Cognitive studies in children with mild mental retardation with externalizing behavioural disorders
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In chapter three the concept of impulsiveness was explored. In the first experiment a task was executed which distinguishes between inattention errors and impulsiveness errors: the CPT according to Halperin. It appeared that children in the target group did not make more inattention errors compared to MMR children without externalizing disorders, but did make more impulsiveness errors. This suggests that impulsiveness in our target group is independent of their low IQ.

In the second experiment the suppression of immediate arousal stimulated by an acoustic signal was measured. It appeared that the children in the target-group have difficulties in suppressing immediate arousal compared to the normal control group.

Chapter three suggests that the target group can be best described in terms of impulsiveness. The question in chapter 4 concerns the extent in which their impulsive behaviour is dependent upon their behavioural state.
CHAPTER 4

SUSTAINED ATTENTION, RESPONSE INHIBITION AND STATE REGULATION IN CHILDREN WITH MILD MENTAL RETARDATION WITH AND WITHOUT EXTERNALIZING DISORDERS.1

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In the first experiment of this study we explored sustained attention capacity in the MMR group with externalizing disorders. It appeared that they had the tendency to make more errors of commission compared to a normal control group. Commission errors are an index of impulsiveness. This interesting finding led us to carry out a second experiment to explore the concept of impulsiveness. Van der Meere, Stemerdink and Gunnink (1995) reported that poor response inhibition in ADHD children with a normal IQ is the reflection of a deficit in behavioural state regulation. The aim is to evaluate response inhibition and state regulation in institutionalized children with mental retardation and externalizing disorders. The children in this study have been officially diagnosed as Mildly Mentally Retarded with externalizing disorders, such as Attention-Deficit/Hyperactivity Disorder (ADHD) and Conduct Disorder (CD). It appeared that the MMR group with ADHD and CD had problems with response inhibition, which could not be explained in terms of poor state regulation. Consequently, the inhibition problems in MMR children with ADHD and CD did not mirror the inhibition problem observed in ADHD children with a normal IQ level. No deficit in response inhibition or in state regulation was found in the MMR-only group.

Keywords: response inhibition, state regulation, sustained attention, mild mental retardation, externalizing disorders.

1 Submitted for publication
CHAPTER 4

INTRODUCTION EXPERIMENT 1

A few years ago, Pearson, Yaffee, Loveland and Lewis (1996) published an important study concerning sustained and selective attention abilities in a sample of children with Mental Retardation (MR) with Attention-Deficit/Hyperactivity Disorder (ADHD). The authors underlined that very little was known about cognition in such children with the dual diagnosis MR plus ADHD, despite the fact that the prevalence of the dual disorder is considerably higher than ADHD minus MR. Since the publication of their study nothing has changed: to this present day subaverage intelligence (IQ < 80) still remains an exclusionary criterion in cognitive studies of ADHD and related disorders.

Pearson and colleagues used a visual Continuous Performance Test (CPT) among others, to explore the relationship between MR and ADHD. The findings were as follows: 1) the MR group with ADHD responded nearly four times more often to non-targets (commission errors) than the MR group without ADHD, which is suggestive of poor impulse control in the MR group with ADHD, 2) no difference in performance decrement with respect to task duration was found between the groups, indicating no differentiation in sustained attention deficit between the MR children with ADHD and the MR-only children.

Given the significant potential consequences of poor cognition for school performance, social interaction etc., this issue clearly merits further systematic investigation. Therefore, within this in mind, the current study elaborates on the findings of Pearson and colleagues concerning poor impulse control and sustained attention in children with a subaverage intelligence level plus externalizing behavioural problems. The first experiment is devoted to sustained attention, the second to response inhibition.

Many Continuous Performance Tests (CPT's) have been developed during the last three decades. What these tests have in common, is that the subject is instructed to press a button when a target stimulus is presented in a visual or auditory modality. The target / non-target ratio is generally 20 : 80. The task generally lasts more than 10 minutes without any breaks. It is obvious that subjects will demonstrate a performance decline as the task duration progresses. According
to Sanders’ (1983) theory of state regulation, the decline in performance over time may be explained as follows:

The factor time-on-task induces a state of underactivation in the subject, which in turn, results in a decrement in task efficiency as the task continues. To counteract this decrement in performance, subjects may change their actual (underactivated) state in the direction of the required state by allocating extra effort across the CPT. Hence, we may hypothesize that task efficiency is "optimal" at the beginning of the CPT and “minimal” at the end of the test, especially in those who do not allocate extra effort in the course of the CPT.

