Visual attention and autonomic adaptivity to attention-demanding tasks in children with autistic-type behavioral problems
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Chapter 10

Summary of the Results and General Discussion

10.1 Summary of the main findings

The frequent co-occurrence of hyperactive-impulsive behavior with behavior problems that characterize (the minor variants of) the pervasive developmental disorders (see chapter 4) and the consideration that problems of impulse control may be related to specific components of attention have induced us to make a distinction between two subgroups of children with PDD-NOS, one group being considered to show this type of comorbidity, while the other is not.

A selective attention deficit in the sense of being easily distracted by irrelevant information could only be demonstrated for those children with PDD-NOS that were also characterized by hyperactivity and/or difficulties in impulse control (chapter 8). The children with PDD-NOS that were not characterized as being hyperactive-impulsive also, were shown to be as capable of neglecting irrelevant information as normal control children are (chapter 5).

Deficits in executive control have been demonstrated to occur in children with PDD-NOS, independently of whether they were characterized as being hyperactive-impulsive or not. When compared to normal control children, these deficits emerged as a reduced capacity for accurately and quickly carrying out the computational processes that make a demand on working memory (WM) and as a deficit in allocating the amount of effort necessary to perform a task efficiently.

A reduced capacity for the performance of WM dependent computational processes has been demonstrated by the use of a divided attention task (chapters 5 and 8). Compared to normal controls, children with PDD-NOS showed a significantly greater increase in their reaction times, in the variability of their reaction times and in the number of targets missed when cognitive load increased.

Deficits in effort allocation have been inferred from (specific) performance decrements exhibited while executing a sustained attention task. These decrements, which were found to be significantly greater than those of normal control children, occurred despite the fact that the children were continuously informed of the accuracy of their task performance (chapter 6).

Deficits in effort allocation have also been inferred from our finding that both groups of children with PDD-NOS showed significantly less autonomic responsiveness to an attention-demanding task than normal children did. This has been demonstrated by analysing changes in heart rate variability (HRV) from rest to task periods measured in a frequency range of 0.07 to 0.14 Hz (mid frequency band: MFB) while adjusting these changes for task-induced changes in respiration variability (chapter 8). By means of the study described in chapter 7 we were able to demonstrate that HRV measured in the MFB is a sensitive index of task-related mental effort if it is adjusted for changes in respiration variability measured in the same frequency band.

Compared to normal control children, both clinical groups showed significantly less decreases in our measure of HRV during the periods of task performance. For the control children only, the decreases were found to vary significantly with task load. Also, for these children only, the magnitude of rest-task differences in HRV appeared to be positively correlated with the accuracy of their task performance. For all children participating in the study, the magnitude of rest-task differences appeared to be negatively correlated with the amount of behavioral problems reported by parents. The results suggested a deficit in the vagal modulation of heart rate in children with a PDD-NOS.
The suggested deficit in vagal modulation has been confirmed by the study described in chapter 9. In this study we analysed a variety of measures derived from the continuous recordings of heart rate, blood pressure and respiration during periods of rest and periods of task performance, while applying a model in which the short term control of blood pressure is conceptualized as being mediated by the baroreflex. Assuming that the vagal system dominates heart rate and the sympathetic system dominates short term blood pressure regulation, the model enabled us to demonstrate qualitative differences between the three investigated groups in the relative contribution of sympathetic and vagal activity to the task-related cardiovascular changes found. Moreover, since the model was designed not only to examine vagal and sympathetic changes in response to task-related baroreceptor feedback, but also to estimate changes in basic vagal tone, we were able to demonstrate that the two subgroups of children with PDD-NOS differ from control children and from each other in their basic vagal tone (central vagal drive).

10.2 Discussion of the results in relation to other findings and the adopted models

10.2.1 Attentional performances

10.2.1.1 Selectivity

10.2.1.1.1 Focused attention and distractibility in children with PDD-NOS and autistic children

Children with PDD-NOS that are not characterized by problems of hyperactivity and/or impulsivity could be demonstrated to have no focused attention deficit in the sense of being easily distractible by irrelevant information. In this they appear to resemble the high-functioning autistic children of a study conducted by Pasqualvaca, Fantie, Papageorgiou and Mirsky (1998) and the autistic children of a study recently published by Ozonoff and Jensen (1999). The autistic children of both studies were able to ignore irrelevant stimuli and detect infrequently presented targets as rapidly and accurately as normal control children on the computerized version of a distractibility test (Pasqualvaca et al.) and to inhibit responses to irrelevant (distractible) information on the Stroop-Color-Word-Test (Ozonoff and Jensen).

Not being easily distractible by irrelevant information may be considered to accord also with the findings of studies that - guided by the observation that autistic people often focus on particular aspects of their environment only- tested the hypothesis that autistic individuals may have impairments in shifting attention, leading to overfocusing or overselectivity (Courchesne et al., 1994; Casey, Gordon, Mannheim, and Rumsey, 1993; Wainwright-Sharp and Bryson, 1993). These studies used spatial cueing tasks derived from Posner's visual orienting paradigm and did indeed demonstrate that people with autism have difficulties in one specific aspect of shifting attention to novel stimuli, i.e. in the process of disengaging attention from a previously cued location in the visual space. According to Casey and colleagues, in (high functioning) autistic people, "once attention is engaged, available resources for detecting other (novel) signals or stimuli will be depleted or inhibited" (1993, p.944).

However, as is described in chapter 8, those children with PDD-NOS that are more hyperactive characterized by hyperactive-impulsive behavior did show significantly more false alarms to irrelevant targets (foils). Hence, this subgroup of children with PDD-NOS appears to be less able to ignore irrelevant targets and inhibit a false response to distracting stimuli. This finding agrees with the results of those studies that investigated increased distractibility in children with AD/HD and other types of externalizing disorders, such as conduct disorder and oppositional defiant disorder (e.g. Barkley, 1997; de Sonneville et al., 1994; Oosterlaan, Logan and Sergenat, 1998; Ozonoff and Jensen, 1999, Swaab-Barneveld, 1998).

In this context it is notable that introverted subjects have been shown to have a "narrower" focus of attention compared to extroverted subjects resulting in less extensive processing of stimuli