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Development of an equipment to improve neural control & eye hand coordination: A pilot study

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Abstract
Background: Eye–hand coordination is the coordinated control of eye movement with hand movement, and the processing of visual input to guide reaching and grasping along with the use of proprioception of the hands to guide the eyes. Eye hand coordination may vary because of age, hand dominance, type of vision, fatigue, exercise, sleep deprivation, alcohol. Eye hand coordination can be measured by different ways, such as alternate Hand Wall Toss Test and upper extremity motor control testing Device. The study objective is to develop a new equipment, establish reliability of the new equipment and to document reference values.
Materials and method: a experimental design with construction validity. Age - 18-35 year healthy individuals both male and female were included to avoid study bias. Subjects with recent upper limb fractures and any visual disturbances were excluded from the study.
Results: The total number of subjects was 707, including 356 male and 351 female. The SPSS Software Packaged was used.
Conclusion: The study was concluded that small OD Ring total number of error 3 is normal, time taken for first error 4-5 sec is considered as good, the distance required to reach the First Error 8-13cm is good and Total time spend to complete task is 14-18sec is consider as a normal for small ring. For Medium OD Ring total number of error 2 is good, Time taken for first error 3-5sec is normal, the distance required to reach the First Error 8-16cm is good, total time spend to complete task is 12-15sec is normal. Large OD Ring total number of error, 2 is good, time taken for first error 3-4sec is good, the distance required to reach the First Error 4-14cm is normal, total time spend to complete task is 11-15sec is normal.
Clinical Importance: Applications of the tool in the field of Physiotherapy for measuring, training and improvement of eye hand coordination.
Future research: Testing can be done using non dominant hand and multiple directions.

Keywords: Eye hand coordination, neural control, instruments, opening diameter ring

Introduction
Eye–hand coordination is the coordinated control of eye movement with hand movement, and the processing of visual input to guide reaching and grasping along with the use of proprioception of the hands to guide the eyes. Eye-hand coordination is a very important skill for several reasons. First, many self-help skills, such as tying shoes and buttoning coats, require well developed eye-hand coordination. Driving a car and using a computer, adults use eye hand coordination [1]. Eye hand coordination is integrated between four and 14 months of age. The infants explore their world and develop hand-eye coordination, in conjunction with fine motor skills. Fine motor skills are involved in the control of small muscle movements, such as when an infant starts to use fingers with a purpose and in coordination with the eyes [2].

Eye-guided hand movement
When eyes and hands are used for coordination exercises, the eyes generally direct the movement of the hands to targets. The eyes provide initial information of the object, including its size, shape, and possibly grasping sites that are used to determine the force the fingertips need to exert to engage in a task. However, for more precise movement or longer duration movement, continued visual input is used to adjust for errors in movement and to create more precise movement [4].

Proprioceptive signals from the hand

The role of proprioception may lie in the information it provides about the arm's inertia (Ghez *et al*. 1990) [7]. Thus, proprioception is necessary for building up a representation about the dynamical properties of the arm (Scarchilli & Vercher 1999) [8] without vision, the sense of proprioception i.e. internal knowledge of limb position is help to guide the hand movement with minor errors. When the hands are being used to guide eye movement both active and passive movement proprioception of limbs are result in eye saccades overshoots [8].

Neural mechanisms

The neural control of eye–hand coordination is complex because it involves the cerebral cortex, sub-cortical structures (such as the cerebellum, basal ganglia, and brain stem), the spinal cord, and the peripheral nervous system [9]. The posterior parietal cortex is believed to play an important role in relating proprioception and the transformation of motor sensory input to plan and control movement with regards to visual input [10]. The superior colliculus (SC) is play a role not only in saccadic eye movements, but also in arm movements in coordinating eye and hand control (Stuphorn *et al*. 2000) [11].

Eye hand coordination can be varied because of age [14], hand dominance, type of vision, fatigue, exercise, stress, any illness, distraction, sleep deprivation, mood changes [15].