Thus, the CPT paradigm and its performance decrement over time may be considered as an excellent paradigm to evaluate the capacity of subjects to regulate their state. Within this perspective, it is important to note that there is accumulating evidence that purely ADHD children with a normal intelligence show a rapid performance decline as the CPT duration progresses (for a review see Van der Meere, 1996), indicating that ADHD children do not allocate extra effort in order to adjust their underactive state in the course of the CPT. This hypothesis was recently tested in the laboratory, of the University of Groningen, by evaluating the 0.10 Hz component of the heart-rate variability. It appeared that control group children were regulating their state by allocating extra effort over time to fulfil the CPT requirements, which was not the case in the purely ADHD group (Börger, Van der Meere, Ronner, Alberts, Geuze & Bogte, 1999). Thus, compared to normal children, purely ADHD children with a normal intelligence level showed a rapid CPT performance decrement over time, which could be explained in terms of a deficit in state regulation.

The goal of the first experiment is to explore sustained attention capacity in MMR children with externalizing disorders. Pearson et al. compared the CPT performance decline of two MMR groups of children (one MMR group with and one MMR group without externalizing behavioural problems) and reported no differential decline in performance efficiency between the two groups. In this perspective, their conclusion that MMR children with and MMR children without ADHD do not differ in their ability to maintain attention over time is correct. This
finding agrees with a study by Melnyk and Das (1992) who also failed to differentiate between MMR children with ADHD and children with MR-only. However, both studies excluded a normal control group. Consequently, to date it remains an open question whether MMR children with externalizing disorders have a sustained attention deficit compared to the norm. Therefore, in an attempt to find the answer, the decline in CPT performance efficiency over time of MMR children with externalizing disorders and normal children will be compared using an auditory CPT. The reason for the choice of an auditory CPT can be explained as follows: Börger and Van der Meere (in press: b) investigated visual behaviour of ADHD children using a visual CPT and reported that ADHD children started to look away from the monitor more and more frequently as the test duration progressed. This ‘staring’ behaviour interfered with the task accuracy of the ADHD children. Hence, the overactivity level (in this case the looking-away-behaviour) may be confused with sustained-attention capacity when using a visual CPT. Therefore, an auditory CPT seemed to be more suitable for indexing sustained-attention capacity in overactive children who make up our group of interest: MMR children with ADHD and CD.

METHOD

Subjects

Twenty-four MMR children (19 of which were boys) with externalizing disorders. The mean IQ of this group was 75 (SD = 9), assessed using the comprehensive version of the WISC-RN. The mean age was 144 months (SD = 16). A qualified child psychiatrist and a qualified child psychologist made independent diagnoses by means of interviews with parents, teachers and caretakers, and observations. Only when the two diagnoses agreed, was each child selected for the experiments. The parents or custodians had to give written consent for the participation of the children (informed consent). The children themselves participated on a strictly voluntary basis. Children met DSM-III-R criteria for ADHD and CD. The IQ alone is only pertinent as far as Borderline Intellectual Functioning is concerned. However in this sample of children exhibiting many comorbid problems, mild mental retardation is a more appropriate description according to
DSM. Children were free from manifest psychiatric behaviour (i.e. psychotic) or neurological impairments. They were inpatients of the Van Arkel Institute, which is a residential establishment in the centre of Holland.

Fourteen children were on medication prior to the study and remained on medication throughout its duration. The decision not to discontinue medication stemmed from the impracticability of entirely eliminating medicines with lengthy half-lives from the children’s systems, e.g. most children were using Dipiperon ® (generic name: Pipamperon). In addition, there were ethical considerations for maintaining medication: the potential deterioration in behaviour and the disruption of treatment programmes. Hence, inhibition and state regulation was evaluated in these children in what physicians describe as their “optimal” clinical condition.

As has already been stated, in most cases the MMR children with behavioural disorders were receiving a low dosage of pipamperon. Pipamperon is registered as an antipsychotic drug. In a normal dosage, pipamperon has a mild antipsychotic effect, a strong antiserotonin effect and is a mild sedative (Farmaco-therapeutisch kompas, 1996). It is also prescribed in clinical practice for aggressive behaviour in children and it is administered if all other medication has been ineffective. Therefore the drug can be seen as a last-resort drug. In the Netherlands and Belgium it is administered to children with mental retardation and integration disabilities (Gunning, 1994). The exact working mechanisms of the drug are unknown.

A low dosage of pipamperon has no side effects, it is not sedating and has no extrapiramidal effects (motor impairments for example), but it can be claimed to have a positive effect on the behaviour (less aggressive behaviour) of mentally retarded subjects (Van Putten, 1990). Also in low doses, pipamperon is a moderate dopamine-D2-antagonist and a strong serotonin-S2-antagonist (Van Putten, 1990). In every experiment, the effects of the medication will be evaluated in order to determine whether it had an effect on the task variables. In an analysis using the CBLC-TRF no differences were found between the medicated and the non-medicated group in the scores in every sub-scale or the total scores.

The design of the study would have been improved by taking separate groups of children with and without medication, or just one group not on medication, or by carrying out experiments
before and after medication. However, if we had chosen only unmedicated children, too few children would have been available for selection, and as a consequence the statistical power of the study would have been decreased.

