 Anthropologist, 9(4): 299-304 (2007)

Comparison of Arm-Hand Steadiness for Shooting Perfection in Armed Forces and Punjab Police

Gaganpreet Kaur*, Shweta Shenoy Sandhu and Jaspal Singh Sandhu

Department of Sports Medicine & Physiotherapy, Guru Nanak Dev University, Amritsar 143 005, Punjab, India
*E-mail: <*gagan10sandhu@rediffmail.com>, <ssandhu2000@yahoo.com>*

KEYWORDS Arm-Hand Steadiness. Psychomotor Test. Nine-Hole Steadiness Tester, Gender

ABSTRACT The present study investigate the differences in arm-hand steadiness arising out of individuals subjected to different training conditions and to investigate for gender differences in performance. The samples for the study are 300 normal, healthy subjects aged between 18-35 years and 100 subjects each from Armed Forces, Punjab Police and Civilians (control). Subjects are tested on a standard laboratory 9 hole steadiness tester for their ability to hold a stylus in a series of holes decreasing from 12.5 mm to 2.5 mm without touching the sides of the holes. The number of contacts and the contact time during the test are noted. It has been observed that the armed forces are steadiest and statistically significant differences in all the holes at $p \leq 0.001$. Also females are steadier than their male counterparts with statistically significant differences in all the holes at $p \leq 0.001$. It is concluded that the Armed Forces are steadier than the Punjab Police personnel due to the strict selection criteria and the regular training they received. And females are steadier than males due to non-prevalence of alcohol and drug abuse of any kind. Potential application of the research includes the validation of strict selection criteria and various psychomotor tests in armed forces. Also there needs to be an increase in the female work force in the tasks requiring a greater degree of Arm-Hand Steadiness.

INTRODUCTION

Different activities place different degrees of demand on an individual muscular capacity and it is well documented that people who have undergone specific trainings for several years develop substantial muscular strength and endurance pertaining to their field of training and hence are better performers of that task than inactive or untrained individuals. For differences in human performance capabilities to be of more than passing interest, it is desirable that they are reliably replicable and generalized beyond the confines of an isolated, narrowly defined laboratory setting. In this study an effort was made to look into one such human performance factor, the Arm-Hand Steadiness.

Steadiness is an important component of skills that require aiming and general immobility such as shooting, pistol marksmanship, archery, or dart throwing.

Arm-Hand Steadiness is the ability to hold one's arm and hand in a specific position for a relatively short period of time. This is a psychomotor phenomenon. It depends upon the combination of psychological processes as well as the motor events of the body. It determines the success in sports events like archery and shooting. Being a psychomotor process it depends upon not only the muscular caliber of an individual but also on the mental ability to concentrate on the target.

There are many factors that determine arm-hand steadiness of an individual like the gender. Physical strength affects perceptual motor abilities and it is well documented that females generally exhibit significantly lower upper body strength than males (Clark, 1986; Heyward et al., 1986) hence implying that females have a lower arm-hand steadiness than males. In contrast to this study (Hudgens et al., 1988) concluded that there were significant gender differences in arm-hand steadiness performance with females performing better than the males. Another study (Christopher et al., 1997) concluded that there were no gender differences in arm-hand steadiness. In lieu of the conflicting literature on the effect of gender differences on arm-hand steadiness in an individual the present study was undertaken.

Factors that can influence arm-hand steadiness are an individual's physique and mental set up. Kinanthropometric parameters such as weight, height, length of upper limb etc can also be influential.

Another factor that influences arm-hand steadiness is age. As with aging process there is decline in nearly all the systems of the body and hence the performance in such a task will also be affected by the age of an individual.

As arm-hand steadiness is a psychomotor function, it is influenced by various psychological factors and anything that will affect the psychomotor system will hence affect arm-hand steadiness. Various drugs like central nervous system stimulants or depressants, artificial hormones like oral contraceptives, alter the performance of psychomotor tasks as do the changes of physiological parameters in the body or the environmental conditions e.g. change of temperature, noise level, humidity etc. The individual's state of mind being another important criteria that cannot be ignored. Not only the state of mind during the testing procedure like anxiety, depression, lack of concentration or disturbance of sleep-wake cycle that can affect the score but also the general mental well being of an individual.

