A STUDY OF NORMATIVE DATA AND TEST-RETEST RELIABILITY USING TWO ECCENTRIC ROTATIONS WITH SUBJECTIVE VISUAL VERTICAL TESTING

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Disorders in the otolithic organs causes postural instability in the absence of other sensory cues and also alters our perception of a true horizontal or vertical line when the patient is deprived of other visual cues (oculogravic perception).

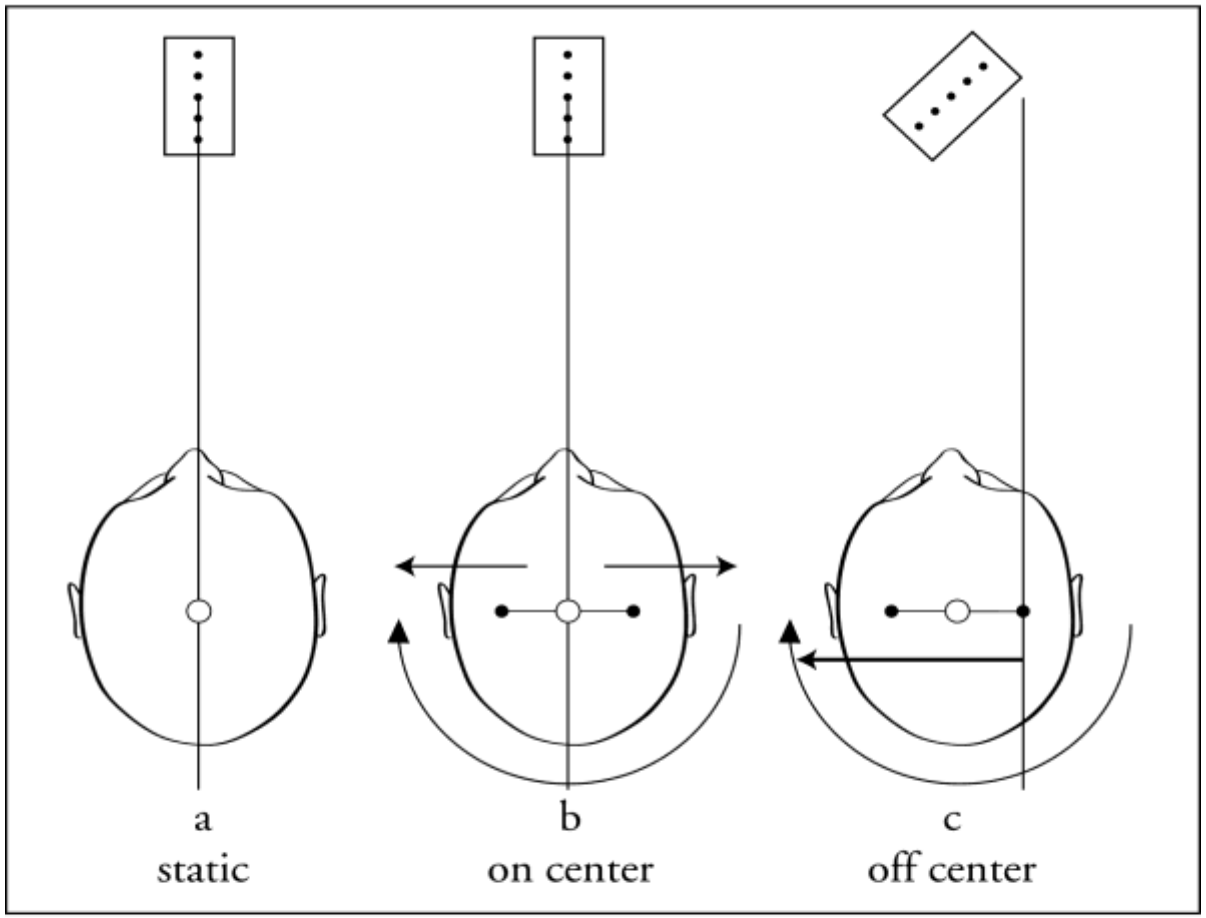
One assessment tool gaining popularity for otolith assessment has been subjective visual vertical (SVV) test during off axis centripetal, or radial acceleration (Clark et.al, 2001, Bohmer and Mast, 1999).