This group was compared with 30 normal children (12 of which were boys) with a mean IQ of 101 (SD = 7) and a mean age of 139 months (SD = 7). IQ was assessed with the WISC-RN, comprehensive version. The normal children were recruited from normal schools, and had no signs of learning disabilities, manifest psychiatric disorders or neurological impairments, and were free from behavioural disorders according to their parents and teachers. The group may be best described as a random school population. The parents of the children were informed about the aim of the study in writing and by means of information sessions, and had to give written consent for the participation of their children. The children themselves participated on a voluntary basis and received no reward for their participation.

**Test**

The test was a subtest of the Test for Attentional Performance (Zimmermann & Fimm, 1996). Children sat 60 cm away from the computer screen and were instructed to respond to irregularities in acoustic signals. The signals were alternating high or low tones (440 and 1000 Hz. and 60 dBA.) and the interval between two tones was fixed at 1000 ms.. When two low or two high tones were presented in succession (e.g. di da di da da da or: di da di da di di) the child had to press a response button. This occurred 23 times every 5 minutes and the complete test lasted for 10 minutes. The children practised until they understood the intention of the task (criterion training). In general, the practice session lasted about 2 minutes.

**Instruction**

The children were instructed to react as quickly as possible but to maintain a high level of accuracy. During the entire experiment the researcher sat beside the child but no interaction was allowed. The test took place in a quiet room.
Design and analysis

The design was a repeated-measurement design with group (2 levels: MMR group with externalizing disorders vs. control children) as the between-group-factor, and condition (minutes 0-5, and minutes 6-10) as the within-subject-factor (two time frames were chosen, otherwise not enough observations would have been made). The dependent variables were: mean of the reaction times, standard deviation of the reaction times and commission errors.

RESULTS

Fourteen children in the MMR group with externalizing disorders remained on medication during the experiment. An initial analysis showed that the medicated group did not differ from the non-medicated group with respect to the mean RT (F(1,22) = 1.851; p < .187), standard deviation of RT (F(1,23) = .367; p < .551), number of correct responses (F(1,23) = .050; p < .826) or commission errors (F(1,21) = .725; p < .404). Since no significant differences were found in task performance, it was decided not assess the medicated and unmedicated children as separate groups any further in order to increase the statistical power of the study. Figure 1 presents the reaction times.

FIGURE 1. Reaction times of the MMR+ADHD+CD and control group in the sustained-attention task.
The MMR group with externalizing disorders performed faster compared to the normal control children: this group main effect was $F(1,52) = 8.356; p < .006$. Children responded slower in the second part of the task compared to the first part of the task: the influence of this main time-on-task effect on RT performance was $F(1,52) = 29.810; p < .000$). However, the performance decline was equal for both groups: the interaction between group and time-on-task was not significant $F(1,52) = .145; p < .705$). Figure 2 presents the standard deviations.

![FIGURE 2](image)

**FIGURE 2.** Standard deviation of the MMR+ADHD+CD and control group in the sustained-attention task.

The MMR children with externalizing disorders had a significantly smaller standard deviation compared to the normal control group: this group main effect was $F(1,52) = 17.397; p < .000$). There was no significant time-on-task effect on the standard deviation of RT: 1) the main effect of time-on-task on SD was $F(1,52) = .413; p < .523$), 2) the interaction between group and time-on-task was $F(1,52) = .011; p < .918$). Figure 3 presents the number of errors.
FIGURE 3. Number of errors of the MMR+ADHD+CD and control group in the sustained-attention task.

Groups did not differ in the number of commission errors: the main group effect was (F(1,52) = 3.314; p < .075). Children made more commission errors in the second part of the test compared to the first part of the test: main effect for time on task on the commission errors was (F(1,52) = 13.810; p < .000). Groups did not differ with respect to the decline in task efficiency over time: the interaction between group and time-on-task for the commission errors was (F(1,52) = .494; p < .485).

INTRODUCTION EXPERIMENT 2

The findings in the first experiment merit further investigation. It was expected that the performance of the MMR group with externalizing disorders would be worse with respect to reaction times and standard deviations. This was not the case. However, they tended to make more errors of commission, which indicates impulsiveness. The tendency to make more commission errors could be a result of their mental handicap, but could also be caused by their other diagnoses. Therefore in the second experiment the concept of impulsiveness will be explored further.

There is no universally accepted definition of impulsiveness or response inhibition. Schagar and Logan (1990) state that deficient inhibitory control is revealed by impulsive...
behaviour, such as responding before a task is understood, answering before a question has been completed, being easily distracted by irrelevant stimuli, or the inability to correct false responses. Impulsiveness within the ADHD syndrome is, according to DSM – III - R, represented by: giving an answer before the question has been completed; the subject is unable to wait his or her turn; the subject frequently interferes in activities of others.

