

**THE EFFECT OF HANDEDNESS AND FAMILY SINISTRALITY ON STROOP
INTERFERENCE TASK, CHOICE REACTION TIME AND VIGILANCE TASK**

A

Thesis submitted

In the partial fulfillment of the requirement for the degree of

**MASTER OF ARTS
IN PSYCHOLOGY
(Clinical)**

Submitted By:

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CERTIFICATE

This is certify that the thesis entitled “**The effect of handedness and family sinistrality on stroop interference task, choice reaction time and vigilance task**” being submitted in partial fulfillment of requirements for the award of degree of **Master of Arts in Psychology, submitted in the School of Humanities and Social Sciences, Thapar Institute of Engineering and Technology , Patiala** is a bonafide work carried out under the supervision of Dr. Santha Kumari, Professor, School of Humanities and Social Sciences, Thapar Institute of Engineering and Technology, Patiala and that no part of this project has been submitted for the award of any other degree.


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I hereby declare that the work presented in this thesis entitled, "**The effect of handedness and family sinistrality on stroop interference task, choice reaction time and vigilance task**" in partial fulfillment of the requirement for the award of Degree of **Master of Arts in Psychology**, submitted in the **School of Humanities and Social Sciences, Thapar Institute of Engineering and Technology**, Patiala, is an authentic record of my own work carried out under the supervision and guidance of Dr. Santha Kumari, Professor, School of Humanities and Social Sciences, Thapar Institute of Engineering and Technology, Patiala and refers other researcher's work which are duly listed in the reference section.

The matter embodied in this thesis has not formed the basis for the award of any other degree of this or any other university.

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ABSTRACT

The association between hand and brain had captured the imaginations of researchers because it would be so captivating to study patterns of brain asymmetries by using a person's handedness as a marker for brain lateralization. The main aim of the present study is to find out the effect of handedness and family sinistrality on stroop test for reading and naming condition, choice reaction time and vigilance task. Handedness questionnaire was administered to 84 students and they were asked to perform these experiments also. It was hypothesized that left-handed people will perform better than right-handed people and individuals with family sinistrality will perform better than individuals without family sinistrality.

Keywords: handedness; brain lateralization; family sinistrality; stroop test; choice reaction time; vigilance

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CHAPTER 1

INTRODUCTION

1.1 Handedness

According to Annett (1970), a lot of people in our society had defined handedness as the hand that we prefer to use for writing. The dominance of one hand over the other is known as handedness. It refers to the uneven distribution of fine motor skills between the left and right hands. It is an ability through which human beings tend to be more dexterous (skilled) with one hand over the other. Merely, it is the inclination of one hand over the other. Handedness is usually referred to fine motor skills that are required to perform daily-life activities like eating, playing with ball etc.

Person's preferred hand requires a lot of drill and hard work with motor skills like playing or the coordination of large groups of muscles to perform activities like batting. Laterality in a larger sense refers to the inclination of sidedness of the body over the other like handedness, footedness, an inclination for using the right or left eye or ear.

1.1.1 Kinds of Handedness

The five kinds of handedness are:

- a) Dextrality – It refers to right handedness. People are usually more skilled with their right hand while performing any tasks. World's 90% of population prefers to use or are more skilled with their right hand. 60% of them can be said as strongly right handed because they do their all activities with right hand.
- b) Sinistrality- It refers to left handedness. People are usually more skilled with their left hand while performing any tasks. World's 10% of population prefers to use or are more skilled with their left hand. 3% of them can be said as strongly left handed because they do their all activities with left hand.
- c) Ambidexterity- People are skilled with either of their hand to accomplish everyday activities. This kind of handedness is very rare covering up to 1% of total population.

Left handers who have been converted to or forced to convert to right handers are usually ambidextrous.

d) Mixed handedness- People tend to use different hands for the performance of different tasks. For example, someone may eat with their right hand but uses left hand for writing. Though it is less common still it is not rare. 35% of world's population lies in this category.

e) Ambisinitrous- It is also known as ambilevous. People are poorly skilled with both hands. It is very rare kind of handedness and can be a result of enervative medical condition.

Handedness cannot be classified into these categories because of ambiguous and inconsistent definitions. Thus, handedness can be referred to positions on a scale or continuum.