Various health-impairing habits have a direct impact on health, as well as performance of various tasks. Smoking, caffeine intake in the form of tea\coffee\soft drinks and alcohol consumption has direct impact on the arm-hand steadiness. Many studies have shown the deterioration of psychomotor performances by the use of various drugs in the body be it a therapeutic drug or a substance of abuse. All these substances have been shown to increase the tremor in the limbs.

Position of the subject and the side tested also influenced the arm-hand steadiness. The findings that the subjects were steadier with their preferred hand and that they were steadier in the elbow supported position can be easily understood.

Aim of the Study: To investigate differences in arm hand steadiness arising out of individuals subjected to different training conditions and to investigate for gender differences in performance and to provide a replication of the test of arm hand steadiness on a standard apparatus using a substantial number of subjects.

Significance of the Study: If there are significant gender differences in the performance variable with females performing better than males, there should be an increase in the female work force in the tasks where arm-hand steadiness is of great value. Also the importance of regular training regime will surface in case of positive results.

MATERIALS AND METHODS

Selection of Subjects: The study was conducted on 300 normal, healthy subjects aged 18-35 years. 100 subjects (50-males and 50-females) were civilians (controls) mostly university students and teachers. Another 100(50-males and 50-females) belonged to the Punjab Police, representing the Punjab state and the remaining 100 (all males) were Armed personnel belonging to the Border Security Forces (B.S.F), who represented the entire nation.

Inclusion Criteria: These are – 1. Age should be between 18-35 years, 2. Healthy subjects with no pathology or injury to the upper limb, 3. Subjects with no history of drug use that might affect steadiness, 4. Subjects with no history of drug abuse of any kind, 5. Subjects were non-alcoholics and non-smokers, 6. The daily caffeine intake of the subject was not more than 2 cups of tea\coffee, 7. Subjects were not be suffering from any psychiatric disorder affecting his psychomotor abilities, 8. Subjects were not be physically exhausted, 9. Subjects had an adequate sleep the previous night before the test.

Side of Testing: Dominant upper limb was tested i.e. the one used for most of their daily activities like writing, eating or shooting.

Apparatus: A standard steadiness tester (Medicaid ST-320) was used. The test surface of the apparatus was situated at an angle of 45 degree to the horizontal and contained nine holes, spaced 1.5 cms apart, in two rows. Diameters for holes 1-9 were 12.5, 8.0, 6.5, 5.0, 4.5, 4.0, 3.5, 3.0, and 2.5 mm respectively. A pencil like stylus with an 11.5 cm handle and an attached 4.8 cm stainless steel probe of 1mm diameter was wired so that when the probe touched the sides of the hole a circuit was closed, activating an auditory signal generator that provided feedback to the subjects. The apparatus was under the control of the computer that for each trial kept the track of the number of touches and of the total time the probe was in contact with the side of a hole. An adjustable table was used to position the apparatus at each subject's shoulder height and at arms length to the second joint of the middle finger.

Procedure: Each subject was seated in front of the apparatus, on a wooden chair with feet resting on a wooden surface. The apparatus was placed on a wooden table whose height could be adjusted so that the top of the apparatus was at shoulder height and its outer edge was in line with the edge of the shoulder of the arm preferred for writing.

The session consisted of single trials for each of the holes, progressing from the largest to the smallest. The subject was told to insert the tip of the probe, upon signal, into the hole to a depth

of about 5 mm and to try to hold it there without touching the sides of the hole until signaled to stop (after 20 seconds). The intertrial interval was 30 seconds.

After each trial both the number of contacts and the contact time (in seconds) were noted for each hole.

RESULTS

The analysis indicated that the two dependent variables, the number of contacts, and the contact time were essentially equivalent yielding virtually identical performance profiles for all the groups (Fig. 1). So the results are presented for the error variable only.

ANOVA showed highly significant differences in performance in Hole 2 ($F = 6.44$); hole 3 ($F = 5.02$); hole 4 ($F = 6.71$); hole 5 ($F = 7.96$); hole 6 ($F = 8.33$); hole 7 ($F = 10.05$); hole 8 ($F = 12.89$) and hole 9 ($F = 19.58$) at ($p \leq 0.001$) (Table 1).

ANOVA showed significant differences in performance in hole 3 ($F = 3.36$) at $p \leq 0.05$. And highly significant differences in performance in hole 2 ($F = 4.67$); hole 4 ($F = 4.63$); hole 5 ($F = 5.01$); hole 6 ($F = 4.74$); hole 7 ($F = 6.15$); hole 8 ($F = 8.63$); hole 9 ($F = 12.68$) at $p \leq 0.001$ (Table 2).

