Cognitive studies in children with mild mental retardation with externalizing behavioural disorders
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The strength of the experiments as discussed in chapter two was that the children were compared to a large group of randomly selected normal children. Three experiments were executed, each measuring a particular aspect of attention. In the first experiment, it appeared that the target-group performed poorly compared to the normal-group when they had to carry out a task in which they had to monitor themselves (self-paced). In the two other tasks, which were computer-paced, they performed equally as well, and in some cases even better than the norm. Against all odds the conclusion is justified that attentional abilities in children of the target-group is intact.

The following chapter will focus on impulsiveness, an other characteristic of the diagnoses of the target-group.
CHAPTER 3

INHIBITION OF RESPONSES AND IMMEDIATE AROUSAL IN CHILDREN WITH MILD MENTAL RETARDATION WITH AND WITHOUT EXTERNALIZING BEHAVIOURAL PROBLEMS

Dirk-Jan van der Meer, Jaap van der Meere, Hanns Jürgen Kunert, Alex Fedde Kalverboer

The current study was designed to provide a rigorous investigation of the locus of poor-response inhibition in Mildly Mentally Retarded (MMR) children (aged between 9 - 12 years) with and without externalizing behavioural problems. In the first experiment, Halperin's CPT-AX test was applied. This test measures attention capacity and response inhibition. The main finding was that children with both mild mental retardation (MMR) and externalizing problems show deficient-response inhibition when compared to MMR children without behavioural problems. This finding was validated by the fact that poor-response inhibition was associated with externalizing behavioural problems as defined in terms of the CBCL-TRF. In a second experiment the MMR group with externalizing disorders was compared to a control group of normal intelligence during the execution of a task which was designed to measure suppression of immediate arousal. It appeared that compared to the control group, the MMR group with externalizing disorders experienced greater difficulty in suppressing immediate arousal. The findings of the two experiments together suggest that poor-response inhibition in MMR children with externalizing disorders (MMR+) is associated with an inability to suppress responses within a specific time domain.

Key words: response inhibition, immediate arousal, mild mental retardation, externalizing disorders

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1 Submitted for publication
INTRODUCTION EXPERIMENT 1

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).

Today, new paradigms have been developed to test the response-inhibition hypothesis in ADHD and CD. Findings are controversial. Both the Toronto team (Schachar & Logan, 1990; Schachar, Tannock, Marriot & Logan, 1995) and the Amsterdam team (Oosterlaan, Logan, & Sergeant, 1998, Oosterlaan & Sergeant 1998) have used the stop paradigm and the stop-and-change paradigm and reported that ADHD and CD is associated with poor response-inhibition, and that methylphenidate helps to overcome this problem. Whereas, Van der Meere and colleagues, using the Response Bias Task and a Go-No-Go paradigm with various stimulus intervals, maintained that such children do not have a response-inhibition deficit per se (Van der Meere, Gunning & Stemerdink, 1996), but that they have a deficit in state regulation which, in turn, may result in poor-response inhibition (Van der Meere, Stemerdink, & Gunning, 1995). The use of methylphenidate does not eliminate this problem (Van der Meere, Gunning & Stemerdink, 1999). Only time will tell which argument proves to be correct. For the time being, we may conclude that there is a rich source of literature available and a lively scientific debate concerning externalizing disorders in childhood and response inhibition will continue.

With respect to children with mental retardation plus externalizing disorders (MMR+), a different picture emerges: here there is a distinct lack of research. There are two reasons why such children with a mental handicap deserve more attention. First, the prevalence of ADHD/CD in children with mental retardation (MR) is considerably higher (ranging from 9 to 18%) compared to ADHD/CD in children with normal IQ's (3 to 5%) (American Psychiatric Association, 1994, Ando & Yoshimura, 1978; Epstein, Cullinan, & Gadow, 1986;
Jacobson, 1982). Second, it is likely that cognitive problems in children with a dual diagnosis will be more pronounced compared to those in children with a single diagnosis (in this case, ADHD children with normal intelligence).

Given the lack of research focusing on mental retardation and externalizing disorders, a study of Pearson, Yaffee, Loveland and Lewis (1996) is particularly important. Pearson and colleagues compared mentally retarded children with ADHD to mentally retarded children without ADHD in an X-only version of the ‘Continuous Performance Test’ (CPT), modelled on Rosvold, Mirsky, Sarason, Bransome and Beck (1956). They reported that children with the dual diagnosis committed four times as many errors of commission compared to children with MR-only. The authors concluded that the children with the dual diagnosis had poor impulse control. However, this conclusion may be premature because CPT commission errors do not comprise a unitary measure that is indicative of a single deficit (e.g. impulsiveness) since other psychological processes, such as attention, are operative as well.