1.1.2 Origin of handedness

Handedness's origin can be linked to genetic inheritance. Study conducted by Bryden et al; (1997) reports the strong genetic link in the transfer of handedness. According to study by Francks et al; (2007), gene LRRTM1 determines handedness. The study conducted by Bakan et al; (1973) states that exogenous factors like fetal environment or the stress related to birth also determines the handedness. Social environment also influences one's handedness. (For example, social stigmatism) as studied by Porac and Coren (1981).

1.1.3 Ways to measure handedness

Measuring handedness accurately is in itself has been the area of interest for many researchers. It's a herculean task to classify an individual based on their handedness because of the uniqueness of an individual. Apart from some strongly left or right handed people, majority of people are ambidextrous. For example, some people use their both hands for everyday activity.

Philip Mickelson, a famous golf player, also known as lefty plays golf with his left hand but he prefers to use his right hand to do all other activities. Babe Ruth, a famous baseball player, holds his bat and throws ball with left hand but uses his right hand for writing. Bill Gates does all his everyday tasks with right hand but prefers to use his left hand while writing cheques. Thus, one can conclude that handedness is not restricted just too writing hand.

Two ways through which handedness can be evaluated are either by asking questions about hand preference or by tests through which precision and speed of each can be measured. However, these two ways yielded results which can be different yet some amount of overlap is guaranteed.

1.1.4 Handedness and Brain Lateralization

Structure of the brain is reflected through handedness specifically because of its asymmetries. The human brain is roughly divided into two hemispheres. Information passes between these hemispheres through corpus callosum. It has been observed that brain is “cross-wired”. It means that right side of body is controlled by left hemisphere and left side of body is controlled by right hemisphere.

Each hemisphere has some specialized functions. For example: Broca’s area which is responsible for speech production and Wernicke’s area which is responsible for language comprehension are located in left hemisphere of the brain. Left hemisphere of the brain controls the tasks that are involved with logic, analytical like in science and mathematics. Meanwhile, right hemisphere of brain control tasks involved with creativity and arts. In humans, this lateralization and specialization of brain’s areas is clearly observed.

Paul Broca believed that handedness usually indicate towards specialized hemisphere dominance on the brain’s other side. Right handers have left hemispheric dominance of speech and vice-versa. However, this association was not fully established. It was statically reported by Springer and Deutsch (1990) that 95% of right-handed people have specialized left hemispheric dominance for speech while 19% of left-handed people have specialized right hemispheric dominance for speech. 20% of people have both hemispheres for processing of speech.

Right handed and left handed also differed in the lateralization of visual areas of the brain. In right handed people, areas responsible for face recognition and body visualization are highly activated in right hemisphere. In left handed people, there is equal activation of these areas across both hemispheres.

Left handed people are more at risk of developing neurological disorders like schizophrenia, autism as compared to right handers.

Thus, handedness association with hemispheric brain dominance is expansive.

1.2 Family Sinistrality

The words 'sinister' and 'dextral' are Latin words designating left and right, respectively. Because of the negative connotations of calling left-handers, sinistrals, these terms are not used by handedness researchers anymore. However, familial sinistrality has a long research history so the term remains in use when discussing these studies.

Familial sinistrality (FS) is a concept defined by the presence of left-handed relatives in a family. Both right and left handers can either be FS+ which means presence of a left-handed member in a family or they can either be FS- which means absence of any left handed member in a family. The calculation of FS+ and FS- is often based on parental handedness but sometimes other relatives, such as siblings and grand-parents, are included in the FS formula.

FS+ and FS- right-handers are common because most people are right handed whereas left-handedness is relatively rare, so one expects most left-handers to be FS+, if there is a biological component to handedness determination. In a very rare condition, sometimes a left hander is all alone left handed in a family composed completely of right-handers (FS-). One theory tries to explain the presence of a lone left-hander in a right-handed family which argues that the sole left-hander is a biological right-hander but a non-biological influence has intervened to switch behavioral handedness from the right to the left side. The exact nature of this non-biological influence is opened to debate.

It was believed that certain family environments correlate with increase in the rates of left-handedness. However, researchers have studied parental education, occupation and income levels as well as the language spoken and the number of books and computers in the home. None of these variables affect rates of left-handedness. Strict versus lax parenting style is also unrelated to rates of left-handedness.

Developmental psychologists are fond of saying that parents take too much credit for their child's successes and too much blame for their child's failures. Left-handers, often look at the handedness of their family members to explain why they are left-handed. If the family contains

many left-handers, it is credited with fostering left-handedness. If the family contains few left-handers, it is blamed for discouraging left-handedness. The truth is that the side of handedness, is affected by many influences. The factors connected to the family, biological or environmental, may not be the most important determinants of whether a person becomes right- or left-handed.