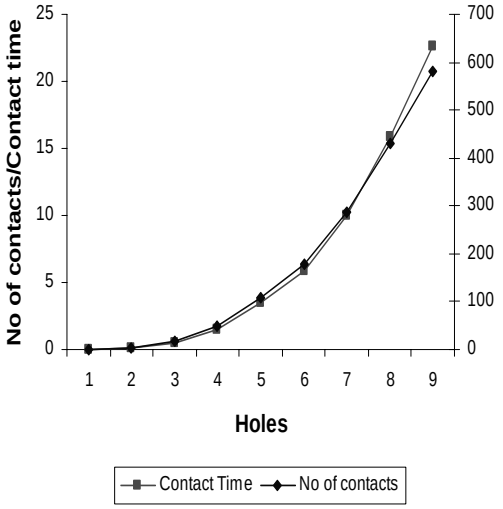

Fig. 1. The two dependent variables, number of contacts and contact time going hand in hand for all of the groups.

Table 1: Number of contacts as criteria for arm-hand steadiness of males of Armed forces, Punjab police and civilians.

HoleNo.	*Armed Forces*	*Punjab Police*	*Civilians*
	Mean ± S.E	*Mean ± S.E*	*Mean ± S.E*
1	0.23 ± 0.09^{a}	0.50 ± 3.62^{b}	0.22 ± 0.14^{ab}
2	2.34 ± 0.52^{a}	7.08 ± 1.73^{b}	4.19 ± 0.91^{ab}
3	12.07 ± 1.52^{a}	25.78 ± 6.24^{b}	16.60 ± 2.29^{ab}
4	38.62 ± 3.2^{a}	71.20 ± 11.93^{b}	49.90 ± 4.88^{ab}
5	89.00 ± 6.33^{a}	145.40 ± 16.85^{b}	113.50 ± 9.48^{ab}
6	150.00 ± 9.76^{a}	228.14 ± 21.24^{b}	189.98 ± 13.69^{ab}
7	242.44 ± 13.61^{a}	352.80 ± 27.61^{b}	315.38 ± 18.17^{b}
8	364.15 ± 17.05^{a}	502.42 ± 31.72^{b}	485.48 ± 22.07^{b}
9	487.38 ± 20.54^{a}	668.68 ± 35.36^{b}	677.02 ± 23.98^{b}

Superscripts a and b highlight multiple comparisons using scheffe's post hoc comparison between the Mean values obtained. Same superscript implying no statistically significant difference and vice-versa.

Table 2: Number of contacts as criteria for arm-hand steadiness of males as compared to females.

Hole No.	*Males*		*Females*	
	Mean ± S.E		*Mean ± S.E*	
1	0.23 ± 0.09^{a}	0.50 ± 0.26^{b}	0.22 ± 0.14^{ab}	0.30 ± 0.15^{a}	0.56 ± 0.20^{ab}
2	2.34 ± 0.52^{a}	7.08 ± 1.73^{b}	4.10 ± 0.91^{ab}	2.16 ± 0.68^{a}	4.36 ± 0.77^{ab}
3	12.07 ± 1.52^{a}	25.78 ± 6.24^{b}	16.60 ± 2.29^{ab}	12.60 ± 2.71^{a}	15.76 ± 2.24^{ab}
4	38.62 ± 3.26^{a}	71.20 ± 11.93^{b}	49.90 ± 4.88^{ab}	41.60 ± 4.25^{a}	47.00 ± 4.95^{ab}
5	89.00 ± 6.33^{a}	145.40 ± 16.85^{b}	113.50 ± 9.48^{ab}	102.52 ± 8.64^{ab}	97.90 ± 8.60^{a}
6	150.00 ± 9.76^{a}	228.14 ± 21.24^{b}	189.98 ± 13.69^{ab}	175.28 ± 12.52^{ab}	175.12 ± 13.05^{ab}
7	242.44 ± 13.61^{a}	352.82 ± 27.61^{b}	315.38 ± 18.17^{ab}	263.00 ± 16.74^{a}	275.10 ± 16.93^{ab}
8	364.15 ± 17.05^{a}	502.42 ± 31.72^{b}	485.48 ± 22.07^{b}	378.34 ± 20.20^{a}	423.56 ± 18.73^{ab}
9	487.38 ± 20.54^{a}	668.68 ± 35.36^{b}	677.02 ± 23.98^{b}	519.78 ± 22.80^{a}	575.12 ± 22.29^{ab}

Superscripts a and b highlight multiple comparisons using scheffe's post hoc comparison between the Mean values obtained. Same superscript implying no statistically significant difference and vice-versa

DISCUSSION

The most important finding of the arm-hand steadiness study was the difference in performance of the three groups of subjects under the study, the Armed forces, the Punjab Police, and the civilians. The Armed forces were steadiest followed by the Punjab Police and then the civilians (Fig. 2).