Eye hand coordination can be measured by different ways, such as alternate Hand Wall Toss Test and upper extremity motor control testing Device.

Need for the study

Developing new equipment for eye hand coordination and motor control training is necessary because up to now there have been a very few equipments developed to train for eye hand Coordination as well as to assess for the same pre and post rehabilitation. Moreover this study aims at the development of eye hand Coordination equipment which will have auditory and visual cues and it will also try to overcome the limitations or demerits of the previously designed and used equipments

Following are the advantages of the new equipment-

1. Testing as well as training can be done.
2. Audio-visual cues which makes the equipment more living and playful.
3. Will test and train for motor control and eye hand coordination in all the available functional positions of the shoulder, the elbow and the wrist.
4. The quickness and accuracy of the task can also be measured.
5. May also improve the static and dynamic stabilizing action of the muscles.
6. Cost effective and simple circuit, no dangers of shocks.

Aim and objectives

Aim: To development of an equipment which improves Neural Control and Eye Hand Coordination.

Objectives

1. To develop an equipment to improve Neural Control and Eye Hand Coordination.
2. To document reference values for Eye Hand Coordination of the equipment.
3. To establish reliability of the new equipment in the training for eye Hand Coordination and Neural Control with the help of the above reference values.

Materials and Methodology

Study setting: Tertiary heath care center

Study design: Experimental design with construction validity

Sample size: 707 subjects including 356 male and 351 female

Inclusion Criteria: Age - 18-35 year both male and female Healthy individuals though not performed on such instruments before.

Exclusion Criteria: Subjects with recent upper limb fractures or any kind of soft tissue injuries Neuropathology such as Optic Ataxia, Optic Apraxia, Balint's Syndrome and visual disturbances as subject will not be able to recognize the stimulus

New equipment model

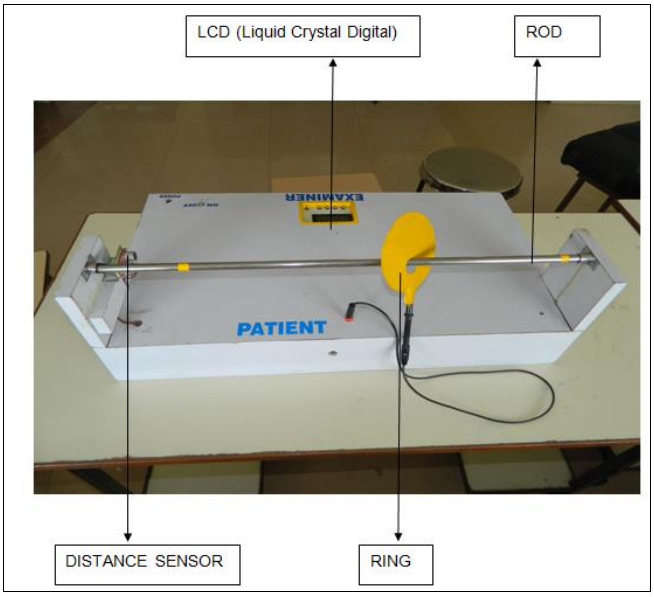


Fig 1: Eye Hand Coordination Equipment Design

Materials: Insulated, non-conductive wood board, Microcontroller, Distance sensor, LCD Screen, Buzzer, Ring and Rod, Buttons

