...hould have been retained longer. Perhaps 3 weeks ...
...e differences in retention resulting from the two ...

...his study and within the limits of the investigation, ...
...he reverse chaining method group required significa...
... learn the given motor task than the subjects in the f...
... the instructional period. However, there was no signif...
...en the two groups.
...d should be recommended as an appropriate way to...
... who have difficulty comprehending the complexities...
...ciated with sport and leisure skills. Motor skills th...
...n particular would appear appropriate for the reverse...

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Automatic Postural Responses of Deaf Children From Dynamic and Static Positions

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This paper describes automatic postural responses of deaf children during anterior body sway. Subjects were placed in a vestibular dysfunction (VDD) or vestibular nondysfunction (VNDD) group based on postrotary nystagmus response. They stood on an electrically driven platform, and brief support surface movement (12 cm/sec) elicited automatic postural responses under both static and dynamic conditions. Subjects underwent trials with and without vision, and electromyographical (EMG) data was recorded from posterior leg muscles. Both groups displayed some response characteristics found in previous reports (Nashner & Cordo, 1981), and under dynamic conditions the response latencies significantly decreased. However, the major finding was the response delay of some 40 msec by VDD subjects. It was proposed that this delay could in part be responsible for balance and movement problems exhibited by many deaf children.

If upright posture is unexpectedly disturbed, then stability is maintained by an automatic postural response. That is, the response is reflex in nature and not under voluntary control. Visual and vestibular feedback as well as support surface inputs, that is, feedback created by forces and motions of the feet and ankle joint (Nashner, Black, & Wall, 1982), interact to complete this long loop reflex response. In identifying neurophysiological characteristics of postural control, recent investigations have attempted to isolate these sources of sensory feedback and therefore highlight their individual importance (Forssberg & Nashner, 1982; Nashner & Cordo, 1981). Presumably, a logical extension of this approach is the study of subjects with known nervous system dysfunction such that posture is clinically disturbed (Badke & Duncan, 1983; Mauritz, Dietz, & Haller, 1980; Nashner et al., 1982). This latter approach also proposes practical as well as scientific outcomes to research. That is, known nervous system dysfunction can be equated with behavioral outcomes and thus assist the rehabilitation process. This study adopts such a philosophy by investigating the automatic postural adjustments of deaf children, specifically those with vestibular dysfunction.

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ADAPTED PHYSICAL ACTIVITY QUARTERLY, 1984, 1, 247-252

children are usually observed during a standard-
bles such as dynamic or static equilibrium and eyes
iferior equilibrium skills of deaf children are well
Myklebust, 1960) and appear to be inherent across
Broadhead, 1983). Severe equilibrium problems
individuals who have some degree of vestibular

ostural adjustment among deaf children, char-
hical (EMG) activity were analyzed with respect
ic and dynamic conditions, both with and without
rotocol, work with normal populations (Forssberg
981) has provided some guidelines to help deter-
t upright posture is displaced anteriorly, then
proximal (gastrocnemius to hamstrings) muscle
tency is approximately 110 msec, with hamstr-
This temporal-spatial structure remains relatively
ment or during eyes open or eyes closed condi-
with vestibular dysfunction subjects (Nashner
ay well be increased and more variable.

ethod

ected from the elementary campus of the Texas
jects had a severe/profound hearing loss. Sub-
of a postrotary nystagmus test (Ayres, 1975),
ive vestibular system mediating the vestibulo-
oss-legged on a rotary board that completed
tions the board was stopped and the duration
is repeated, rotating the child in the opposite
s were grouped according to normal or slightly
group, n = 3) or zero nystagmus response
ysfunction (n = 3). This data and further
in Table 1.