The better performance of Armed forces can be attributed to many factors like strict selection criteria, the regular training regime and the demanding working conditions they are subjected to, like their being posted at the border areas, where perfect physical and mental health is must in 24 hour on call schedule. As stated by Barrett et al. (1966) that groups of subjects performing a motor task under different conditions of previous practice produce radically better performance curves which would differ in terms of initial starting point and final level of performance. Murbe et al. (2001) had also stated that hand steadiness could be improved by training and experience.

Fig. 2. The distribution of number of contacts in male subjects of Armed Forces (AF), Punjab Police (PP) and Civilian Population (control) in the nine holes

On the other hand the Punjab Police personnel and the civilian population lead an easygoing life without a regular training and exercise regime. There was also prevalence of alcohol and drug abuse in these 2 populations hence affecting their test scores as proved by Reilly et al. (1993).

Other factors like the effect of life style and personality can also not be ruled out, as they affect the individual's psychomotor performance. The association between personality and performance is based on a common neuropsychological base for both. Neural arousal affects performance in psychomotor task (Eysenck, 1965). Also as concluded by Welford (1968) that extroverts gave a poorer task performance as compared to introverts. Concentration of an individual while performing any motor act affects performance. Conscious concentration on the limb position and bodily attitudes heightens performance as stated by Brayant (1967). So this could be one of the many factors that affected the test results.

It was made mandatory for subjects to have a minimum of eight hours of sleep the previous night before the testing procedure to avoid low performance as after loss of sleep. Low performance was also reported when tests were given late in the day (Colquhoun et al., 1964). This factor was eliminated as the psychomotor test was conducted at the fixed time of the day for all the subjects.

The females were found to be significantly steadier than the males (Fig 3) in this study, thus adding to the evidence of a valid gender difference. This result is in accordance with the study done by Hudgens et al. (1988), who concluded that there were significant gender differences in arm-hand steadiness performance, with females performing better than the males. Several investigators (Bird, 1975; Edwards, 1948) had also reported significant gender differences in hand steadiness. Their better performance can be attributed to various factors like sincerity towards the work, be it the training regime they follow or the psychomotor test they were subjected to. There was also less prevalence of alcohol or drug abuse of any sort, as in Indian female population these things still bear a social stigma.

The analysis indicated that the two dependent variables; the number of contacts, and the contact time were essentially equivalent yielding virtually identical performance profiles for all the groups in accordance with the study done by

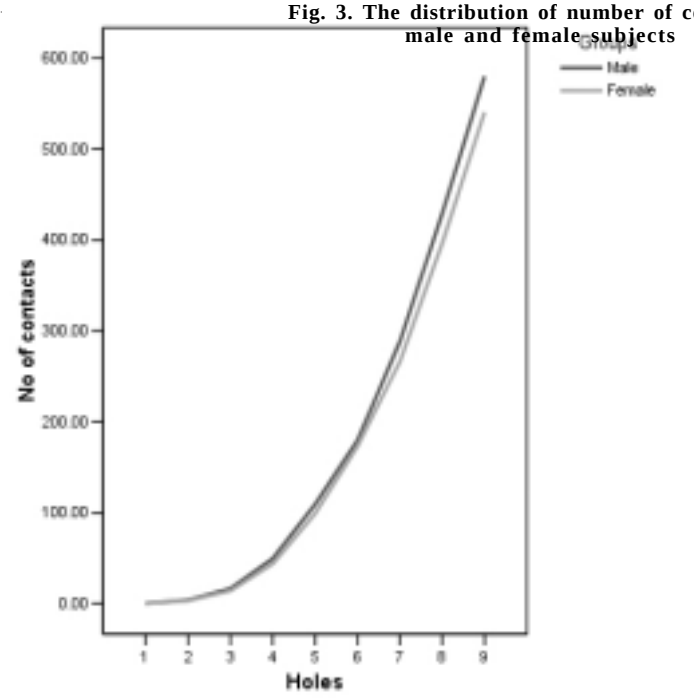

Fig. 3. The distribution of number of contacts in male and female subjects

own that
ormance
Also that
e more
d in the
oting and
position
orted by

ing the
d audio-
nce. All
ced by
ntensity,
of limb
ed limb

l or they
onitored.
s attempt
2, 1966).
ding the
esults.