Impulsiveness is not the same as perseveration (frequently seen in (M)MR). Although perseveration is easily confused with impulsiveness (the person cannot stop certain activities), they are separate constructs and can be differentiated in terms of goal directed behaviour: i.e. in perseveration the goal is already reached, but the person keeps responding, whereas with impulsiveness the person is unable to inhibit a performance before the goal is reached. Another way in which impulsiveness can be understood is the inability to abruptly stop behaviour once it has been initiated. Therefore, impulsiveness is related more to an inability to alter an ongoing output rather than a deficit in initiation of behaviour. Another definition of impulsiveness is given by Buss and Plomin (1975) who included persistence and sensation-seeking in the impulsiveness concept. Block, Gjerde and Block (1986), and Olsen (1989) defined impulsiveness in terms of risk taking, over-reactivity to frustration, and the inability to plan ahead respectively.

Given the definitions/interpretations mentioned above, it is not surprising that there is no indubitable definition of the concept of impulsiveness. It is not clear whether the construct of impulsiveness is truly multidimensional or whether this is an artefact born of the heterogeneity of tests measuring it. There is a strong need for a practical way of defining a measurement of response inhibition. On a practical level (although somewhat limiting) response inhibition is defined as the ability to withhold a motivated and goal-directed response to enhance adaptive functioning.

A plethora of (frontal) tests have been used in the past to test the response-inhibition hypothesis in externalizing disorders [Attention-Deficit/Hyperactivity Disorder (ADHD) and Conduct Disorder (CD)], such as the Children's Embedded Figure Test, the Wisconsin Card Sorting Task, the Porteus Maze, the Matching Familiar Figures Test, Draw/Walk a line Slowly, Trail Making, and the Stroop. It is well established that children with externalizing disorders
perform poorly in such tests (see Barkley, 1994 for an extensive review). However, the critical issue is whether poor performance in such tests is really a reflection of poor response inhibition, because these tests measure a whole web of cognitive functions and display low differential validity between clinical populations (for an extensive review on this issue, see Van der Meere, 1996).

Recently, new paradigms have been developed to test the response-inhibition hypothesis. For example: the Stop paradigm of Schachar and Logan (1990). In this test the child is given a primary-reaction time task, where a stimulus is presented, to which the child is expected to respond. Intermittently, a secondary stimulus (following the primary stimulus) is presented, to which the child is instructed to inhibit its response. It was found that the further a response has proceeded, the more difficult it is to stop the process of response in children with ADHD.

A large number of commission errors is traditionally seen as a reflection of poor response inhibition. However, it is likely that their level of performance accuracy, especially in children with an externalizing disorder, is influenced by the (behavioural) state in which they execute a cognitive test (for an extensive elaboration of this concept, see Van der Meere, 1996). This was recently demonstrated by Van der Meere, Stemerdink and Gunnink (1995). They investigated response inhibition in ADHD children with a normal IQ using a Go-No-Go test, derived from Sanders’ (1983) theory of state regulation. Their test merely required subjects to press a response button when the letter Q was presented (Go-signal). No response was required when the letter O appeared (No-Go-signal). The ratio of Go-No-Go trials was 80:20. Signals were presented under three conditions with an inter-stimulus-interval of one second (fast condition), four seconds (medium condition) and eight seconds (slow condition). The ADHD group made many errors of commission under the fast and, in particular, slow conditions. Under the medium condition, the ADHD children’s performance was equal to the control group. Overall, test performance of the control group was the least influenced by the presentation rate of the Go-No-Go stimuli. Findings were interpreted in terms of a state regulation deficit in the ADHD group as follows:

The control children were able to counteract a performance decrement under the fast and slow conditions by adapting their behavioural state with respect to the presentation rate of the
stimuli, i.e. they were able to reduce their behavioural state under the fast condition, and to increase their behavioural state under the slow condition. The ADHD children in contrast, were unable to adjust their behavioural state with respect to the task demands: they were easily overactivated and underactivated with poor response inhibition as a result. ADHD children showed no poor response inhibition under the condition with a medium presentation rate of stimuli. Consequently, it was concluded by the researchers that the key problem in ADHD with a normal IQ is poor state regulation, not response inhibition per se. This hypothesis was recently tested in the laboratory of the University of Groningen, by evaluating the (tonic) 0.10 Hz component of the heart-rate variability and the (phasic) heart-rate deceleration before the Go- or No-Go signal was presented. The first measurement is considered to be a psychophysiological index of effort: the more effort the subject allocates, the smaller is the variability of the 0.10 Hz component. The second measurement is considered to be a psychophysiological index of motor activation. Groups did not differ with respect to the two indices when the Go-No-Go stimuli were presented at the fast rate. However, groups did differ with respect to both indices when the signals were presented slowly, indicating an (activation/effort) state regulation deficit in the ADHD group (Börger & Van der Meere, in press: a). A normative study indicated that their ability to regulate the behavioural state (defined in terms of the Go-No-Go test) is arrested by at least 2 years (Van der Meere & Stemerdink, 1999), and a psychopharmacological study showed that their state regulation deficit is resistant to methylphenidate and clonidine (Van der Meere, Gunning & Stemerdink, 1999). Note: the hypothesis that ADHD is not associated with poor response inhibition was confirmed, to a limited degree, by Van der Meere, Gunning and Stemerdink (1996) using a Stop and Change response bias test.