f. posterior support surface perturbations at
cm/sec. These movements were sufficient
nterior body sway without destabilizing the
feet shoulder-width apart and arms folded.
nd then eight trials with eyes closed. Each
m/sec (static condition). This was followed

hildren of the Texas School for the Deaf for

Table 1
Subject Characteristics and Postrotary Nystagmus Results

Group	Subject	Sex	Age (mths)	Etiology of deafness	Nystagmus scores Total (sec)	*SD*
VNDD	1	F	96	Hereditary	12	−1.0
	2	F	114	Goldenhars	10	−1.3
	3	F	123	Rubella	19	+0.2
VDD	4	F	127	Meningitis	0	−3.0
	5	M	129	Hereditary	0	−3.0
	6	F	99	Meningitis	0	−3.0

by four continuous platform perturbations of different speeds, presentation of which were counterbalanced across trials, and included a platform movement also at 12 cm/sec (dynamic condition). The duration of each trial was approximately 8 seconds and complete stability was only momentarily maintained prior to a subsequent perturbation. Temporal and spatial automatic EMG responses were monitored from gastrocnemius and hamstring muscles. Surface EMG electrodes were placed centrally on the muscles and EMG signals were transmitted to four amplifiers (Tektronix AM 502 Differential Amplifiers by Harvard Apparatus Preamplifiers). Muscle activity was recorded with a Hewlett-Packard 396A instrumentation tape recorder in conjunction with a Harvard Apparatus 10-speed chart mover that provided hard copy from which the data was analyzed.

Statistics

For both distal and proximal muscles the data was analyzed by a 2 by 2 by 2 (group by platform movement by vision) analysis of variance with repeated measures on the last two factors. The dependent measures were mean response latencies (msec) for eight trials at the platform speed of 12 cm/sec from static and dynamic positions (platform moved a distance of approximately 1.5 cm). The .05 level of significance was accepted on all analyses.

Results and Discussion

Response latencies for both the gastrocnemius and hamstring muscles are shown in Figure 1. For the gastrocnemius, analysis yielded a main effect for group only ($F = 11.69$, 1/4 df). With eyes open the VNDD group yielded a mean latency of 141 msec ($SD = 12$) and 134 msec ($SD = 12$) during platform movement. Minimal changes existed for the eyes closed condition. However, the VDD group recorded delayed response latencies with respective means being 178 msec ($SD = 7$) and 168 msec ($SD = 4$). Again minimal differences were noted for different visual conditions.

For the hamstrings, main effects for group ($F = 9156$, 1/4 df) and platform condition ($F = 10.59$ 1/4 df) were recorded. For the VNDD group, eyes closed condition, mean response latencies decreased from 179 msec ($SD = 25$) to 157 msec ($SD = 17$).

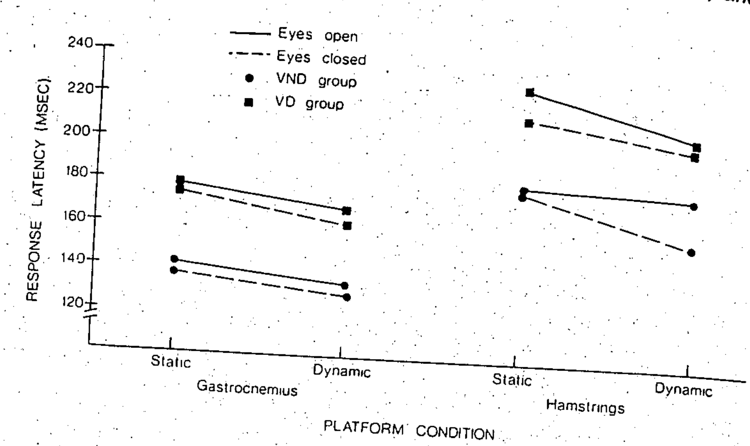

Figure 1- Subject mean EMG response latencies to anterior body sway.

Again the VDD group displayed increased response latencies which also decreased during platform movement. Mean responses for the static condition were 227 msec (SD = 15) and 213 msec (SD = 14) and during platform movement 204 msec (SD = 12) and 203 msec (SD = 3). There were no significant interaction effects for either analysis.

The performance of both groups coincide with what appears to be invariant characteristics of an automatic postural response (Nashner & Cordo, 1981). That is, in general only minimal differences existed between eyes open and eyes closed conditions, and clearly both groups displayed a distal to proximal muscle activation pattern. The reduction in response latencies with eyes closed may well reflect an overall increase in muscle tension. Both groups also displayed decreased latencies to the dynamic platform condition. This was certainly more evident for the proximal musculature and was presumably in response to more stringent control over upper body displacement during the dynamic condition. Interestingly for the VNDD group, this effect occurred only during the eyes closed condition and otherwise the addition of visual monitoring (together with an intact vestibular system) during displacement was sufficient to maintain the performance noted during the presumably less demanding static condition.