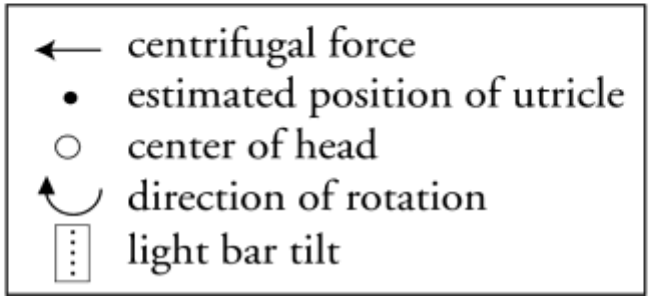
Patient Setup

Procedure;

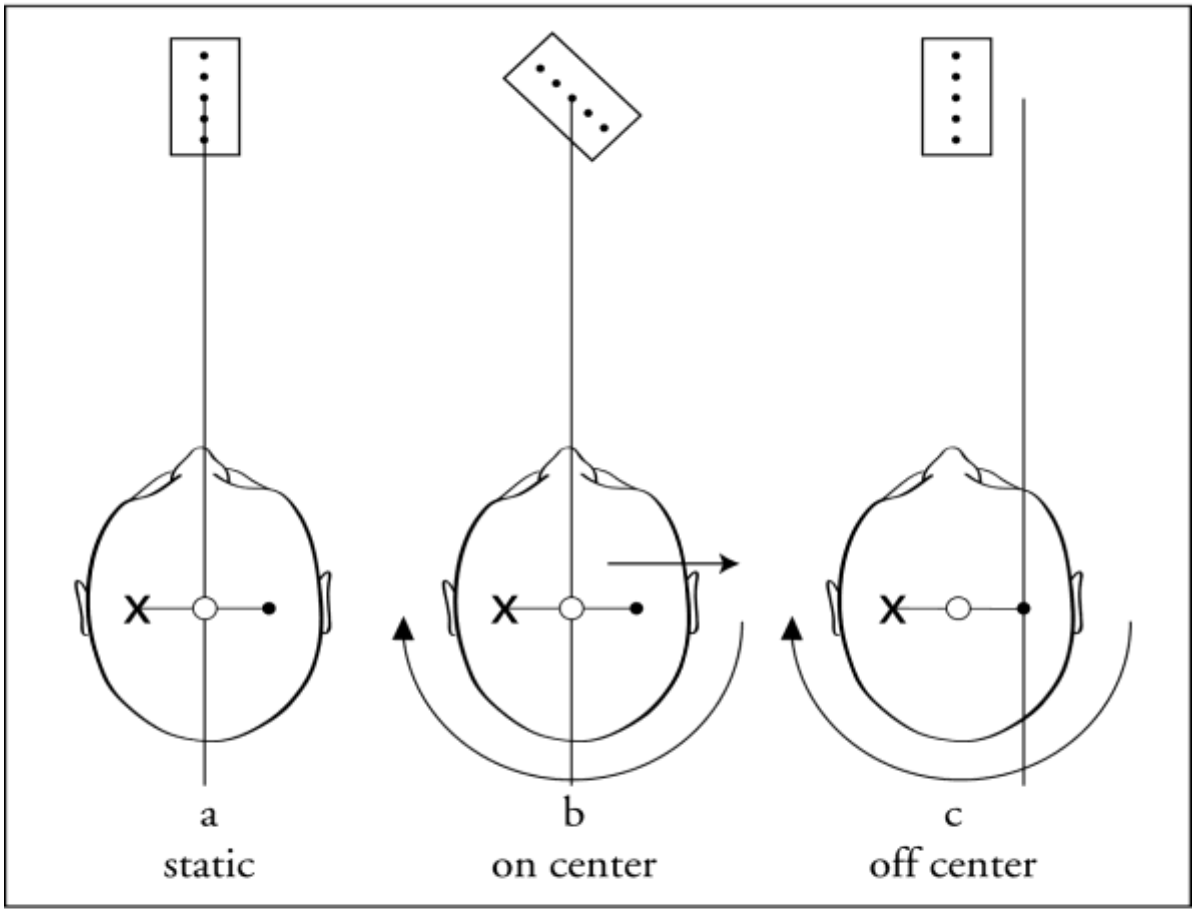
- the SVV test the patient spins at a constant velocity with an eccentric displacement of the axis of rotation. When the axis of rotation is through one of the vestibular systems, the afferent activity from the otolith within that system is minimized and the contralateral otolith is stimulated.

