements that have all been linked to maladaptive functioning in schizophrenia.

When working with people with schizophrenia as a clinician, one gets the impression that patients often behave in a way that does not contribute to or is even limiting achievement of their goals in daily life situations. At first sight, this seems hard to understand. Brouwer’s model may offer an explanation here. According to the model, several explanations arise for inadequate behaviour. First, a patient may not have goals at all. In other cases, goal-directed behaviour will be hampered because declarative knowledge on how to obtain a goal may be lacking or relevant schemata may not be present or inadequate. Also, Van Beilen (2004) stresses that goals may not have the emotional value they would normally have to begin with. Thus, in absence of a motivational representation of goals, the monitor does not pick up the right cues to react upon. Because people do not have their long-term goals ‘online’, the may pursue short-term satisfaction. Therefore, people with schizophrenia may react too much on irrelevant aspects of the context and these irrelevant aspects will trigger irrelevant or dysfunctional schemata. This may explain why patients sometimes seem motivated for a certain treatment and work very hard within the context of a consult (were external cues are clear and unambiguous), but do not actively use strategies they were thought in their daily life. Moreover, the capacity of working memory may be to small to keep cues that will activate schemata online. In this case, a patient seems to react on irrelevant aspects of the interval and external context of a situation. Alternatively, an individual may not be able to generate enough effort to achieve a goal.

Another explanation for the lack of goal-directed behaviour may be a defect in the monitor. This could lead to incorrect judgement of the motivational representation of the goals (Van Beilen; 2004) and the triggering of dysfunctional schemata. This makes sense because the ability to screen and interpret contextual cues, and in particular social ones, it is necessary to be able to make sense of other
people’s behaviour and relies thereby heavily on social cognitive processes. These do deteriorate in schizophrenia.

Finally, it might be that schema’s of individuals with schizophrenia itself are dysfunctional, because schizophrenia may prevent the development of relevant schemata. That is, patients the content of the schemata is not adequate and does not suit the demands of complex situations in daily life. They may, for example, not know how the behave in social situations, such as a birthday party. Normally, people are able to compensate for inadequate schemata by their using their cognitive functions. In particular aspects of executive functioning such as working memory or problem solving are useful then. Unfortunately, as functioning deteriorates in schizophrenia, most patients do not have such a buffer.

Van den Bosch and Hemsley link schizophrenia to impaired moment by moment integration of perceived stimuli with previously stored information. Hemsley’s model has been validated with a series of experiments (Hemsley, 1993) and a link with symptoms of schizophrenia has been hypothesized (Van den Bosch, 1995; Hemsely, 2005a). Typically, validation experimental task was done be administering experimental task in the diagnostic category of schizophrenia. The models do not explicitly link contextual fragmentation to goal-directed behavior in daily life. For this purpose, Hemsley’s and Van den Bosch’s model of schizophrenia can be integrated into Brouwer’s general model. Since connected previous knowledge with present stimuli is impaired in schizophrenia (this connection should be considered part of the monitor), patients will act on redundant environmental cues while salient stimuli may not be detected. This will obviously hamper schema selection and subsequently goal directed behavior in daily life. The above should primarily be considered a theoretic discussion of the model. To illustrate the use of the model for clinical purposes, a representative case study will be discussed.

**Case Peter**

*Peter is a 21-year old man, diagnosed with paranoid schizophrenia. He has experienced one psychotic episode. At this moment, psychotic symptoms are virtually absent, and residual cognitive impairments have become prominent. In particular, Peter suffers from executive impairments: the capacity of his working memory is limited. The same holds true for his problem solving abilities, although they fall within the normal range during structured assessment he fails in complex situations in daily life. Disorganisation is very pronounced in his conversation; his speech is incoherent and associative.*

*Peter has weekly appointments with a social worker, a psychiatrist, and a psychologist. Although he feels these appointments are very important, he very often*
misses them. Peter is a very creative person and likes to paint. Every Wednesday, patients have the opportunity to work under supervision of a professional painter and Peter is very motivated to attend this workshop. However, at Wednesday Peter is usually engaged in a number of activities, but not in painting. He only arrives at the study when someone else accompanies him. Once he arrives at the studio, he is very productive and makes beautiful paintings. Furthermore, Peter’s room is very messy and he is often not able to trace his belongings there. Although Peter repeatedly states he wants to clean his room, he only does so when a nurse prompts him. He enjoys the cleaning and is always very satisfied with the results.