With this in mind, Halperin and colleagues (Halperin, Wolf, Pascualvaca, Newcorn, Healey, O'Brien, Morganstein, & Young, 1988; Halperin, Sharma, Greenblatt, & Schwartz, 1991a; Halperin, Wolf, Greenblatt, & Young, 1991b) developed a classification of CPT errors in an attempt to distinguish more clearly between the constructs of inattention and impulsiveness, or response inhibition. This test involves responding to an "X" only when "X" is preceded by the letter "A". Four different commission errors are possible: 1) the subject responds directly after the appearance of an "A" and does not wait for the appearance of the sequential letter “X” (A-only error), 2) the subject responds to a letter other than "X" following an "A" (A-not-X error), 3) the subject responds to an "X" not preceded by an "A" (X-only error), 4) the subject responds to a sequence of two letters consisting of neither "A" nor "X" (random errors). Halperin et al. (1988) reported that A-not-X responses were faster than the other CPT commission-error responses, reflecting hasty decision making. Some of the A-only errors (20%) were long latency errors, reflecting an inability to wait for the next letter (Halperin, Wolf, Greenblatt & Young, 1991b). Both error types were correlated with educational ratings of impulsiveness, and error categories have made it possible to differentiate between Developmental Reading Disorder (DRD) in groups with and without ADHD and normal control groups (Kupietz, 1990), and between control groups and a group of mixed hyperactive/aggressive children (Halperin, O'Brien, Newcorn, Healy, Pascualvaca, Wolf & Young, 1990). It must be emphasized here that Halperin's operationalism of
impulsiveness is based partly on fast but inaccurate responses (A-not-X errors) and partly on
the inability to suppress responses to inappropriate (distractive) stimuli (A-only errors).

In sum, Halperin’s CPT-AX has proven its clinical significance as an objective
measure of attention capacity and response inhibition and can be used to differentiate between
symptoms of inattention and impulsiveness in children. Therefore this CPT-AX has been
adopted in the current study to test whether externalizing behavioural problems in MMR
children is associated with poor attention and/or poor-response inhibition. There was chosen
for a shorter version of the CPT, because we wanted to measure response inhibition, not
sustained-attention.

**METHOD**

**Subjects**

Twenty-one children (17 of which were boys) with a mean age of 145 months (SD =
13) participated in the current study. The children were inpatients of the Van Arkel Institute,
which is a residential establishment in central Holland. 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. They were diagnosed as MMR (mean IQ
= 75, SD = 9) with externalizing behavioural problems (ADHD with co-morbid CD). IQ only
is pertinent as far as Borderline Intellectual Functioning is concerned. However as this sample
involved children with many co-morbid problems, Mild Mental Retardation is a more
appropriate description according to DSM. The children were not only mentally handicapped
but also had many impairments as far as adaptive behaviour was concerned. Independent
diagnoses were made by a qualified child psychiatrist and a qualified child psychologist,
using DSM criteria. Only when the two diagnoses agreed, was each child selected for the
experiment. IQ was assessed using the WISC-RN test (comprehensive version). Children
were free from manifest psychiatric disorders (i.e. psychosis) and neurological impairments.
Criteria for residential placement were: the presence of both a dysfunctional family and
disruptive behaviour in the community, which would preclude foster-care placement. Prior to
their admission the subjects had also failed to respond to a course of outpatient
psychotherapy. About half of this sample was on medication, i.e. a low dosage of
pipamperon. This compound is registered as an antipsychotic drug. For practical (lengthy
half-lives) and ethical reasons it was decided not to discontinue medication for the purposes of the current study.

Nineteen children (10 of which were boys) with the mean age of 132 months (SD = 13) were recruited from a special-needs school and were diagnosed as MMR (mean IQ = 73, SD = 8). The children had no history of psychiatric behaviour or neurological impairments, and were assessed as being free from behavioural disorders using the CBCL-TRF test. The results of the CBCL-TRF are shown in figure 1. IQ was assessed using the WISC-RN test (comprehensive version).