Block diagram of the equipment

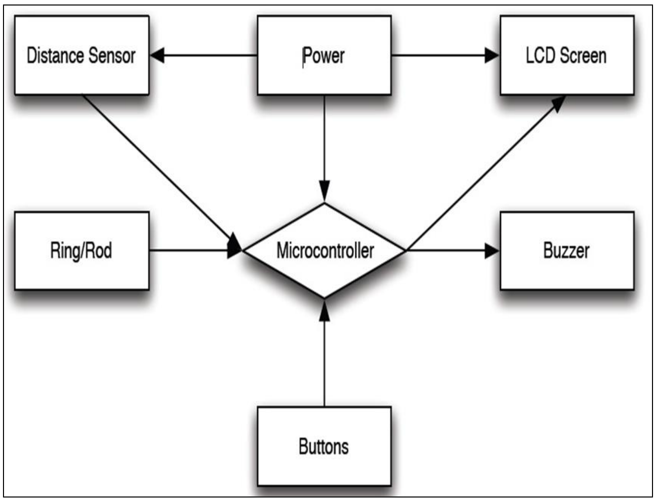
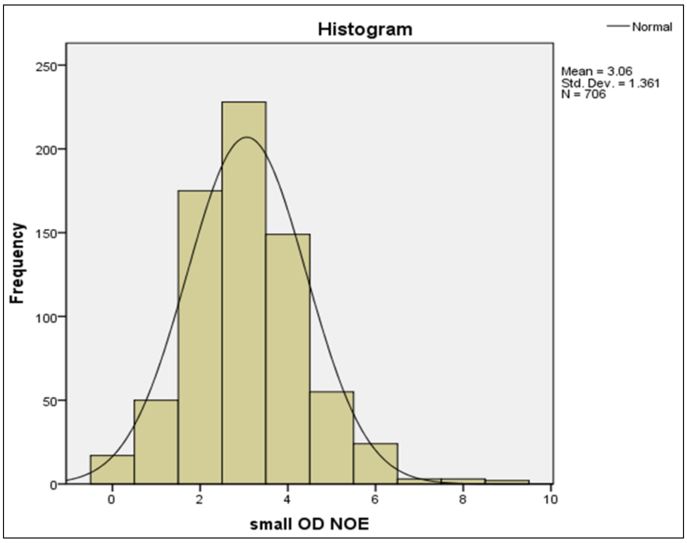


Fig 2: Block diagram of the equipment

Results

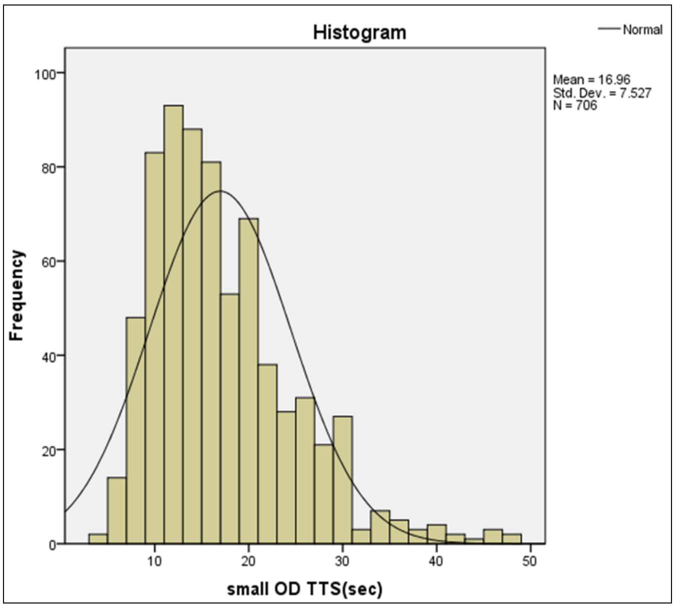
Table 1: The table explains the Mean, median, maximum and minimum limit, Range, kurtosis, skewness, Std. Deviation of the Small Opening Diameter Ring.

Small OD Ring	No. of Error	Time of First Error (sec)	Distance of First Error (sec)	Total time taken to complete task (sec)
Mean 95% Confidence Interval for	3.06	5.11	12.25	16.96
Lower Bound Mean	2.96	4.80	11.53	16.40
Upper Bound	3.16	5.41	12.98	17.51
5% Trimmed Mean	3.02	4.69	11.47	16.44
Median	3.00	4.00	9.50	16.00
Variance	1.85	17.08	96.38	56.65
Std. Deviation	1.36	4.13	9.81	7.527
Minimum	0	0	0	4
Maximum	9	32	47	48
Range	9	32	47	44
Skewness	0.54	1.90	1.04	1.10
Kurtosis	1.28	5.56	0.73	1.50



Graph 1: No of samples and their best Number of Error score achieved at small OD Ring.

