SUDOMOTOR SYMPATHETIC HYPOFUNCTION IN DOWN'S SYNDROME

K. V. NAVEEN AND SHIRLEY TELLES*

Vivekananda Kendra Yoga Research Foundation,
9, 1ˢᵗ Main, Appajappa Agrahara,
Bangalore – 560 018

Abstract : General sympathetic dysfunction has been proposed as an explanation for the inability to reach normal heightened attention in Down's syndrome (DS). The present study on 15 DS subjects (group average age ± SD, 14.3 ± 3.6 years; 11 males) and in an equal number of age - and gender - matched normal subjects (NS), evaluated activity in different subdivisions of the sympathetic nervous system. DS subjects had (i) lower skin conductance levels (i.e., lower sudomotor sympathetic activity) and (ii) higher heart rates than NS. In response to auditory stimuli, DS subjects showed abnormal SSR responses (also indicating sudomotor sympathetic activity) but normal cutaneous vasoconstriction. Hence the results suggest that sympathetic dysfunction in DS is restricted to the sudomotor subdivision, activity of which has been associated with attention and recognition.

Key words : Down's syndrome   autonomic dysfunction
                sudomotor sympathetic   focused attention

INTRODUCTION

Autonomic nervous system dysfunction is frequent in persons with Down's syndrome (DS) and is constituted mainly by an imbalance between sympathetic and vagal systems (1). Standard tests (i.e., postural change and the cold pressor test) revealed no differences between DS subjects and age matched controls, with respect to heart rate, BP, and plasma catacholamines (2). A decrease in heart rate variability and breath amplitude, which is normally associated with focused attention while on a task, was not seen in retardates, who showed an opposite trend, which is incompatible with sustained attention (3). Also, autonomic activity during the phases of sleep has been studied in DS to understand the greater incidence of central sleep apnoea in these persons (1). DS subjects showed lower sympathetic activity during REM sleep compared to control subjects (4). A series of studies reported by Luria in 1963 (5), suggested that mentally retarded children could be distinguished from non retarded children on the basis of the orienting response (OR). This "what is it?" response, reflects a very basic reaction to inputs from the surroundings. Some

*Corresponding Author

retarded individuals were shown to have unstable or weak OR, which, if they occurred, extinguished rapidly. Children with DS showed electrodermal hyporesponsivity in their ORs to auditory stimuli (6).

In the studies cited above (1-4), autonomic activity in the mentally retarded was described in relation to a task or a change in arousal, as in sleep. The present study compared autonomic and respiratory measures at baseline in subjects with DS compared with age-matched, normal subjects. Also, studies on habituation of the ORs (5-6) described changes in electrodermal reactivity (EDR). The present study reported responses of other autonomic measures (e.g., heart rate and cutaneous blood flow) during exposure to auditory stimuli, in subjects with DS.

METHODS

Subjects: Baseline autonomic measurements were made in 15 subjects (11 males) with DS (7), with group average age ± SD, 14.3 ± 3.6 years; and 15 age and sex matched normal subjects (NS). Also recordings were made in these 15 DS subjects and in another 10 DS subjects (n = 25; group average age ± SD, 17.0 ± 5.4 years; 19 males) to compare baseline recordings with those during exposure to auditory stimuli.

Assessment procedure: During assessments subjects were seated erect, with back support, in a dimly lit, sound attenuated recording room. Autonomic and respiratory measures were recorded with a 4-channel polygraph (Medicaid, Chandigarh, India) in 5-minute periods (baseline and during

auditory stimuli). The EKG was recorded using standard limb lead I configuration. The skin conductance level (SCL) was recorded using Ag/AgCl electrodes covered with electrode jel and placed in contact with the volar surfaces of the distal phalanges of the index and middle fingers of the right hand. A low-level DC preamplifier was used and a constant voltage of 0.5V was passed between the electrodes. The respiration was recorded using a nasal thermistor clipped at the more patent nostril. The spontaneous sympathetic skin response (SSR) was recorded using Ag/AgCl electrodes filled with electrode gel (8). Electrodes were placed (a) on the back of the hand, in the second interosseous space, about 3-cm proximal to the interdigital web (b) on the palm of the hand. Amplifier settings were kept at: TC 0.1 ms, high cut filter at 70 Hz and sensitivity at 2 mV/cm.

Design: (1) To compare baseline differences between DS and NS, subjects were assessed in separate 10 minute sessions. (2) To study responses to auditory stimuli in DS subjects, the baseline period of 5 minutes was followed by another 5 minute period with 10 auditory stimuli spaced 30 s apart evenly, to elicit habituation.