Figure 1 presents the CBCL-TRF scores of both groups. Note: It was not possible to assess the parents using CBCL for two reasons: 1) not all the parents were able to cooperate, 2) several children were placed in the institute under the Child Protection Act.

![Figure 1. CBCL-TRF t-scores of the MMR+ADHD+CD group and the MMR group. Note: a score above 68 should be interpreted as significant problematic behaviour. A score of 50 or lower should be interpreted as free from behavioural problems.](image)

**Description of the test**

The CPT-AX was implemented using an Apple Macintosh LC-II. Children sat 60 cm away from the screen and were instructed to press a response button if an “A” on the screen
was followed by an “X”. (Note: the letter "A" functioned as a pre-target to prime the children to prepare for a response). When the “A” was followed by any other stimulus (letter), the child was supposed to refrain from responding. The stimuli were 1.5 cm high and the presentation time of each stimulus was 450 msec. The inter-stimulus interval (ISI) was 2.2 seconds. In total the stimulus duration and ISI was quite prolonged; this was to allow for the MMR status of the sample.

Procedure

Twenty-five practice trials were presented before the experiment (100 trials) started. The experiment commenced only when a child completely understood the intention of the task (criterion training). The children were instructed to react as quickly as possible but to maintain a high level of accuracy. In general, the practice session lasted about 1 minute. During the experiment the researcher sat beside the child. No interaction was allowed between the researcher and the child during the experiment. The test took place in a quiet room.

Design and analysis

The design was a repeated measures multi-level model, with group (two levels: MMR with co-morbid problems and MMR without co-morbid problems) as the between group factor. Trial type was the within-subject factor.

The data was initially analysed to determine whether the different commission error sub-types were associated with particular response times (RTs) by comparing the children’s mean RT for A-not-X errors and A-only errors to their mean RT for correct responses ("Hits") by means of two-tailed paired t-tests. This was done following the Halperin model (1991). Analyses were carried out using non-parametric tests: Kruskall-Wallis.

RESULTS

Three latency findings for the groups of MMR subjects in this current study substantiated the interpretational scheme of errors set out by Halperin and colleagues. A-not-X responses (431 ms) were faster than ‘Hits’ (562 ms; t(20) = 6.01; p < .001), X-only errors (671 ms) were slower than ‘Hits’ (562 ms, t(20) = 2.78; p < .05), and the speed of “Random”
and ‘Hits’ (601 vs. 562 ms) did not differ ($t(4) < 1$). This allows us to interpret the findings in terms of Halperin’s et al. model.

Table 1 shows the percentage of errors in the different categories and the percentage of correct responses (‘Hits’) of the two groups.

**TABLE 1.** Percentage of errors and hits on the CPT test

<table>
<thead>
<tr>
<th>Percentage of errors</th>
<th>MMR+ADHD+CD</th>
<th>MMR Control</th>
<th>Chi-square</th>
<th>df = 1; p &lt; .004</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-not-X</td>
<td>17.89</td>
<td>6.32</td>
<td>8.371</td>
<td></td>
</tr>
<tr>
<td>A-only</td>
<td>5.39</td>
<td>4.6</td>
<td>4.492</td>
<td></td>
</tr>
<tr>
<td>X-only</td>
<td>13.6</td>
<td>6.75</td>
<td>3.724</td>
<td></td>
</tr>
<tr>
<td>Random errors</td>
<td>0.83</td>
<td>0.12</td>
<td>1.806</td>
<td></td>
</tr>
<tr>
<td>Percentage of hits</td>
<td>84.13</td>
<td>86.4</td>
<td>0.255</td>
<td></td>
</tr>
</tbody>
</table>

The groups did not differ with respect to the proportion of inattention errors (A-not-X), or to the speed or SD of ‘Hits’ and commission errors (p values between .605 and .930). However, the MMR group with externalizing problems committed significantly more inhibition errors (A-only) than the MMR group without externalizing problems (p < .034). However, as mentioned in the introduction, only the A-only errors with long latencies reflect impulsiveness. Too few A-only errors were made to divide A-only errors.