Obviously, the major difference between the normal and vestibular dysfunction group was the response latencies. In fact, the gastrocnemius response for the normal group was a little delayed when compared to previous findings (Forssberg & Nashner, 1982). However, the fact that subjects 1 and 2 also showed a below-average nystagmus response may well explain this. Figure 2 displays the temporal and spatial EMG structure of a typical response. Understandably, if equilibrium displacement was unexpected or faster, then any response delay must contribute to balance loss. Also, during tasks on a narrow balance beam the somatosensory input involving the foot and ankle joint is reduced, thus further delaying the automatic postural response (Nashner, 1982). Of further concern is how this response delay interacts with skilled movement or subsequent responses within a movement sequence. To maintain body sway within the parameters of expected normal disturbance, then, this delayed response must be accompanied by a more aggressive muscle contraction. The closer a child approaches postural limits then, the more this contraction will become aggressive, and certainly inappropriate, if subsequent responses are forthcoming. Needless to say, with experience some children may well develop postural strategies to overcome these difficulties.

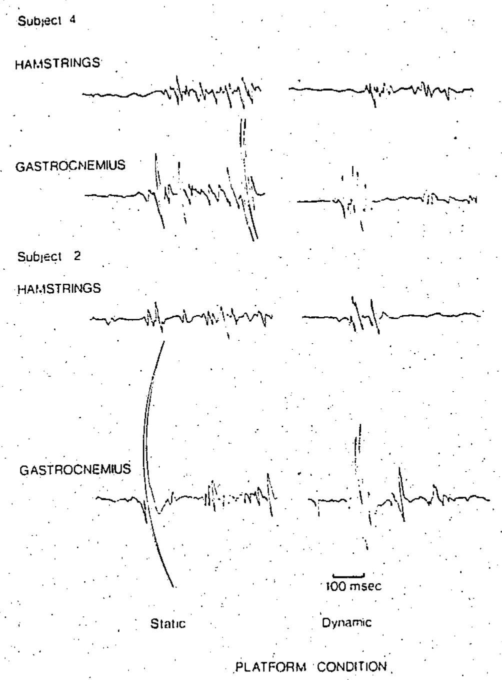

Figure 2- Typical hamstrings and gastronemius EMG responses for both static and dynamic platform conditions for subject 4 and subject 2.

This study provided an initial investigation into automatic postural adjustments of deaf children during anterior body sway. It was proposed that a delayed postural response exhibited by those deaf subjects with vestibular dysfunction could contribute to equilibrium and skilled movement disorders. With the exception of this delayed response, other properties of the automatic postural response appeared to be intact. However, under less stable conditions (dynamic condition) different response strategies between the groups in controlling trunk displacement were noted. Studies linking upper limb coordination with postural displacement will provide further insight into the cause of movement problems noted in many deaf children

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DIGEST

Psychomotor Change With Practice In Older Adults

A number of investigations have examined psychomotor performance decline in older adults. As the authors of this report correctly summarized, research concerned with elderly persons' capacity to acquire new psychomotor skills, and this acquisition's relationships to performance, has been sparse. Therefore, this study was conducted to determine the pattern of older adults' psychomotor performance change associated with practice and to examine the influence of information storage and processing capacities. The authors hypothesized that although older adults would demonstrate positive psychomotor performance change through practice, the rate of change would be significantly less than for that of a college-age comparison group. It was further hypothesized that this differential rate of change would be explained at least partially by the interaction of information storage and information processing limitations in the older adults.

Using the Bassin anticipation timer in an experimental research design, 120 older adults and 120 college-age adults were randomly assigned to one of six treatment conditions created by varying the temporal location of knowledge of results during psychomotor practice. An analysis of variance revealed motor performance proficiency differences favoring the college-age adults, but no difference between the age groups in the pattern of performance change associated with practice. Both age groups significantly decreased errors on the physical task with practice. The authors were able to partially explain the proficiency difference