The case of Peter illustrates how functional cognitive impairments that were linked to clinical symptoms by Hemsley (working memory and response inhibition) directly contribute to activity limitations and participation restrictions in daily life. Peter clearly has circumscribed goals and is motivated to accomplish them. Moreover, the schemata that are needed are present. However, it seems that Peter is unable to demonstrate goal-directed behaviour.

However, goals are ‘forgotten’ (that is, they do not guide behaviour) unless a very clear and unambiguous stimulus that is directly related to his goal (prompting by a nurse) is provided. Contextual information (e.g. it is Wednesday) is not used to perceive a stimuli (e.g. seeing on a clock that it is almost two: the start time of the workshop) as a salient cue for schema selection and subsequent response. This renders Peter is stimulus bound (that is, he reacts on random and irrelevant external stimuli, instead of goal-directed behaviour).

2.4 Summary and Conclusion

Cognitive impairments are a prominent symptom of schizophrenia. Seven cognitive domains have emerged from factor analytic studies: speed of processing, attention/vigilance, working memory, verbal learning, visual learning, reasoning and problem solving, and verbal comprehension. Because of the recent evidence of its relevance, social cognition was added as an eighth domain. The extensive literature on cognitive impairments in schizophrenia was summarized in terms of this categorization.

It is argued that for clinical purposes a dynamic model of cognitive functioning is more useful than an overview of separate cognitive factors, as the whole of cognitive impairments is in many cases more than, or at least different from, the sum of its parts. Several models are discussed in this regard. Frith (1992) and Garety et al. (2007) link cognitive impairments to clinical symptoms. Although these theories explain how cognitive impairments may underlie clinical symptoms of schizophrenia, they do not link impaired cognitive functions directly to everyday activities.
For this purpose a model about the control of perception and action on the basis of mental schemata and executive functions (supervisory attentional control) was discussed, namely Brouwer’s elaboration (Brouwer & Schmidt, 2002) of the well known model of Norman and Shallice (1986). The model can be used to illustrate and predict how goal directed action can fail in every day life, and also to suggest how this could be compensated.

An apparent lack of goal-directed behaviour is among the more prominent features of schizophrenia. Several explanations for poor cognitive functioning in everyday life in terms of the model were discussed, integrating theories about schizophrenia by Hemsley (2005a) who sees it primarily as an impairment in internal and external context processing, and by Van den Bosch (1995) who primarily sees it as an impairment of self-monitoring (see also case study Peter).

Brouwer’s version of Norman and Shallice’s model is an important framework for thinking of ways to improve everyday functioning. The fact that people with schizophrenia benefit less from contextual information is an important notion for the cognitive rehabilitation of schizophrenia. Usually, the context will be used to keep relevant information online for future actions (this is what we usually refer to as prospective memory: working memory with a longer timeframe). Many patients however, do not use contextual cues to anticipate on relevant stimuli; they act on irrelevant environmental or cognitive cues on do therefore often not achieve goals that are important to them. This can explain why in many cases a discrepancy exist between performance during neuropsychological assessment and performance in daily life situations. As goals are clearly expressed in the test situation, the selection of stimuli to act upon will be rather straightforward. Therefore the ability to anticipate on upcoming stimuli by using prior knowledge will be hardly required in test-situations, as behavioural codes in that specific situation are quite clear and emerge readily from the situation itself. It is probably therefore that people with schizophrenia experience difficulties in the initiation of willed action - contextual information that would help them to select relevant stimuli in a ambiguous situation is not picked up- but can adequately react on external cues (Frith, 1992; Van Beilen, 2004). As patients do not profit from the context to disambiguate daily life, an environment with clear and unambiguous contextual cues that trigger relevant schemata may optimise their performance. This would mean that if we can provide people with schizophrenia with clear external prompts to action, their performance will improve. We argue that in many cases these cues can be provided by a cognitive prosthesis that provides unambiguous prompts. This argument will be elaborated in Chapter 7 and 8 of this thesis, where the efficacy of SMS text-messages sent to mobile phones is studied.