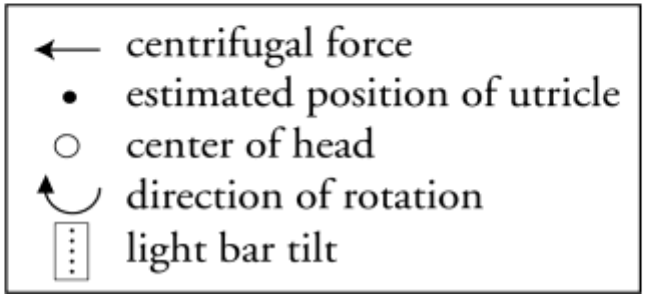
Normal


a
static
b
on center
c
off center


centrifugal force
estimated position of utricle
center of head
direction of rotation
light bar tilt

Left Deficit - Compensated



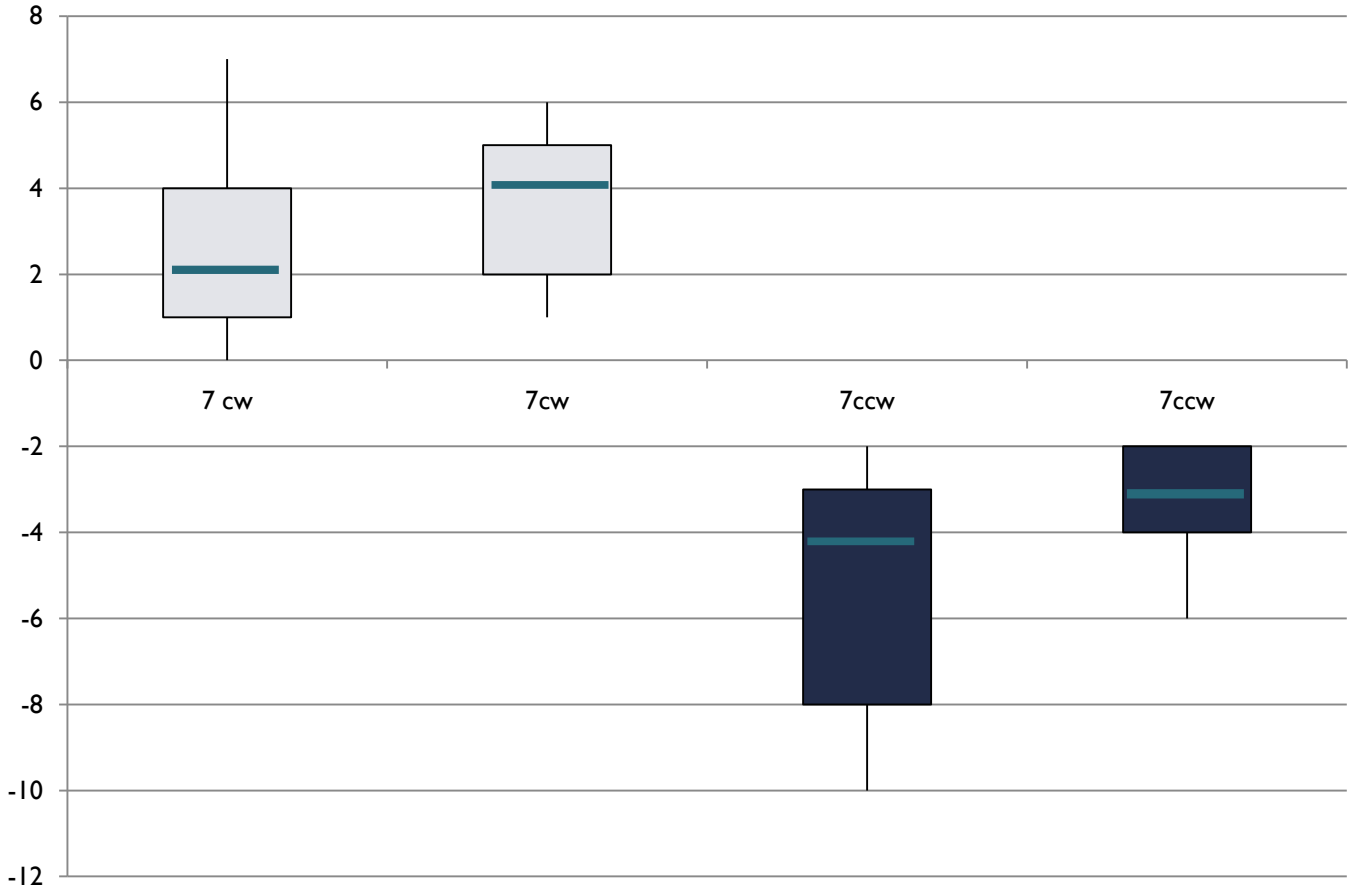


Concerns;

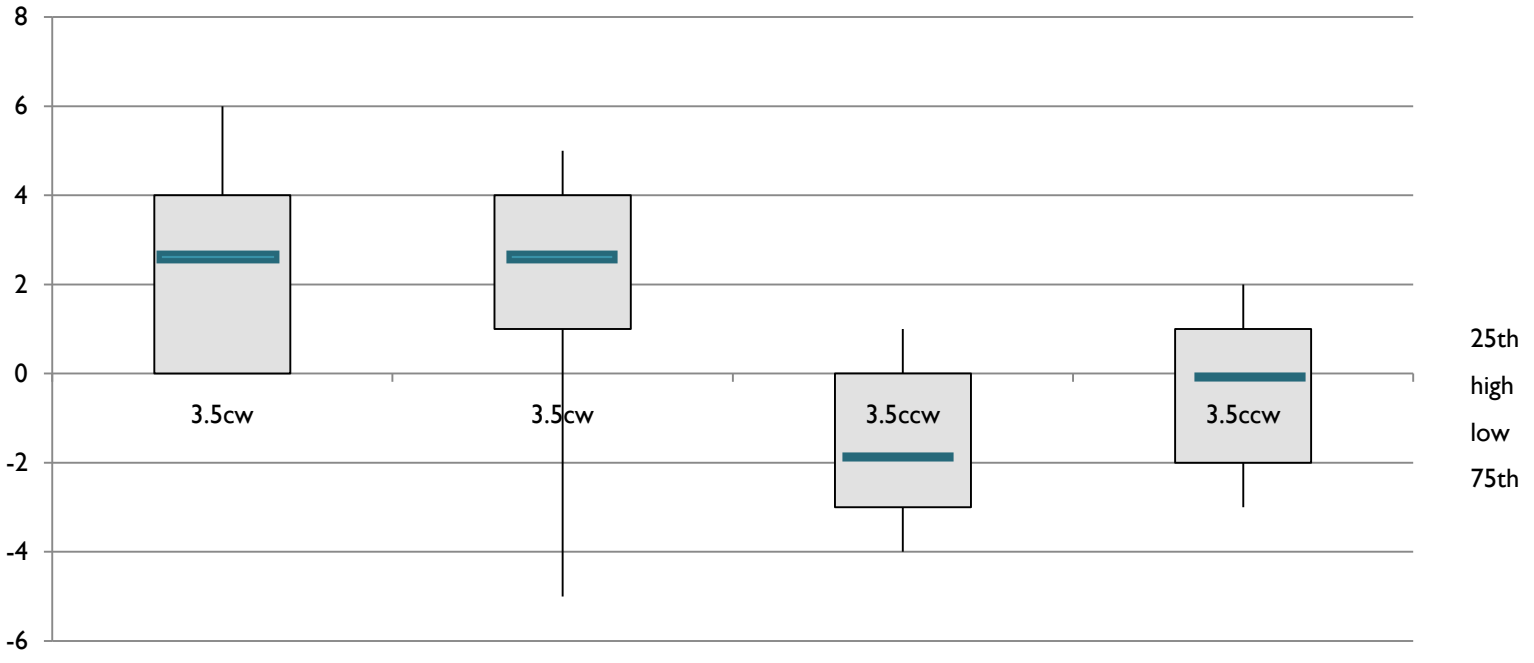
The current normative data for the SVV test suggests that normal individuals tilt the perceived vertical between 6 to 8 degrees towards the axis of rotation while those with known otolithic weaknesses either produce no shift in the vertical or offset it only by a few degrees. There is a lack of data showing the variability in the horizontal offset in normal populations, the test-retest consistency among normal individuals, and the relationship of SVV test results to other laboratory tools that are sensitive to otolithic injury.