Graph 1 show that number of samples, mean, std. deviation and the best number of Error score achieved at small OD Ring.
Small OD NOE: - Small Opening Diameter Number of Error
Frequency: - Number of People

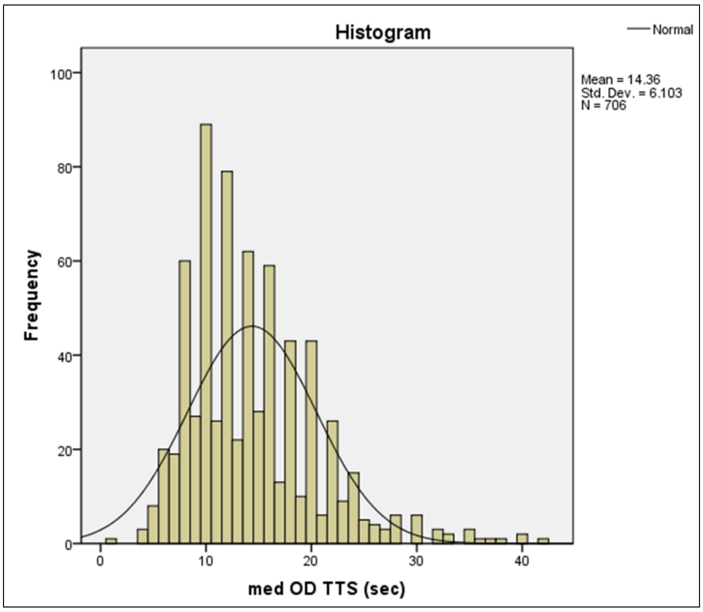


Graph 2: No of samples and their best total time spend to complete task score achieved at small OD Ring.

Graph 2 shows that number of samples, mean, std. deviation and the best total time spend to complete task achieved at small OD Ring.
Small OD TTS: - Small Opening Diameter Total Time Spend
Frequency: - Number of People

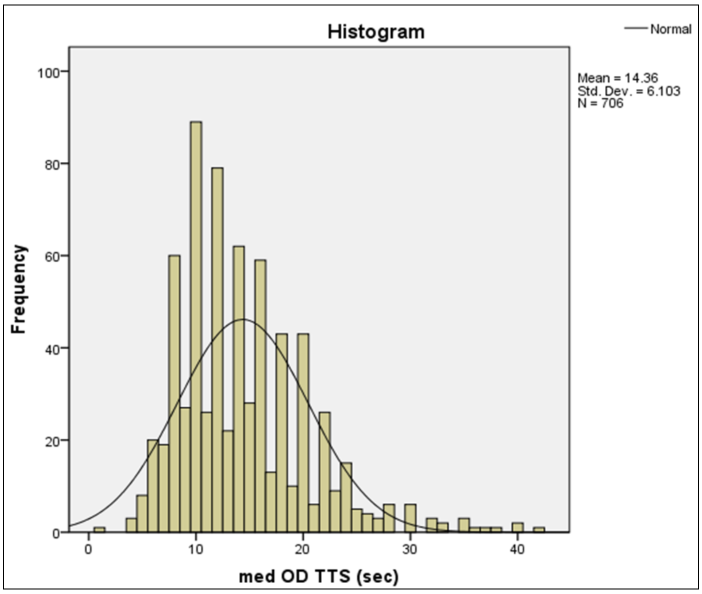
Table 2: The table explains the Mean, median, maximum and minimum limit, Range, kurtosis, skewness, Std. Deviation of the Medium Opening Diameter Ring.