Using the same Go-No-Go test, Van der Meere and colleagues found that poor response inhibition in: 1) Learning Disabled children without ADHD (Van der Meere, Vreeling & Sergeant, 1992), 2) ADHD children with a comorbid Tic Disorder (TD) (Van der Meere, Stemerdink & Gunning, 1995), 3) children who have been continuously treated for Phenylketonuria (PKU) from infancy (Stemerdink, Van der Meere, Van der Molen, Kalverboer, Hendrikx, Huisman, Van der Schot, Van Sprongen & Verkerk, 1995) was determined to a lesser
degree by the presentation rate of the Go-No-Go stimuli. That is to say, such patient groups demonstrate poor response inhibition independently of the signal rate, indicating that poor response inhibition in these groups cannot be explained in terms of poor state regulation, which is the case in purely ADHD children with a normal intelligence level. This finding is important with respect to the discriminant validity problem in childhood psychopathology. The sum of these results form a first step on the road to understanding the true nature of the cognitive deficit in ADHD children with a normal intelligence level.

As discussed earlier, Pearson and colleagues reported that MR children with externalizing disorders have problems in inhibiting responses. The goal of the second experiment in the current study, is to test whether poor response inhibition in children with externalizing disorders and a subaverage IQ level mirrors the inhibition problem of the purely ADHD child with a normal IQ. To this purpose, three groups were selected: 1) a group of children with mild mental retardation with externalizing disorders [ADHD plus Conduct Disorder (CD)], 2) a group of children with mild mental retardation, but without externalizing disorders, 3) a normal control group. A Go-No-Go test with the variable inter-stimulus-intervals was used. The hypothesis is as follows: if the response inhibition deficit in MMR with externalizing disorders mirrors the response inhibition deficit of ADHD children with a normal IQ level, then the number of commission errors ought to be related to the presentation rate of the Go-No-Go stimuli.

METHOD

Subjects

Twenty-one MMR children (16 of which were boys) who met DSM-III-R criteria for ADHD and CD participated in this experiment. They had a mean age of 144 months (SD = 14) and an IQ of 75 (SD = 10). IQ was assessed using the WISC-RN (comprehensive version). The
The MMR group with externalizing disorders was compared to 15 children (9 of which were boys) who did not meet any DSM-III-R diagnosis other than MMR (the MMR-only group). Their mean IQ was 67 (SD = 7), and their mean age in months was 143 (SD = 12). The IQ was assessed using the WISC-RN (comprehensive version). The children were selected from a larger sample of MMR children who had been placed in special education programmes. The parents of the children were informed about the aim of the study in writing and by means of information sessions, and had to give written consent for the participation of their children. The children were selected as follows: 1) from a larger sample (n = 120), teachers were asked to identify children who were free from behavioural disorders; 2) using the Licor questionnaire (frequently used in Dutch schools) to select children who were free from behavioural disorders (n = 25), 3) finally also using the Child Behavior Check List-Teachers Report Form (CBCL-TRF, Achenbach & Edelbrock 1983) to select those children who were free from behavioural disorders (n = 15). No aetiologies of MMR were identified. In sum, the inclusion criteria were: freedom from manifest psychopathology; no neurological symptomatology, no behavioural disorders and not on medication.

Figure 4 presents the CBLC-TRF scores of the MMR group with externalizing disorders and the MMR-only group. Note: It was not possible to assess the parents with the CBLC for two reasons: 1) not all the parents were able to co-operate, 2) several MMR children with externalizing disorders were placed in the institute under the Child Protection Act.
FIGURE 4. CBCL-TRF scores of the MMR+ADHD+CD group and the MMR-only group. Note: a score above 68 should be interpreted as significant problematic behaviour. A score of 50 (and lower) should be interpreted as free from behavioural problems.

The normal control group consisted of 18 children (9 of which were boys) with a mean IQ of 104 (SD = 10) and a mean age of 141 months (SD = 26). IQ was assessed using the WISC-RN (comprehensive version). The normal children were recruited from normal schools, and had no signs of learning disabilities, manifest psychiatric disorders, neurological impairments and were free from behavioural disorders according to their parents and teachers. The group may be best described as a random school population. The parents of the children were informed about the aim of the study in writing and by means of information sessions, and had to give written consent for the participation of their children. The children themselves participated on a voluntary basis and received no reward for their participation. The three groups (MMR with externalizing disorders, MMR-only and the control group) did not differ with respect to age.
Test

A monitor was placed 60 cm away from the children. In each trial, 3 stars and 1 letter, either P or R were presented inside a square (4 cm), on the monitor screen for 700 milliseconds. The location of the stars and letter in the square changed in each trial. The children were instructed to press a response button with their dominant index finger when the P appeared. When the letter R was presented (in 20 percent of the trials) no response was allowed. These trials measured the capacity to withhold response.