A regression analysis was carried out to determine the relationship between the CPT test and the total CBCL-TRF scores. This clearly indicated a connection between response inhibition, as measured with the A-not-X error rate, and the total CBCL-TRF external score ($F(1,38) = 6.114; p < .018$). The relationship of the A-not-X error rate to the aggressive and delinquent scores in the CBCL-TRF also proved to be significant ($F(1,38) = 4.809; p < .035$ and $F(1,38) = 6.204; p < .017$). No association between A-not-X error rate and the other behavioural scales of the CBCL-TRF were found. No connection was found between A-not-X error rate and age or IQ level.
In sum, relative to the MMR-only group, the MMR children with externalizing disorders exhibited poor-response inhibition operationalized in terms of the A-not-X CPT instrument. However, as stated earlier, half of this sample was on medication during testing. Three analyses were carried out to determine whether medication was a confounding factor in the current study. In the first analysis, children receiving medication were compared to the unmedicated children with respect to the number of errors, the mean reaction time (RT) and the standard deviations of the RT. No group differences were found. In the second analysis, the medicated and unmedicated children were compared with the MMR-only group. It appeared that both the medicated and unmedicated children exhibited poor-response inhibition in comparison to the MMR-only group: the p values were .05 and .003, respectively. In the third analysis the CBCL-TRF scores of the children with externalizing disorders receiving and not receiving medication were compared. No differences were found on any sub-scale, p values varied from .958 to .082.

INTRODUCTION EXPERIMENT 2

The main finding of the first experiment was that relative to MMR-only, MMR+ was associated with poor-response inhibition. The goal of the second experiment was to explore whether poor-response inhibition in such children was associated with an inability to suppress immediate arousal.

Research has shown that a high-intensity auditory signal occurring simultaneously with a response stimulus reduces RT, but increases the error rate (e.g. Van der Molen & Keuss, 1979; 1981). If there is no risk of responding incorrectly, as in a simple RT task, speed increases without a loss of accuracy. Furthermore, the effects of immediate arousal on
performance are helpful when response preparation is low, but will lead to errors when response preparation is already high. This pattern has been interpreted to suggest that an auditory stimulus elicits an immediate arousal effect on motor activation (Bertelson & Tisseyre, 1969). According to Sanders (1977), the auditory signal causes a direct coupling of input and output processes, with errors as a possible result. Hence, in order to avoid high error rates, immediate arousal should be suppressed. In his cognitive energetics model, Sanders (1983) argued that this might be accomplished by means of the effort mechanism, which links and, if necessary, disconnects perception from action.

The phenomenon of bypassing mental steps as a result of immediate arousal may be of interest with respect to the observation made in Experiment 1: that children with the dual diagnosis MMR+ commit many CPT errors of commission. Within this perspective, RT performance of MMR children with an externalizing behavioural disorder (ADHD and CD) will be compared to a normal control group under two different conditions (Condition A - without a high-intensity auditory signal present, Condition B -with a high-intensity auditory signal present) in order to test whether poor-response inhibition in the clinical group is associated with an inability to suppress immediate arousal.

METHOD

Subjects

The group of 21 MMR children with externalizing disorders who participated in Experiment 1 was extended to 30 children (24 of which were boys). The group had a mean IQ of 74 (SD = 8) and a mean age of 146 months (SD = 16). The control group consisted of 101 children (48 of which were boys) with a mean IQ of 102 (SD = 11) and a mean age of 141 months (SD = 8). IQ was assessed using the WISC-RN test (comprehensive version). The control children were recruited from normal schools in the immediate vicinity of the Van Arkel Institute, and had no signs of learning disabilities, manifest psychiatric disorders, or neurological impairments.

Description of test

The Alertness task, a sub-task of the Test for Attentional Performance (Zimmermann & Fimm, 1996) was implemented using an IBM-PS/VP. The children sat 60 cm away from the monitor. Under condition A, the children were instructed to press a button as fast as
possible when a cross (x) appeared on the screen (n = 20 trials). Under condition B, the children were instructed to wait for an acoustic signal (60 dBA) before reacting as fast as possible when a cross (x) appeared on the screen (n = 20 trials). Figure 2 shows the time parameters of the test.

![Diagram of time parameters of the Alertness task]

**FIGURE 2.** Time parameters of the Alertness task.

To help focus the children's attention, the cross (x) was always preceded by a dot under both conditions A and B. Responses were made by pressing a button. The condition sequence of conditions applied in the test was A, B, B, A. Each test lasted about 6 minutes.

**Procedure**

The children were instructed to react as quickly as possible but to maintain a high level of accuracy. They were instructed to focus on the dot on the screen and to press the button when a cross appeared on the screen, or to wait until they heard the auditory signal (a tone). The children practised until they completely understood what they had to do in the test (criterion training). In general, the practice session lasted about 2 minutes. During the test no interaction was allowed between the researcher and the child. The test took place in a quiet room.
RESULTS

RT, accuracy, anticipation error rate and SD were each analysed for variations with regard to the group factors (MMR vs. control) and the warning signal factor (present vs. absent).

