3·5 Visual attention and autonomic responsiveness to attention-demanding tasks in children with autistic-type behavior

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Social maladjustment has been repeatedly suggested to be accompanied by deficient parasympathetic (vagal) modulation processes involved in the individual's autonomic response to environmental demands. We studied vagal and sympathetic responses to an effort-demanding attention task in a group of normal children and two subgroups of children with a lesser variant of the Pervasive Developmental Disorders (PDD-NOS, DSM-IV, 1994). One of these subgroups was considered to be also hyperactive-impulsive, the other was not.

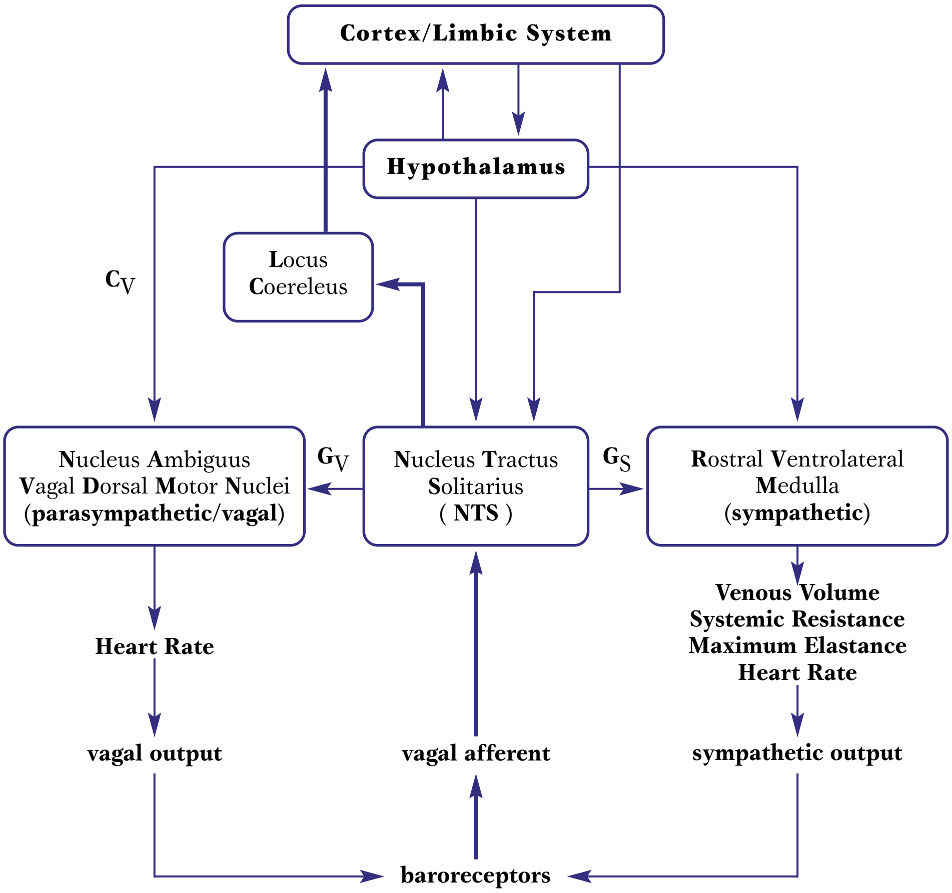

Figure 4 ▸ Cardiovascular control and feedback of cardiovascular changes to the brain
Gv*: Vagal gain: the degree in which peripheral information is transferred to the vagal structures in the brain stem.
Gs*: Sympathetic gain: the degree in which peripheral information is transferred to the sympathetic structures in the brain stem
Cv: Central vagal drive: baroreflex-independent basic vagal tone

*Note: Decreases in vagal and sympathetic gain result in a decrease of vagal and an increase of sympathetic activity

A number of measures was derived from the continuous recordings of heart rate, blood pressure and respiratory activity conducted during periods of rest and of task performance. Adopting a model, in which the short-term control of blood pressure is conceptualized as being mediated by the baroreflex (see figure 4), we simulated task-related changes in baroreceptor feedback-dependent vagal and sympathetic gain (i.e. strength of peripheral transfer, G_V and G_S) as well as in the level of basic vagal tone (C_V). Changes in basic vagal tone were simulated by implementing in the model a direct hypothalamic innervation of the medullary vagal structures involved in cardiovascular control, bypassing the peripheral feedback of changes in baroreceptor activity signaled to the nucleus tractus solitarius (NTS). While vagal and sympathetic gain are expected to decrease during task performance due to a temporary cortical inhibition of the NTS, high levels of basic vagal tone have been described in literature to correspond with high states of alertness.

Adopting Gv, Gs and Cv having a value of 1 at rest and varying these values in steps of 1/100, we simulated changes in mean HR, mean BP and variability values corresponding with a number of frequency bands. We then compared our actual experimental values with the simulated values in order to estimate changes in Gv, Gs and Cv. The best estimations were considered those that were reached by the smallest multivariate distance between the simulated and experimental values.

Table 1 shows that - during task performance - the group of normal control children display about equally reduced sympathetic and vagal gain values in combination with an increased central vagal tone. In contrast, neither of the PDD-NOS groups showed a decrease in vagal gain. Instead they show a decrease in central vagal tone, being lowest in the group of hyperactive PDD-NOS children. These findings accord with how our children performed the task. Both groups of PDD-NOS children showed a less efficient use of working memory, making significantly more mistakes and becoming slower with increasing task load than the control children. Both PDD-NOS groups showed time-on-task-related fluctuations in alertness, being less selective during the second task-block. Moreover, the hyperactive group appeared to be significantly less able to inhibit false responses to distracting stimuli.

Table 1 ▸ Estimations of vagal and sympathetic gain (Gv and Gs) and basic vagal tone (Cv) in three groups of children

	Controls	**PDDNOS NonHyperactive**	**PDDNOS Hyperactive**
G_V	0.72	1.04	1.20
G_S	0.78	0.84	0.84
C_V	1.24	0.72	0.24
Goodness of fit:	F(4,12)=1.66	F(4,12)=1.83	F(4,12)=0.22

It was recently demonstrated that the feedback of the somatic changes that accompany information processing contributes to enhanced attention, more efficient information processing and acquisition, and thus improved formation of memories. Hence, we conclude that a deficient vagal response (i.e. no vagal gain reduction in response to attention-demanding information) may explain why coherent mental representations are built up only weakly in children with autistic-type behaviour problems. This interpretation fits into the recently proposed “Central Coherence” theory, which is based on the observation that autistic people show a preference for featural “piecemeal” processing, being very well able to quickly detect small parts of a whole, but less able to integrate information in a larger context. A weak somatic marking of experiences may also explain autistic people’s poorly developed theory of mind.