Do individuals with no postural complaints produce consistent , predictable, and reliable subjective visual vertical offsets? Is there a relationship between the offsets and individual differences in the SOT subtest? All individuals were assessed with the SOT battery and with the rotary chair protocol, requiring vertical estimations before rotation, during rotation at 7 cm off axis both directions, during rotation at 3.5 cm off axis both directions, and all conditions repeated on a different date.

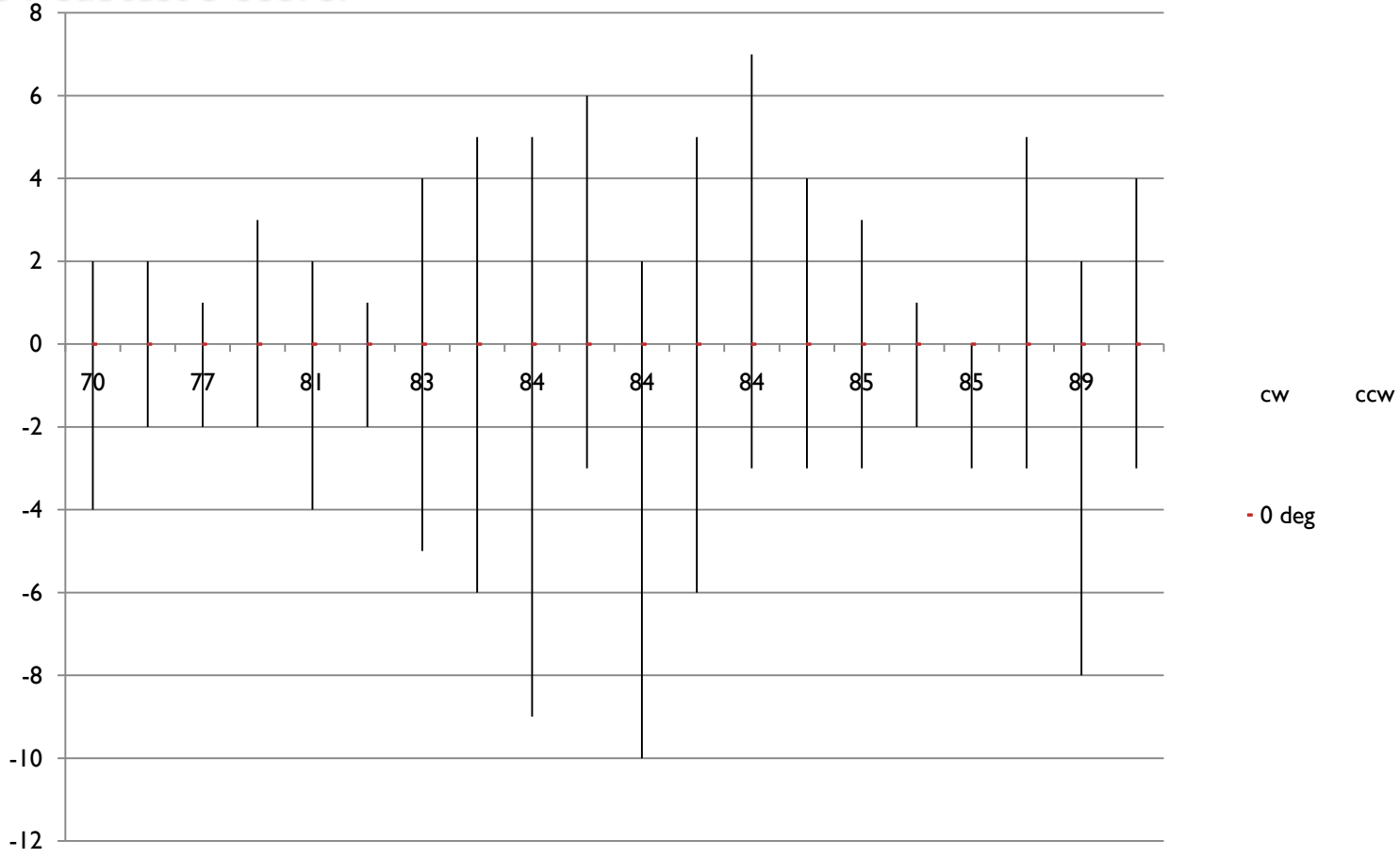
A comparison of vertical tilts with 7 CM offset chair. The whisker chart shows the least tilt, the greatest tilt, the 25th, median, and 75th percentile tilts. Negative values are leftward tilts, positive are right.