Figure 3. Results of the MMR group with externalizing disorders and the control group in the Alertness task. (Upper left figure: RT; upper right figure: SD; bottom left figure: correct responses; bottom right figure: anticipation errors)

Figure 3 presents the test performance of the MMR+ group and the control group. Overall, the control-group children responded faster (F(1,128) = 25.623; p < .001) than MMR+ children with a smaller SD (F(1,128) = 65.029; p < .001). They also made more correct responses (F(1,128) = 13.561; p < .001).

The auditory signal was found to have no effect with respect to the SD of RT (F(1,128) = 1.466; p < .228). However, it did effect the mean RT and performance accuracy quite significantly. Firstly, responses to the stimuli with an auditory signal were faster than responses to the stimuli without the signal (F(1,128) = 50.319; p < .001). This was the same in both groups: the interaction between the group and the conditions was not significant.
(F(1,128) = .424; p < .516). Secondly, the number of commission errors decreased under conditions with the auditory signal (F(1,128 = 10.254; p < .002). This was especially true in the case of the children with MMR +: the interaction between group and conditions was (F(1,128) = 7.595; p < .007). The following findings have important significance with respect to the inhibition hypothesis in MMR +: 1) MMR children with externalizing disorders made more anticipation errors overall (F(1,128) = 49.141; p < .001), 2) this was particularly the case under the condition where the auditory signal was present (error range: 0-11): the interaction group versus condition nearly reached significance (F(1,128) = 3.693; p < .057).

To determine whether the medication factor confounded the current data, the same analyses done in Experiment 1 were carried out again here. No differences were found between the medicated and unmedicated groups with respect to RT (F(1,27) = 1.66; p < .207), SD of RT (F(1,27) = .667; p < .421), number of correct responses (F(1,27) = 2.556; p < .121), or number of anticipation errors (F(1,27) = .388; p < .566). Separate comparisons made between the medicated and the unmedicated children and the control group showed that all children had longer response times than the control group. This was the case in Condition B with the auditory signal and Condition A without the auditory signal (p values were < .001). With respect to the number of anticipation errors, it appeared that both the medicated children and the unmedicated children made more anticipation errors compared to the control group under auditory-signal conditions. Under Condition A without the auditory signal, only the medicated children made more anticipation errors relative to the control group.

**DISCUSSION**

Using an X-only version of a Continuous Performance Test, Pearson, Yaffee, Loveland and Lewis (1996) compared a group of children with mental retardation (MR) and externalizing disorders to a group of children with MR-only. The MR group with externalizing disorders committed four times as many errors of commission relative to the MR-only group. Based on this finding, Pearson and colleagues concluded that MR plus externalizing disorders is associated with poor-response inhibition. However, this conclusion may have been premature since the CPT (X-only version) test is not inclined to differentiate between inattention and impulsiveness. The goal of the first experiment was to explore whether MMR children with externalizing disorders do indeed suffer from an inability to
suppress an intended response compared to MMR children without co-morbid problems. For this purpose, we used the CPT model developed by Halperin and colleagues, which is designed to differentiate between attention and response inhibition.

The conclusion of Pearson et al. was confirmed: it appeared that children with MMR and externalizing behavioural problems have difficulty inhibiting their responses compared to children with MMR without externalizing problems. An analysis of the response times indicated that poor-response inhibition (increased number of A-not-X responses) in this group could not be explained in terms of the speed accuracy trade-off principle: that is to say, the group did not sacrifice accuracy for speed.

Halperin, Newcorn, Matier, Bedi, Hall and Sharma (1995) reported that impulsiveness is associated with aggression regardless of whether ADHD was present or not, and argued that it is an underlying personality trait. This is confirmed by our finding that impaired-response inhibition is associated with aggression and delinquent scores in the CBCL test in the clinical group.