Medium OD Ring	No. of Error	Time of First Error (sec)	Distance of First Error (sec)	Total time taken to complete task (sec)
Mean	1.51	4.84	15.38	14.36
95% Confidence Interval for Lower Bound	1.43	4.51	14.37	13.91
Mean Upper Bound	1.59	5.17	16.39	14.81
5% Trimmed Mean	1.44	4.43	14.55	13.93
Median	1.00	4.00	12.40	13.00
Variance	1.26	20.25	187.36	37.25
Std. Deviation	1.12	4.50	13.68	6.10
Minimum	0	0	0	4
Maximum	10	29	49	42
Range	10	29	49	38
Skewness	1.15	1.34	0.68	1.16
Kurtosis	4.55	2.36	0.55	2.01



Graph 3: No of samples and their best Number of Error score achieved at Medium OD Ring.

Graph 3 shows that number of samples, mean, std. deviation and the best number of Error score achieved at medium OD Ring.
Medium OD NOE: - Medium Opening Diameter Number of Error
Frequency: - Number of People

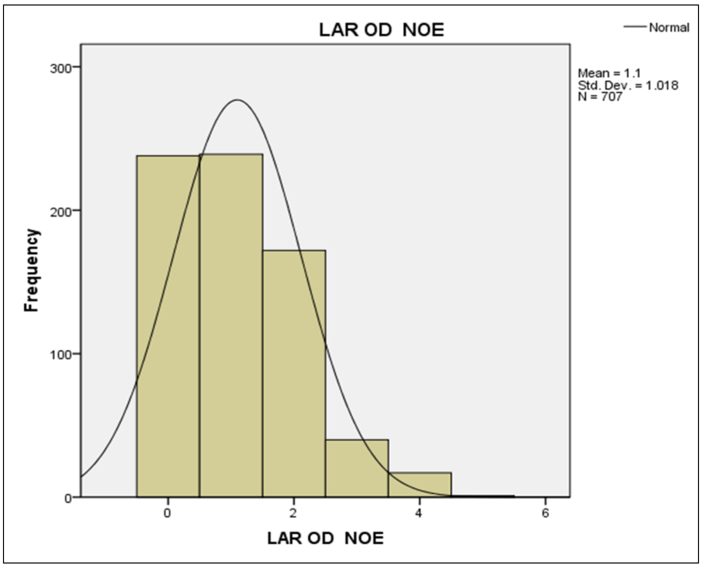


Graph 4: No of samples and their best total time spend to complete task score achieved at Medium OD Ring

Graph 4 shows that number of samples, mean, std. deviation and the best total time spend to complete task achieved at Medium OD Ring**.**
Medium OD TTS: - Medium Opening Diameter Total Time Spend
Frequency: - Number of People

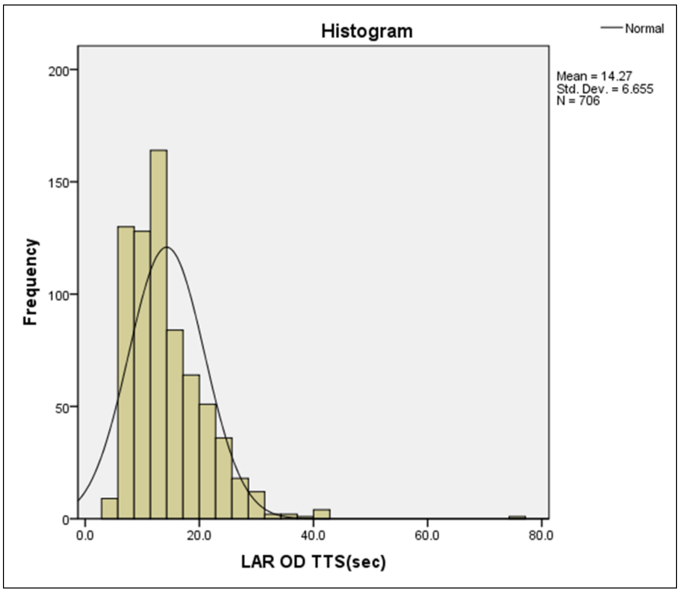
Table 3: The table explains the Mean, median, maximum and minimum limit, Range, kurtosis, skewness, Std. Deviation of the Large Opening Diameter Ring.