![Figure 5](image)

**FIGURE 5.** Stimuli in the Go-No-Go task. The stimulus on the left is an example of a Go stimulus and the stimulus on the right is an example of No-Go stimulus.

The presentation rate of the stimuli was varied by changing the inter-stimulus-interval. Under the condition with a fast presentation rate the interval was 1 second and the number of trials was 462. Under the conditions with a medium and a slow presentation rate, the intervals were 4 and 8 seconds and the number of trials 140 and 72 respectively. Each condition lasted about 10 minutes. The 3 conditions were counterbalanced. Conditions were practised until 5 consecutively correct responses were made.

Instruction

The children were instructed to react as quickly as possible but to maintain a high level of accuracy. After each test condition a short break was taken. During the entire experiment the researcher sat beside the child, but no interaction was allowed. The test took place in a quiet room.
Design and analysis

The design was a repeated-measurement design with group (3 levels: MMR with externalizing disorders (ADHD and CD), MMR-only, and normal) as the between-subject-factor. Presentation rate of stimuli (3 levels: fast, medium and slow) was the within-subject-factor. Mean reaction time, standard deviation and errors of commission were the dependent variables. Analysis was done by General Linear Model-Repeated Measures Model: Full-factorial, sum of squares: Type III, contrasts: non.

RESULTS

Fourteen children in the MMR group with externalizing disorders remained on medication during the experiment. An initial analysis showed that the medicated children did not differ from the non-medicated children with respect to mean RT (F(1,19 = 1.706; p < .207), standard deviation of RT (F(1,19) = .889; p < .358), or number of commission errors (F(1,19) = .135; p < .874). Therefore, it was decided not to assess the medicated and unmedicated children as separate groups any further in order to increase the statistical power. Figure 6 presents the reaction times.

**FIGURE 6.** Reaction times in the Go-No-Go task of the MMR+ADHD+CD group, the MMR-only group and the control group under fast, medium and slow conditions.
Presentation rate of stimuli strongly influenced task performance; the faster the presentation rate, the faster was the mean reaction time: the main effect of presentation rate on reaction time was \( F(2,102) = 118.201; p < .000 \).

Groups differed with respect to mean RT: the group main effect was \( F(2,51) = 4.167; p < .021 \). However, the group by condition interaction was not significant \( F(4,102) = 1.192; p < .319 \), indicating that the effect of presentation rate was the same in all three the groups. A series of Post-hoc tests revealed that the MMR group with an externalizing disorder responded faster in all three conditions compared to the MMR-only group and the control group. Under the fast condition, the MMR group with externalizing disorders responded faster than the control group \((p < .022)\), but not significantly faster than the MMR-only group \((p < .148)\). The MMR-only group, in turn, did not differ in mean RT from the control group \((p < .460)\). Under the medium condition, the MMR group with externalizing disorders responded faster compared to both the MMR-only group \((p < .042)\) and the control group \((p < .006)\). Again, the mean RT of the MMR-only group was not different from the control group \((p < .527)\). Also under the slow condition, the MMR group with externalizing disorders responded faster than both the MMR-only group \((p < .020)\) and the control group \((p < .023)\). Once again, the MMR-only group did not differ in mean RT from the control group \((p < .872)\). In sum, the MMR group with externalizing disorders reacted faster to target stimuli than the two other groups, irrespective of the presentation rate of the stimuli. Figure 7 presents the standard deviations of the reaction times.
The presentation rate had no significant effect on the standard deviation of RT: the main effect for condition was (F(2,102) = .512; p < .601). Groups differed with respect to their standard deviation of RT: the group main effect was (F(2,51) = 5.536; p < .007). Post hoc tests revealed that under the fast condition, the MMR group with externalizing disorders had a greater standard deviation than the control group (p < .010). No difference was found between the MMR with externalizing disorders and MMR-only group (p < .412). The MMR-only group did not differ from the control group (p < .103). No difference in SD under the medium condition was found between the three groups. Under the slow condition, the MMR with externalizing disorders had a greater standard deviation than the normal group (p < .000), but no difference was found with the MMR-only group (p < .107). Figure 8 presents the percentage of errors.
Groups differed with respect to the percentage of commission errors: the group main effect was (F(2, 51) = 6.797; p < .002). The two-way interaction group by condition was not significant (F(4, 102) = 1.091; p < .365), indicating that the difference in inhibition capacity between the groups was independent of the presentation rate of stimuli. Post hoc tests revealed that the MMR group with externalizing disorders made the greatest number of errors of commission, irrespective of the presentation rate. Under the fast condition, the MMR group with externalizing disorders made more errors of commission than the two other control groups (p < .014), however the contrast with the MMR-only group was not significant (p < .213). The contrast between the MMR-only group and the normal control group was not significant (p < .273). Under the medium condition, the MMR group with externalizing disorders made more errors of commission than both the control group (p < .007) and the MMR-only group (p < .000). The contrast between the MMR-only group and the control group was not significant (p < .410). Under the slow condition, the MMR group with externalizing disorders made more errors than both the MMR-only group (p < .007) and the control group (p < .011). The contrast between the MMR-only group and the control group was not significant (p < .771).
GENERAL DISCUSSION