It is interesting to note that the sample of children studied by Pearson et al. (1996) had a mean IQ level of 56 which was considerably lower than the IQ level of the children who participated in the current study. This suggests that poor-response inhibition is associated with externalizing disorders, not with low IQ per se. This idea has recently been put forward by Oosterlaan, Logan and Sergeant (1998) who carried out a meta-analysis concerning eight response-inhibition studies in children with externalizing disorders (ADHD and CD) and a normal IQ level. On the basis of a covariance analysis they argued that it is unlikely that poor-response inhibition in externalizing disorders is associated with intellectual functioning. However, children with an IQ level below 80 were excluded from their analysis. Consequently, one may argue that the IQ range was too small to justify such a statement. However, this argument no longer stands up given the outcome of the current study and the study of Pearson et al. (1996). The current model (IQ-matched groups with and without externalizing disorders) determined that the group differences regarding impulsiveness were not attributable to low IQ scores.

The goal of the second experiment was to explore whether poor-response inhibition in the MMR group with externalizing disorders was associated with an inability to suppress immediate arousal. Findings were straightforward. The auditory signal had an immediate arousal effect in both the MMR group with externalizing disorders and the control group: all
children performed faster under Condition B with the auditory signal relative to Condition A without the signal. However, the control-group children were able to suppress the immediate arousal effect of the auditory signal, i.e. they uncoupled the input from the output mechanism by means of the effort mechanism. However it was clear that the children with dual diagnosis were unable to suppress the immediate arousal effect of the auditory stimuli given the many anticipation errors they made, which in turn is suggestive of impulsiveness.

The two experiments together show that MMR children with externalizing disorders do not have the ability to delay arousal within the time domain: in Experiment 1 they were unable to suppress their response within the time domain after a visual warning signal was presented (the letter A) and before the GO signal (X) was presented; in Experiment 2 they were unable to suppress their response when an auditory signal was presented virtually simultaneously with the GO signal. Therefore, their difficulty in withholding their responses was unrelated to the model used, and findings agree with the delayed-responding hypothesis of Barkley (1994) and the delayed-aversion hypothesis of Sonuga-Barke 1992), creating a hyper-responsiveness to signals used to stimulate response in children of normal intelligence with an externalizing disorder.

Factors affecting the interpretation of the current study will be now discussed. These include: 1) the type of children who participated in the experiments, 2) the fact that about half of the institutionalized MMR children were on medication during testing, 3) the number of subjects who participated.

The purpose of the current study concerned the nature of the cognitive deficit in children with mild mental retardation and externalizing disorders. The MMR sample with externalizing disorders, which participated, is unlikely to be representative of children with ADHD and a low IQ score, given their inpatient status and the required admission criteria of dysfunctional family and intractable disruptive behaviour. As a result, their drug treatment (pipamperon which is a neuroleptic drug) is atypical in the field of ADHD. In The Netherlands and Belgium, the drug is given to mentally retarded children with integration disabilities. The drug is administered when all other medication has been ineffective. Therefore, the drug can be seen as a last-resort drug. The severity of the problematic behaviour of the children who participated made it unethical to stop medication for the purposes of the experiments. Therefore, given the aim of the study, an important question
arises concerning the extent to which pharmacology has contributed to the main finding of the study, i.e.: MMR children with externalizing disorders are impulsive. Several analyses were carried out in order to measure the effect of medication on RT performance. Based on such post hoc analyses, it seems safe to conclude that medication did not confound the outcome of the current study; even the unmedicated MMR children with externalizing disorders demonstrated poor response-inhibition compared to the control group.

It must be emphasized again that the aim of the study was to investigate cognitive abilities in a patient group, which required a controlling device to check for the possible effects of medication, in this case pipamperon. The aim was not to measure the clinical effectiveness of pipamperon because the range of dependent variables employed was obviously too limited to meet the requirements needed to achieve this. However, it remains a surprising finding that this compound did not interfere with the cognitive measures used in this investigation. At best, we could speculate that the MMR children on medication might perhaps have performed even more poorly had they not been on medication while participating in the tests. For the moment, however, it is more appropriate to conclude that the outcome with respect to medication calls for further research with the measurement of the beneficial effects of pipamperon in MMR children with externalizing disorders as the primary aim.

It may be argued that a model involving a small number of subjects, as was the case here, does not provide a ready interpretation of experimental effects. There are three points to be made regarding this issue. 1) in spite of the small numbers, all groups conformed to the predicted effects of the manipulative tasks. 2) the MMR group with externalizing disorders exhibited poor-inhibitory control in two different experimental paradigms. Hence, the strength of the present findings is not only based on statistical or group size, but also on replicativeness. 3) and Gaito (1963) has indicated that given two experiments with the same level of significance, the experiment with the smaller sample size would produce the more convincing results.
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