Large OD Ring	No. of Error	Time of First Error (sec)	Distance of First Error(sec)	Total time taken to complete task (sec)
Mean	1.10	4.22	13.36	14.27
95% Confidence Interval for Lower Bound	1.02	3.84	12.32	13.77
Mean Upper Bound	1.17	4.60	14.41	14.76
5% Trimmed Mean	1.02	3.59	12.38	13.73
Median	1.00	3.00	10.00	12.00
Variance	1.03	25.88	198.94	44.29
Std. Deviation	1.01	5.08	14.10	6.65
Minimum	0	0	0	4
Maximum	5	33	49	75
Range	5	33	49	71
Skewness	0.75	1.89	0.79	2.02
Kurtosis	0.20	4.81	-0.54	10.51



Graph 5: No of samples and their best Number of Error score achieved at Large OD Ring

Graph 5 shows that number of samples, mean, std. deviation and the best number of Error score achieved at Large OD Ring**.**
Large OD NOE: - Large Opening Diameter Number of Error
Frequency: - Number of People



Graph 6: No of samples and their best total time spend to complete task score achieved at Large OD Ring.

Graph 6 shows that number of samples, mean, std. deviation and the best total time spend to complete task achieved at Large OD Ring**.**
Large OD TTS: - Large Opening Diameter Total Time Spend
Frequency: - Number of People

Discussion

The study was done to find out the normative data for eye hand coordination for various sizes of ring e.g. Small, Medium, and Large. For small OD Ring total number of error, 3 is good, 2 is very good, 4 is fair, 5 and above is poor and 1 and below is excellent. Time taken for first error 4-5 sec is considered as good, 2 – 3sec is fair, below 1 it is poor, 6 – 8sec is very good and 9sec and above is excellent. The distance required to reach the First Error 8-13cm is good, 14 – 21cm is very good, 3-7cm it is fair, 2cm and below is poor and 22cm and above it is considered as excellent. Total time spend to complete task is 14-18sec is good, 10-13sec is very good, 19-22sec it is fair, 23sec and above is poor and 9sec and below it is excellent. For Medium OD Ring total number of error, 2 is good, 1 is very good, 3-4 is fair, 5 and above is poor and 0 is excellent. Time taken for first error 3-5sec is good, 1-2sec is fair, 0 is poor, and 6 – 8sec is very good and 9 sec and above is excellent. The distance required to reach the First Error 8-16cm is good, 17 – 27cm is very good, 3-7cm it is fair, 2cm and below is poor and 28cm and above it is considered as excellent. Total time spend to complete task is 12-15sec is good, 9-11sec is very good, 16-19sec it is fair, 20sec and above is poor and 8sec and below it is excellent. For Large OD Ring total number of error, 2 is good, 1 is very good, 3 is fair, 4 and above is poor and 0 is excellent. Time taken for first error 3-4sec is good, 1-2sec is fair, 0 is poor, and 5–7sec is very good and 8 sec and above is excellent. The distance required to reach the First Error 4-14cm is good, 15–26cm is very good, 2-3cm it is fair, 1cm and below is poor and 27cm and above it is considered as excellent. Total time spend to complete task is 11-15sec is good, 8-10sec is very good, 16-19sec it is fair, 20sec and above is poor and 7sec and below it is excellent.

Chart for Normal Reference Values
Grading according to Likerts scoring system
Poor = 1, Fair = 2, Good = 3, Very Good = 4, Excellent = 5

Conclusion

Small OD Ring total number of error 3 is normal, time taken for first error 4-5 sec is considered as good, the distance required to reach the First Error 8-13cm is good and Total time spend to complete task is 14-18sec is consider as a normal for small ring. For Medium OD Ring total number of error 2 is good, Time taken for first error 3-5sec is normal, the distance required to reach the First Error 8-16cm is good, total time spend to complete task is 12-15sec is normal. Large OD Ring total number of error, 2 is good, time taken for first error 3-4sec is good, the distance required to reach the First Error 4-14cm is normal, total time spend to complete task is 11-15sec is normal.

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