Annett and Corballis proposed the genetic model of handedness. According to this, majority of individuals inherit a single allele for right handedness but that left handers do not inherit this right shift factor. According to Annett (1978), individuals who lack this right shift factor has environmental influence on left handedness, right handedness and mixed handedness.

1.3 Stroop Effect

One of the best known phenomena in cognitive psychology is the stroop effect. Stroop effect is a demonstration of interference in reaction time of a task. Reaction time is the amount of time taken by an individual to respond to a stimulus. Stroop effect studies the interference caused in the reaction time. It has been reported by John Ridley Stroop in the published version of his dissertation in 1935. This effect has led to development of a neuropsychological test known as stroop interference test. It is widely applied in clinical institutions for various psychological disorders.

Stroop Test, in its basic form involves two tasks. The first task is to read the word (name of color) that is displayed on the computer screen. It has two conditions- congruent condition when the ink color and the word refer to the same color. For instance, the word 'red' is written in red color. The other condition is incongruent. It occurs when the ink color and word differ. For instance, the word 'green' is written in red color. When the word is a color-word printed in a mismatched ink color, then it is very difficult to respond quickly which results in slow and error prone responding. In other words, the individuals perform a task of "naming color" while restricting interference from "reading the word". Studies conducted by MacLeod and Dunbar, (1988) and Ivnik et.al; (1996) explored the cognitive interference. Difficulty faced in inhibiting the interference is termed as "stroop effect" (Stroop, 1935).

The stroop color word test is broadly used to measure the capacity to restrain cognitive interference. Other cognitive functions like attention, cognitive flexibility and processing speed

can be measured using this test reported in the study of Jensen and Rower, (1966). It is also used to measure working memory as explored in a study conducted by Kane and Engle, (2003). Stroop test also helps in diagnosing and characterization of neurological and psychiatric disorders. Stroop test is also used to explore the brain areas responsible for cognitive function like planning, decision-making through neuroimaging techniques.

1.3.1 Brain areas involved in stroop interference

Neuroimaging techniques like functional magnetic resonance imaging (fMRI) , magnetic resonance imaging (MRI) as well as positron emission tomography (PET) revealed that the anterior cingulate cortex and the dorsolateral prefrontal cortex are responsible for the processing of the stroop effect. These areas are highly activated while fixing conflicts and identifying errors. The dorsolateral prefrontal cortex is involved with executive cognitive functions. It is also responsible for activation of areas involved in perceiving color. Research has evidence to show that left dorsolateral prefrontal cortex is activated during stroop test while function of right dorsolateral prefrontal cortex is to lower the conflict. Allocating attentional resources and giving apt responses are controlled by anterior cingulate cortex. It is also involved with decision making and response evaluation during stroop test.

1.3.2 Theories

Various theories are postulated to describe the Stroop effect and they are referred as “race models”. The underlying notion that supports these theories state that information is processed parallelly. They also "race" to embark on the processor while selecting the response. These theories are:

a) Processing speed theory

This theory suggests that the brain reads words faster than it recognizes colors. There is a lag in the brain's ability to recognize the color of the word. Underlying idea behind this is that human brain process words significantly faster than colors. Sometimes, there is a conflict regarding words and colors, for instance, Stroop test, if the subject is asked to name the color, the word information reaches first before the color information which creates confusion in processing.

Contrary, if the subject is asked to state the word, a decision is made before the conflicting information since the word is processed faster than the color information.

b) Selective attention Theory

This theory suggests that the brain while recognizing the color requires more attention as compared to reading a word. Thus, the brain takes a little longer to recognize a color as compared to encoding the word. The responses cause the interference that is noted in the Stroop task.

c) Automaticity Theory

It is the most basic theory to explain stroop effect. It suggests that due to habit of reading, brain automatically comprehends the word but takes time to identify the color. Thus, identifying color is not an automatic process.

d) Parallel distributed processing Theory

This theory suggests that when our brain encodes the information, separate pathways are formed for different tasks. A few of these pathways are stronger than the others, for example reading. Therefore, we can conclude that the speed of the pathway is less important than the strength of pathway. Interference in stroop task is mainly due to the triggering of stronger and weaker pathways concurrently. (Stronger pathway being “word reading” and weaker pathway being “color naming”).