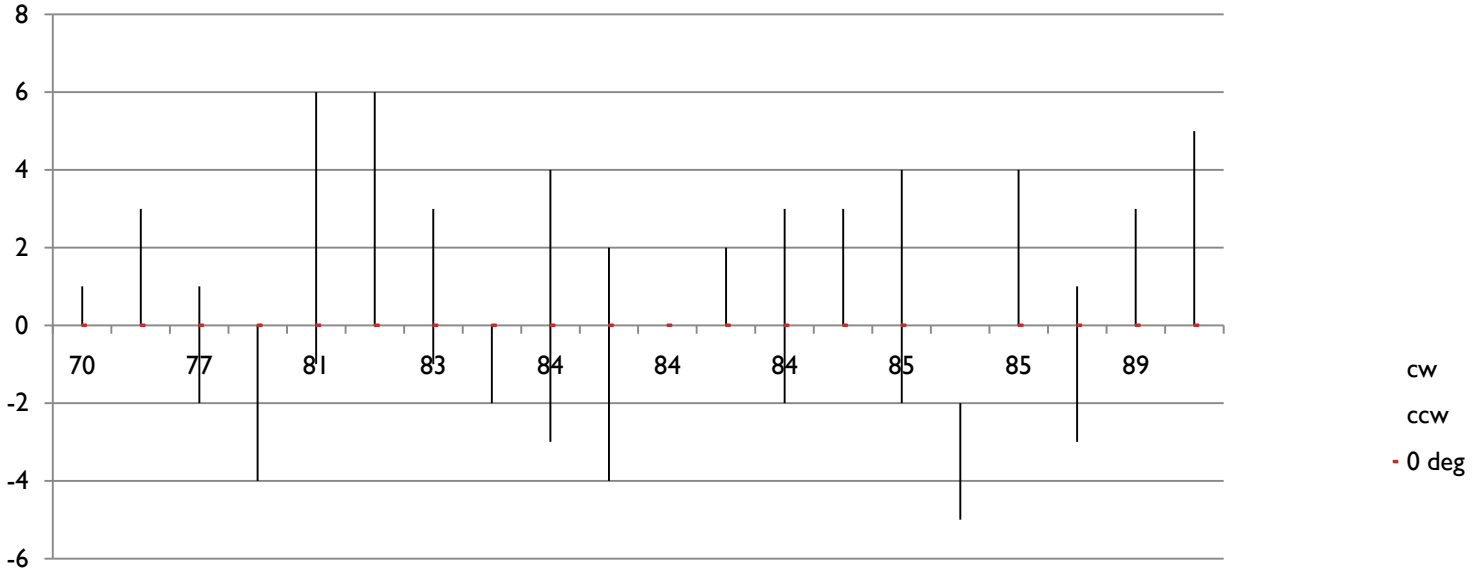
A comparison of vertical tilts with 3.5 cm chair offsets. The whisker chart shows the least tilt, the greatest tilt, the 25th, median, and 75th percentile tilts. Negative values are leftward tilts, positive are right.



Test and retest subjective vertical shifts for the 10 subjects for 7 cm chair offsets. The positive values reflect rightward vertical line shifts as a result of clockwise (cw) rotations and the negative values reflect leftward shifts as a result of counterclockwise (ccw) rotations. The subjects are ranked by the SOT subtest 5 score.



Test and retest subjective vertical shifts for the 10 subjects for 3.5 cm chair offsets. The positive values reflect rightward vertical line shifts as a result of clockwise (cw) rotations and the negative values reflect leftward shifts as a result of counterclockwise (ccw) rotations. The subjects are ranked by the SOT subtest 5 score.