The first experiment investigated the issue of state regulation and sustained attention in children with the dual diagnosis MMR plus ADHD/CD. To this purpose, their CPT performance was compared to a normal control group. Findings were straightforward. First, it was found that the MMR group had the tendency to make more errors of commission than the norm group. Errors of commission are generally considered to reflect poor impulse control. Therefore a second experiment was carried out and the initial finding was confirmed: i.e. MMR children with externalizing disorders have problems with impulse control. Secondly, no difference in performance deterioration over time was found between the two groups. This finding was also confirmed by the results of the second experiment: i.e. the problems with impulse control of the MMR children with externalizing disorders cannot be explained in terms of a state regulation deficit. Consequently, the results of the two experiments demonstrate that the cognitive problems seen in purely ADHD children are different in nature compared to those in children with the dual diagnosis MMR plus externalizing disorders.

The goal of the second experiment was threefold: 1) to confirm the tendency found in the first experiment, 2) to confirm whether this tendency was a result of mental retardation or externalizing disorders, 3) to test whether cognitive problems in children with the dual diagnosis MMR plus externalizing disorders mirrored the cognitive problems seen in purely ADHD children of normal intelligence. In the second experiment, a Go-No-Go test was used with a fast, a medium and a slow presentation rate of stimuli. Previous studies have found that the capacity to inhibit responses in purely pervasive ADHD children of normal intelligence is strongly related to the presentation rate of Go-No-Go signals displayed: i.e. with a medium presentation rate, ADHD children show no problems with response inhibition. However with a fast presentation rate, children are easily overactivated, and with a slow presentation rate, they are easily underactivated. Overactivation and underactivation both result in poor response inhibition. This finding has been interpreted in terms of poor state regulation in ADHD: seen in this way, the key problem of ADHD is state regulation, not response inhibition. The hypothesis that a sub-optimal
activation level can be held responsible for poor response inhibition in children with externalizing disorders with a normal intelligence level has recently been replicated by other researchers (Scheres, Oosterlaan & Sergeant, 1998) using a different inhibition paradigm (the Stop-Signal paradigm) in another laboratory in The Netherlands (Amsterdam). The stop-paradigm in their research, was applied under three presentation-rate conditions similar to our Go-No-Go paradigm: i.e. signals were presented every 1 second, every 4 seconds and every 8 seconds. Scheres et al. also found a response inhibition deficit in their study. Given the consistency in the findings of the two laboratories, it is unlikely that Van der Meere had stimulated a ‘Hawthorn effect’ when he reported that it is the presentation rate of stimuli which is a crucial factor in ADHD children with normal intelligence, not response inhibition per se.

The central question of the second experiment in the current study concerned the association between the constructs of state regulation and response inhibition in children with externalizing disorders and a low IQ. There were two main findings: 1) the study demonstrated that poor response inhibition in the MMR group with externalizing disorders did not mirror the cognitive deficit as observed in ADHD children with a normal IQ: i.e. poor impulse control in the MMR group with externalizing disorders was not related to the presentation rate of stimuli. Hence, poor response inhibition in this group could not be explained in terms of a state regulation deficit: it seems as if their lack of impulse control is less dependent upon state factors, which is the case in the ADHD child with a normal intelligence level. However, poor response inhibition in the MMR group with externalizing disorders could be explained in terms of the speed accuracy trade-off principle: i.e. this group responded faster to target stimuli than the MMR-only and the control group, but with many errors of commission as result. In other words, the high rate of commission errors in the target group is a result of a different approach to the task in hand. Another type of task which distinguishes between inattention errors and commission errors (such as the CPT according to Halperin) should clarify this point. Again, this demonstrates that the target group’s cognitive problems do not mirror the cognitive deficit of ADHD children of normal intelligence, since, as reviewed elsewhere by Van der Meere (1996), there is no data available showing that ADHD children with a normal IQ, trade accuracy for
speed in RT paradigms. On the contrary, such children have slow, inaccurate responses instead of fast, inaccurate ones; 2) the effect of the presentation rate of signals on response speed and response inhibition was about the same in the MMR-only and the control group. Only under the fast condition, did the performance of the MMR-only group drop to between the MMR group with externalizing disorders and the control group. Thus, in general terms, it may be concluded that MMR-only is not related to either a deficit in state regulation or a poor response inhibition. The question emerges, how can this finding be explained in respect to the growing body of literature showing that children with mental retardation perform poorly in a variety of cognitive tests (for a review, see Pearson, Norton & Farwell, 1997). For example, children with MR have more difficulty inhibiting responses stimulated by distracting dimensions of task difficulty than normal children (Ellis, Woodley-Zanthos, Dulaney & Palmer, 1989). The answer is twofold: 1) the IQ level of the children who participated in our study was about 12 points higher than the sample in the Ellis et al. study, 2) the cognitive load of the test used in the present study was low: test stimuli (P and R) were easy to detect (even for children with learning and reading problems) and there were no distracting (task irrelevant) stimuli presented. Hence, the test we used tapped response inhibition and state regulation, but was not equipped to measure the adequacy of functions involved with processing information of a higher order or filter mechanisms, which was the case in the Ellis et al study.