Severe disruptions in the motor performance were achieved through the use of an audio feedback (Smith, 1962). On the other hand Davies et al. (1966) had concluded that even noise, which may be regarded as increasing arousal and attention prevented the performance decline in vigilance tests.

So the audio feedback given to the subjects was a boon or a bane for the performance still needs to be researched upon.

The findings that the subjects were steadier with their preferred hands are not surprising and are similar to the ones observed by Hudgens et al. (1988). The predominance of right handed majority in the performance of many perceptual motor skills has led to assumption that right handedness is normal and proper (Clark, 1957). As in this study all the subjects were right handed so the effect of handedness was ruled out.

Apart from these, there can be many other factors affecting the psychomotor performance of an individual, as human mind is a puzzle in itself. So there is a lot that still needs to be researched upon for the better understanding of the human performance variables.

RECOMMENDATIONS FOR FUTURE STUDIES

As much research has not been done in this field of human performance, in future studies should be carried out on arm-hand steadiness as well as the factors that affect arm-hand steadiness or for that matter psychomotor task performance. Also research should be carried out over a period of time to confirm the validity of the results obtained.

REFERENCES

Barrett, J., Davies, W., Hart, J. and Woods J.: *Unpublished Diploma in Physical Education.* Dissertation. Leeds University (1966).

Bird, A. M.: Cross sex effects of subject and audience during motor performance. *Research Quarterly*, **46:** 379-84 (1975).

Brayant, J. C.: *Individual Differences in Motor Learning. Learning and Individual Differences*. Columbia, Ohio (1967).

Chapanis, A., Garner, W. R. and Morgan, C. T.: *Applied Experimental Psychology: Human Factors in Engineering Design*. Wiley, New York (1949).

Christopher, P. K.,Valerie, J. R., Jason, S. I., Donna J. M. and Richard F. J.: *The Effect of Gender, Rifle Stock Length, and Rifle Weight on Military Marksmanship and Arm-Hand Steadiness*. Technical Report-A737133. Stroming Media. August (1997).

Clark, D. H.: Sex differences in strength and fatigability.

Research Quarterly for Exercise and Sport, **57:** 144-149 (1986).

Clark, M.M.: *Left Handedness*. University of London Press. London (1957).

Colquhoun,W. P. and Corcoran, D. W.: Effect of time of day and social isolation in vigilance decrement. *J. Experimental Psychology*, **68:** 381-389 (1964).

Davies, D. and Hockey, G.: The effect of noise and doubling the signal frequency on individual differences in visual vigilance performance. *British J. Psychology*, **57:** 139-144 (1966).

Edwards, A S.: Handedness and involuntary movement. *Journal of General Psychology*, **39:** 293-295 (1948).

Eysenck, H.: *Facts and Fiction in Psychology*. Penguin, London (1965).

Heyward, V.H., Johannes-Ellis, S.M. and Romer, J. F.: Gender differences in strength.. *Research Quarterly for Exercise and Sport*, **57:** 154-159 (1986).

Hudgens, G.A., Fatkin, L.T., Billingsley, P.A. and Mazurczak, J.: Hand steadiness: effect of sex, menstrual phase, oral contraceptives, practice, and handgun weight. *Human Factors*, **30(1):** 51-60 (1988).

Murbe, D., Huttenbrink, K.B., Zahnert, T., Vogel, U., Tassabehji, M., Kuhlisch, E. and Hofmann, G.: Tremor in Otosurgery : influence of physical strain on hand steadiness. *Otol. Neurorol.*, **22(5):** 672-677 (2001).

Reilly, T. and Scott, J.: Effects of elevating blood alcohol levels on tasks related to dart throwing. *Percept Mot Skills*, **77(1):** 25-26 (1993).

Scott, M. G.: Measurement of kinesthesis. *Research Quarterly*, **35:** 116-125 (1955).

Smith, K.U. and Smith, K.M.: *Perception and Motion*. W B Saunders, Philadelphia (1962).

Welford, A T.: *Fundamentals of Skills*. Methuen. London (1968).