1.4 Choice Reaction Time

A volitional response to a stimulus in the environment can be referred to as reaction. Time recorded to respond to a stimulus in environment is reaction time. It is commonly demonstrated in milliseconds. Stimulus in environment is initially reflected on the sensory of person. From there, cognitive and neurophysiological information are processed and the speed of this processing is reflected in reaction time. The information can either be visual or auditory. Reaction time involves many processes like processes the visual and auditory information, making decision about it. Last step involves responding or executing the motor response.

Hermann Von Helmholtz has been credited to give the concept of reaction time by studying on its component, “nerve conduction velocity”.

One needs to have sound sensory system, able cognitive processing and good motor performance to give reactions or responses to stimulus. Reaction time tells about the coordination of sensorimotor and performance of a person. It reflects the alertness of a person. Lesser the reaction time will be, the better the performance is considered. Occupations which demands alertness and low reaction time are military forces, pilots, doctors, security guards etc. However, reaction time recorded for visual or auditory stimulus, can be influenced due to many factors like age, gender, personality type, physical fitness, level of tiredness, distraction, substance abuse, limb used for test, biological rhythm and health of a person. Reaction time is from any socio-cultural influences.

Three different kinds of experiments existed for reaction time. They are simple, recognition and reaction time. The first kind is simple reaction time experiment which involves only one response to one stimulus. In a second kind of experiment, there are targeted stimuli which one needs to respond to and non-target stimuli which one needs to avoid. Targeted stimuli are referred to as “memory set” and non-targeted is referred to as “distractor set”. In third kind of experiment, that is, choice reaction time experiment, there are many different stimuli and many different responses. Participants have to choose the one response from many that aligns with the stimulus. Stimuli are either auditory or visual. The motor activity does not affect the reaction time while processing the information does affect it. Studies are conducted that proves when the experiment is performed with dominant hand then reaction time is less. It also proves that men responds quickly and takes less time to respond to a stimulus as compared to women.

1.5 Vigilance or Sustained Attention

Vigilance commonly known as “sustained attention” or “tonic alertness” has wide ranging definitions. It tells about the level of our cognitive performance. Our capability to process the information is influenced by the activation of cerebral cortex. These activations can be referred to either “tonic” or “phasic” Many scientists have described the term vigilance given by different group of scientists are:

According to psychologists and cognitive neuroscientists, “vigilance is an ability to sustain attention to a task for a period of time”.

According to psychiatric clinicians,” vigilance refers to attention to potential threats or dangers”.

According to clinical neurophysiologists, “vigilance level refers to arousal level on the sleep–wake spectrum without any mention of cognition or behavioral responsiveness”.

When we perform any vigilance task, subcortical areas like amygdala and reticular activating system plays very key role. Amygdala which is responsible for perceiving emotions acts very important in controlling the vigilance. Reticular activating system comprising basal forebrain cholinergic system and locus coeruleus noradrenergic are linked with arousal. Basal forebrain cholinergic system is responsible for release of cortical acetylcholine release which is connected with arousal. Vigilance performance can be reduced when we block the release of acetylcholine. Locus coeruleus noradrenergic releases non adrenaline which is responsible with alert waking state. Lapse of attention and drowsiness is generated when we block the release of noradrenaline. This can be a cause in reducing the vigilance. Attention and vigilance can also be connected to various cortical areas of the brain. These areas are right frontal, prefrontal, inferior parietal, cingulate gyrus and temporal cortices. When there is high activity in the right hemisphere of the brain, it is also increased in frontal lobe during vigilance tests. Less activity in cingulate gyrus is reported during vigilance tasks.

1.5.1 Factors affecting vigilance

Vigilance can be affected through many external and internal factors. They are:

- a) Noise refers to the unwanted sound .Noise during a vigilance task can affect the person’s perception. Higher level of noise makes a person unable to concentrate and divide its attention.
- b) Temperature is another factor which can affect a person’s performance. It has been observed in a study by Mackworth and Pepler that a person’s performance in vigilance task decreases significantly when the temperature increases by 30 degrees. Also increasing performance increases our heart rate and blood pressure which can significantly affect our performance.
- c) Sleep loss - loss of sleep is directly related to lack of attention during different tasks. The effects if sleep loss can be observed shortly after the task starts. When there is sleep deprivation there is fatigue in the body and thus low concentration levels.
- d) Motivation - it plays a key role in determining task performance. It can be either extrinsic or intrinsic. Motivation provided from outside source is extrinsic like rewards, praises

etc. and motivation from oneself is intrinsic. In a vigilance task motivation can be increased by giving feedback.