Data extraction: The following data were extracted from the polygraph records: The respiratory rate (in cycles per minute) was calculated by counting the breath cycles in 60 second epochs, continuously. Finger plethysmogram amplitude (in mm) and skin conductance level (in µS) was sampled at 20-second intervals. Values averaged across each of the periods (before, after) of a session, were used for analysis. An SSR was said to occur as a response to the sound

stimulus, if it occurred within 1 s and the amplitude was greater than 2000 µV.

Analysis: (i) Baseline data of DS and NS subjects were compared using the Student t-test for unpaired data. (ii) Data of the DS group (a) before and (b) during exposure to the stimuli were compared using the t-test for paired data. (iii) Number of DS subjects who showed habituation of the SSR to sound stimuli were compared to those who did not, using the McNemar test.

RESULTS

(1) Comparison of baseline autonomic measures between NS and DS (Table I; n = 15 each; Student t-test for unpaired data): The skin conductance level (SCL) in uS was significantly lower in DS compared with NS (P<.01) and heart rate was significantly higher in DS (P<.01). (2) Comparison of autonomic measures in DS (n = 25) before (5 min) and during exposure to 10 auditory stimuli (5 min) (Table II). The finger plethysmogram amplitude was significantly lower during exposure to sound stimuli compared to before (P<.05). (3) Comparison

TABLE I : Autonomic and respiratory measures in normal subjects (NS) and those with Down's syndrome (DS). Values are group mean (95% CI).

	NS (N =15)	DS (N = 15)
Heart rate (bpm)	73.58 (69.76-77.40)	91.80** (80.04-103.56)
Breath rate (cpm)	21.5 (19.77-23.23)	22.8 (20.03-25.57)
Skin conductance (uS)	9.52 (6.82-12.22)	4.21** (1.27-2.65)

**P<.01, DS versus NS, Student t test for unpaired data

TABLE II : Autonomic and respiratory measures in Down's syndrome subjects (n = 25), at baseline (BL) and during auditory stimuli (ST). Values are Group Mean (95% CI)

	BL	ST
Heart rate (bpm)	88.39 (81.33-95.45)	87.18 (80.16-94.20)
Breath rate (cpm)	21.08 (19.30-22.86)	21.72 (20.16-23.28)
Skin conduct-ance (uS)	4.77 (3.70-5.84)	4.36 3.44-5.28)
Finger plethys-mogram (mm)	1.65 (1.37-1.93)	1.25* (0.99-1.51)

*P<.05, paired t test, ST versus BL

of number of DS subjects who showed habituation of SSR to the stimuli versus those who did not habituate: The number of subjects who showed abnormal SSRs (i.e., did not show SSRs [n = 10] and no SSR habituation [n = 7]), was not significantly different from the number of subjects who did habituate (n = 8), using the McNemar test (P>.05).

DISCUSSION

In the present study DS subjects showed lower SCL and higher heart rates, compared with age matched, normal subjects. Also, DS subjects showed a decrease in finger plethysmogram amplitude during exposure to auditory stimuli, but no other autonomic changes. Though more subjects showed abnormal SSRs to auditory stimuli, they were not significantly more than those who did habituate.

A lower SCL (higher skin resistance) is correlated with lower sympathetic sudomotor activity suggesting that baseline electrodermal responsivity is lower in DS as was described previously as part of the OR (5, 6). Some of the present DS subjects

also showed abnormal SSRs to repeated auditory stimuli, with 10 subjects showing no habituation, 7 subjects showing no SSR, and 8 subjects showing the expected response, i.e., habituation.

The higher resting heart rate in DS and the reduction in finger plethysmogram amplitude (i.e., cutaneous vasoconstriction) (9) during auditory stimuli suggest that cardiovascular sympathetic tone is not lower, but possibly exaggerated in DS, which may be related to the hyperkinetic behavior which is frequently associated with this syndrome (10). Also, our previous preliminary results (11), showed that the sole difference in the HRV spectrum components between DS and NS was that the HF component peak power was higher in DS. This suggests that activity in the HF band is well within the RSA (Respiratory Sinus Arrhythmia), vagal band of activity. However, this does not suggest any change in cardiac sympathetic-vagal balance.

Hence in DS, there appears to be selective reduction of sympathetic sudomotor activity with either no change or an increase in cardiovascular sympathetic activity. This is in keeping with the accepted idea that different subdivisions of the sympathetic nervous system may be active differently (12). The inadequate sympathetic activity in some subdivision (i.e., sudomotor) in DS may explain the inability of these subjects to focus attention. Electrodermal activity has already been reported to be abnormal in subjects who lose their ability to attend to and recognize familiar information (13). Hence the sudomotor dysfunction in DS may be related to the inability of these persons to focus attention and learn normally, especially since recognition and recall are essential to learning and memory (14).

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