Descriptive Statistics

Dependent Variable: vertical tilt

offset		Mean	Std. Deviation	N
7	cw	3.0500	2.03845	20
	ccw	4.2500	2.38140	20
	Total	3.6500	2.27077	40
3.5	cw	2.7000	2.00263	20
	ccw	1.7000	1.17429	20
	Total	2.2000	1.69766	40
Total	cw	2.8750	2.00240	40
	ccw	2.9750	2.25874	40
	Total	2.9250	2.12147	80

Tests of Effects

Dependent Variable: vertical tilt

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	66.450(a)	3	22.150	5.823	.001	.187
Intercept	684.450	1	684.450	1.932	.000	.703
offset	42.050	1	42.050	11.054	.001	.127
direction	.200	1	.200	.053	.819	.001
offset * direction	24.200	1	24.200	6.362	.014	.077
Error	289.100	76	3.804			
Total	1040.000	80				
Corrected Total	355.550	79				

a R Squared = .187 (Adjusted R Squared = .155)

Dependent Variable: vertical tilt

offset	sequence	Mean	Std. Deviation	N
7	test	3.8000	2.82097	20
	retest	3.5000	1.60591	20
	Total	3.6500	2.27077	40
3.5	test	2.2000	1.88065	20
	retest	2.2000	1.54238	20
	Total	2.2000	1.69766	40
Total	test	3.0000	2.50128	40
	retest	2.8500	1.68781	40
	Total	2.9250	2.12147	80

Tests of Effects

Dependent Variable: vertical tilt

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	42.950(a)	3	14.317	3.481	.020	.121
Intercept	684.450	1	684.450	166.405	.000	.686
offset	42.050	1	42.050	10.223	.002	.119
sequence	.450	1	.450	.109	.742	.001
offset * sequence	.450	1	.450	.109	.742	.001
Error	312.600	76	4.113			
Total	1040.000	80				
Corrected Total	355.550	79				

a R Squared = .121 (Adjusted R Squared = .086)