CHAPTER 2

LITERATURE REVIEW

2.1 Handedness

A study conducted on 4282 Japanese students from high school by Shimizu and Endo (1983), students were given a handedness inventory comprising thirteen items. The inventory would give information on the presence of left handedness as well as on people who were pressurized to convert into right handers. Result shows that there were 7.2% of left handers with males in higher ratio as compared to females. However, it was also found out that ratio of females were higher to males in forced conversion. It makes up to 11% when left handers and forced converted to right handers were combined. These results clearly indicate towards the social pressure in Japan.

Many studies have been reported on left handedness. In a hundred studies reviewed by Seddon and McManus (1993), it was reported that left handedness in the world ranges up to 8.75%. It was also reported that there was no effect of culture but there significant difference in gender.

Dawson (1977) reported that parenting styles often influence left handedness. It was observed that permissive style of parenting resulted in high percentage of left handedness like in Alaskan Inuit whereas authoritarian style of parenting resulted in low percentage of left handedness like in Hong Kong Boat people. Studies of Teng et al., (1976) and Porac et al., (1990) demonstrated low percentage of left handedness among Orientals. In Muslim community, the percentage of left handers is 6.2% as reported by Singh and Qureshi (2011). While, studies conducted by Singh & Bryden, (1994); Singh & Manjary, (1995); Singh, et al., 2001; Singh, (2006) in Indian population, the percentage of left handers is 5%.

Nevertheless, the left-handers are found with their own peculiarities. Left-handedness has been linked to many disorders including three leading causes of death in our society. They are alcoholism, smoking and breast cancer (London, 1989). Along with it are several neurological

and immune disorders and reading disability (Geschwind & Behan, 1982). Thus, the population of left-handers is higher in these disorders than among the normal population. Left-handedness has also been related to mentally retardation and schizophrenia. (Coren, 1992) Coren (1990, 1992) has provided a brief list of the psychological and physiological problem, which are often been associated with left handedness. They are alcoholism, allergies, attempted suicide, autism, bed-wetting, brain-damage, chromosomal damage, criminality, drug abuse, depression, emotionality, epilepsy, homosexuality, immune disorders, juvenile delinquency, mental retardation, migraine, headaches, neuroticism, poor verbal ability, poor spatial ability, predisposition, reading disability, slow physical development, schizophrenia, school failure, and sleep difficulty psychosis. Conflicting results have been found about the relationship of left-handedness with the above mentioned disorders.

Hoffstein, et al. (1993), revealed in his study that left-handedness has also been linked with many mental and physical conditions such as attention deficit disorder, shortened lifespan, sleep apnea, (Comings & Comings, 1987), cognitive impairment in development of Alzheimer's disease (Doody, et al, 1999), and homosexuality (Bailey, 1999). According to U.S. News & World Report (1993), left-handers who have higher injury rates in general also die at an early age.

2.2 Handedness and Family sinistrality.

Study reported by McKeever and VanDeventer, (1977) evaluated the relationship of familial sinistrality and degree of left-handedness. 71 normal left-handed and 80 right-handed individuals were taken as the subjects. It was established that no association between degrees of left-handedness and familial sinistrality existed. Handedness was measured by for handedness tasks. Finger tapping speed task (one of the tasks) had significant difference between left handers with presence of sinistrality in their family and left-handers with absence of sinistrality in their family. It was also concluded that the left-handers with presence of sinistrality were being more strongly left-handed on this task.

Porac (1992) did a study on 459 Canadian families for three years. Result indicated that if none of the parent is left-handed or if only the father is left-handed, there is only 10% chance of the child being left-handed. But the chance increased to 20% if mother is left-handed. It was also concluded that there is 40% chance of child being left handed if both parents are left-handed. It

depicts the genetic inheritance. But the chances of the child being right-handed are still more than being left-handed. The presence of family sinistrality in left handers indicates toward lateralization of right hemisphere.

Salmaso and Longoni, (1983) concluded in his study that, “family sinistrality increases the probability of being left handed”.