The present finding that MMR is not related to a deficit in state regulation indicates that the state regulation deficit in ADHD children with IQ levels in the normal range, as claimed by Van der Meere and colleagues, is a deficit above and beyond intelligence level (as far as the upper range of MR is concerned). This is an important issue. As Milich and Kramer (1984) argued, many of the most commonly employed measurements used to study response inhibition in ADHD (MFFT, Wisconsin Card Sorting Test, Stroop etc. etc.) exhibit a high correlation with IQ. Therefore, one may pose the question whether these measurements show any incremental validity: i.e. do such tests measure anything other than IQ. In the same vein, the incremental validity of the Go-No-Go test with a variable presentation rate of stimuli is reflected by the fact
that the contrast between mildly mentally retarded children and their peers in the normal control group was not significant in the present study.

The present finding that poor response inhibition is not associated with low IQ per se fits with Oosterlaan, Logan and Sergeant (1998). They concluded on the basis of a meta-analysis concerning eight stop-paradigm studies that it is unlikely that poor response inhibition in externalizing disorders is associated with intellectual functioning. However, since children with an IQ level below 80 were excluded from this analysis, one may argue that the IQ range in their analysis was too small to justify such a statement. Therefore, this argument does not hold given the present findings.

In sum, Pearson and colleagues showed that MMR children with externalizing behavioural problems (ADHD) have difficulty in suppressing responses. The current study confirmed their findings: children with externalizing disorders and a low IQ do have problems with response inhibition. However, what makes this study particularly relevant is the fact that it shows that the nature of the response inhibition problem is different in ADHD children of normal intelligence.

The findings of the two experiments also fit with the Barkley model (1994). Barkley tried to develop a unifying theory about ADHD. He argued, that the core deficit of ADHD is not impulsiveness but impaired delayed response, which in turn leads to impulsiveness, disturbances in self-control and disturbances in goal-directed behaviour. This impairment creates a hyperresponsivity to immediate signals or events. The three deficits or symptoms believed to be the core deficit of ADHD – poor sustained attention, impulsiveness and hyperactivity – can be reduced to a single core impairment: delayed response or response inhibition. Barkley is not the first in making this claim, others have also made similar assertions (Still, 1902; Quay, 1988; Van der Meere, 1993).

The implications for treatment are not optimistic. Aggressive and delinquent behaviour are a result of impulsive behaviour. I agree with Barkley and consider impulsiveness to be a handicapping condition for which, at present, there is no cure. By accepting this impairment in
children, frustration could be prevented among the caretakers and teachers, as well as the children. Halperin, Newcorn, Matier, Bedi, Hall & Sharma (1995) stated that impulsiveness is an underlying construct, irrespective of a specific diagnosis. This is also the case in the target group in this study. It is the impulsiveness or hyperresponsiveness (as Barkley also calls it) that makes the target group difficult to deal with, not their specific diagnosis.

Developmental concern.

A common dilemma in MR research is whether to compare children with MR to children of normal intelligence, or to take a comparison group of children with normal IQ’s but matched in mental age, which would mean that it would be chronologically younger than the children in the other two groups.

Mosley (1980) compared MMR children (mean IQ 66) with normal subjects on a selective attention task. His data revealed that under minimal load conditions MMR children are equal to normal controls, however if the load increases the MMR children were less efficient relative to the normal control group. MMR may also have a negative impact on vigilance performance (Tomporowski & Tinsley, 1994; Kirby, Nettelbeck & Bullock, 1978; Kirby, Nettelbeck, & Thomas (1979): i.e. children with MMR show a more rapid decline in performance as the test duration progresses compared to children without MMR. However, in adults with MMR this rapid decline is not found. Therefore, Kirby et al. (1979) concluded that the performance decrement in the MMR group is largely a developmental problem compared to subjects with a normal intelligence. This conclusion is tempting, but lacks empirical evidence. The field of MR research combining developmental studies and studies using IQ as a continuous variable is missing. Not surprising, given the fact that such an experimental design demands extremely careful task and design selection to deal with the role of intelligence.

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