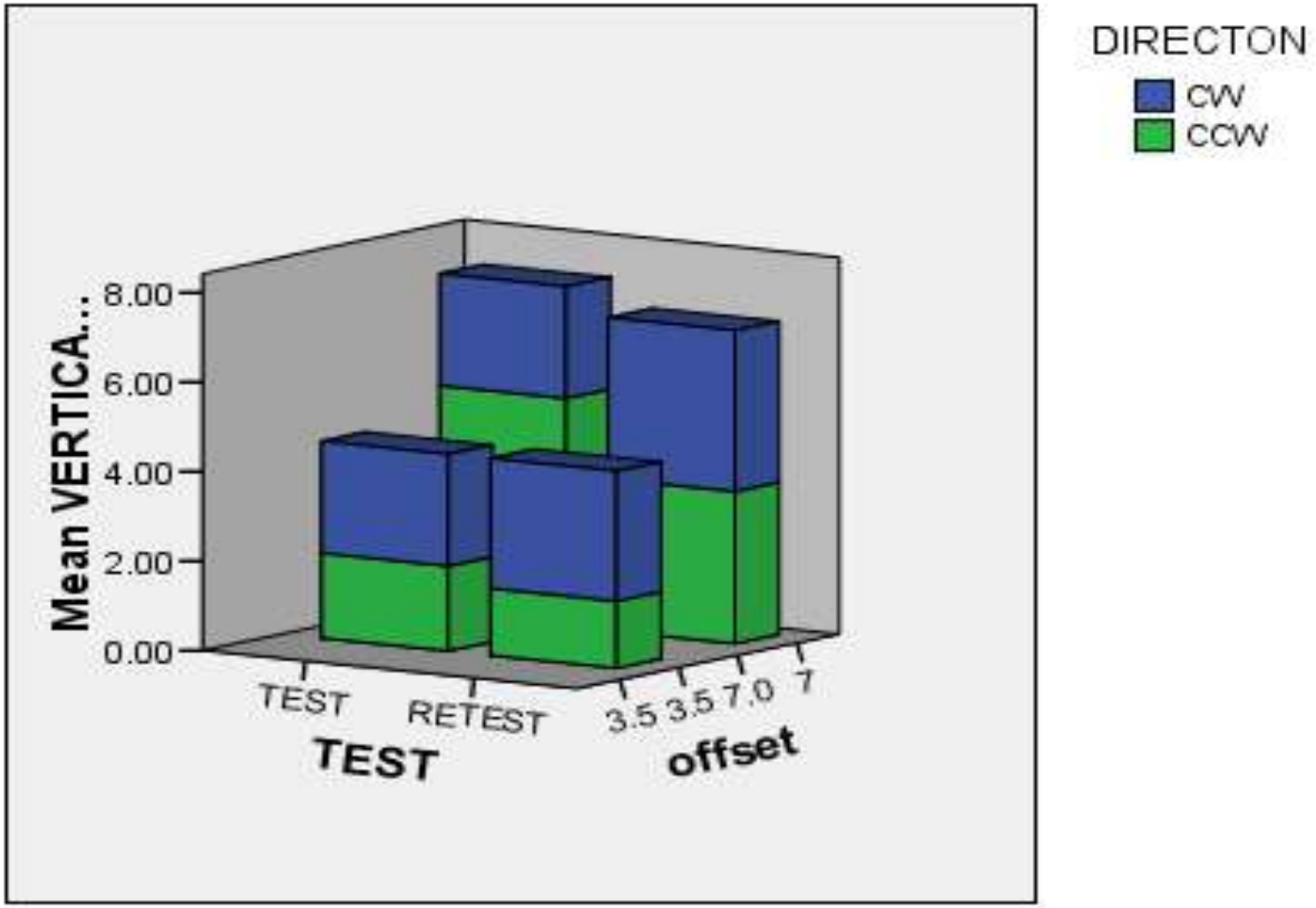
Tests of Between-Subjects Effects

Dependent Variable: VERTICAL TILT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	88.550(a)	7	12.650	3.411	.003	.249
Intercept	684.450	1	684.450	184.571	.000	.719
OFFSET	42.050	1	42.050	11.339	.001	.136
DIRECTION .	200	1	.200	.054	.817	.001
SEQUENCE	. 50	1	.450	.121	.729	.002
OFFSET * DIRECTION	24.200	1	24.200	6.526	.013	.083
OFFSET * SEQUENCE	.450	1	.450	.121	.729	.002
DIRECTION * SEQUENCE	16.200	1	16.200	4.369	.040	.057
OFFSET * DIRECTION * SEQUENCE	5.000	1	5.000	1.348	.249	.018
Error	267.000	72	3.708			
Total	1040.000	80				
Corrected Total	355.550	79				

a R Squared = .249 (Adjusted R Squared = .176)

Display of mean SVV tilts as a function of test sequence, amount of chair rotation offset, and direction of spin. Significant differences occur between the chair offset factor, the offset/direction, and the direction/sequence interactions.



Analysis of covariance with established homogeneity of slopes on the axis offset factor. The results show no significant effects of the sensory organization test subtest 5 scores on the perceived vertical tilts at both chair offsets.

Tests of covariant Effects

Dependent Variable: vertical tilt

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7.200(a)	2	3.600	.510	.609	.057
Intercept	.591	1	.591	.084	.776	.005
SOT	8.01E-005	1	8.01E-005	.000	.997	.000
offset	7.200	1	7.200	1.020	.327	.057
Error	120.000	17	7.059			
Total	284.000	20				
Corrected Total	127.200	19				

a R Squared = .057 (Adjusted R Squared = -.054)

Conclusions;

- A 7 cm eccentric rotation produces consistent and replicable shifts in perceived vertical orientations.
- The 3.5 eccentric rotation seems to detect a lot of abnormal otolith function in a normal population. Also, variablility in the results were high.
- Test – retest reliability is good for both the 7 and 3.5 cm chair offsets
- There does seem to be a slight differences in the amount of vertical tilt perception depending whether the subject rotates clockwise or counterclockwise. At the 7 cm offset there seems to be greater tilt during counterclockwise movement.
- For postural stability scores that fall within a normal range, there is no relationship between those individual scores and SVV test results. Also, the postural stability score has ne effect on the tilt perception.

What does this mean?

- The pattern of results may reflect the differences between a measure of impairment and one of pathology. The 7 cm offset could reveal a compensated system we all have due to lifetime experiences with head tilts. The 3.5 offset results are unique and the variability is due to a process of re-tuning sensory integration. It is hypothesized that a population with true unilateral otolithic lesions will show low variability because a replicated bilateral disorder of the otolith-ocular reflex should be the same for all