There is lot of evidence to show that left handers with family sinistrality (FS+) differ significantly in many ways from left handers without family sinistrality(FS-) (Dee,1971 ; Hardyk and Petrinovich, 1977 ; Harshman et al., 1983)

2.3 Family sinistrality and stroop task

In a study of Graham, Pringle; Samuel, Anderson conducted on 29 boys and 35 girls with the right-hand dominance, between the age group of five to seven, were checked for the effect of familial sinistrality on a stroop task. There was a significant effect of degree of family sinistrality in the girls but not in the boys despite the age and size of the family.

The literature shows that the relationship between familial sinistrality (FS) and laterality is disputed. An investigation on multiple parameters of laterality and rigorous methods of handedness and FS determination was administered for a population of left-handers and right-handers. The results did not yield a relationship between FS and hemispheric representation of language despite the fact that a strong relationship was found between handedness and hemispheric language specialization.

2.4 Handedness and stroop task

Many studies were conducted by Bugg, et al; (2007); Graf, Uttl, and Tuokko, (1995). It demonstrated that though relationship of handedness with cognition remained ambiguous still there is relationship between handedness and cerebral organization. How handedness effects stroop test can be observed in this study. Stroop task measures certain aspects of executive control. Stroop task was demonstrated on 90 young adults. There were 47 right handed out of which 23 were boys and 24 were girls and 43 were left-handed including 21 boys and 22 girls. “The dependent variables were Stroop baseline (SB), Stroop incongruent (SI), and the proportional derivative Stroop reduction (SR) [$SR = (SB - SI)/SB \times 100\%$] scores”. The results

reported both left and right handedness and gender affects stroop incongruent. It also shows the interaction effect between gender and handedness. Handedness also affects stroop reduction. Later, comparisons were made that showed that left-handed female's performance was significantly better than right-handed females on both stroop incongruent and stroop reduction. The analysis also demonstrated that smaller stroop interference of left-handers was caused by the association of handedness and cognitive function irrespectively of gender.

According to study conducted by Mariagrazia Capizzi (2017), on relation between handedness and cognitive functioning through stroop task Results revealed that underlying brain asymmetries is a useful variable to partly explain individual differences in executive functioning. It also confirmed that left handers performed relatively better than right handers.

2.5 Handedness and Choice reaction time

This study illustrates the difference between the dominant and non-dominant hands on four reaction time (RT) tasks. It was established that reaction time for both the dominant and non-dominant hands correlated with intelligence quotient. It was also found that the difference in mean reaction time between the dominant and non-dominant hands on a particular task was strongly correlated with the mean reaction time of each respective task. It states the possibility that both cerebral hemispheres are capable of negotiating the cognitive demands of reaction time tasks.

In the present study, 16 right-handed and 15 left-handed participants have been selected to perform a mental rotation task. They have been asked to identify the images of a hand presented in four different orientations (upright, inverted, clockwise rotated, counterclockwise rotated) as either a right or a left hand. The difference in their reaction times has been compared. The results show that right-handers recognize a left hand slower than a right hand, while there is no difference as seen for left-handers. Also, both left and right handers recognize a right hand placed in counterclockwise position faster than the left hand, and a left hand placed in clockwise position faster than the right hand. The results show that the difference in the reaction times between right and left handed individuals relies on a laterality balance of hand motor skills.

A sample of 32 young adults (16 boys, 16 girls; 18-25 years old) was taken to perform a simple or choice reaction time task. The adults were asked to respond to the right or left visual target by keeping their middle finger on either side of a midline. The study found that there is no difference between left-hand reaction time and right-hand reaction time. However, sub movement times were noted to be longer for the right hand than the left hand when the response was going to be bilateral. Also, pause times were longer for the left hand than the right hand, whether the response was unilateral or bilateral. The above results show that the better efficient response by the left hemisphere motor mechanism is not expressed behaviorally. For sub movements, it was found that intense attention to the left hand compensated for the less efficient motor control of the hand”.

2.6 Vigilance

A divided visual field technique was used to present a vigilance task to either the left or the right hemisphere. It was found that the left hemisphere was superior in detection and gave rise to less false positives. Also, handedness was found to be related to performance in the right-hemisphere. The results suggested that there were two vigilance systems inside the brain - a primary and a secondary system. The primary system, associated with the left hemisphere, operated initially at a high level and showed decrement with time. While the secondary system, associated with the right hemisphere, showed no decrement but operated at a lower level.

Patients of the same age and education were taken and compared to patients with frontal lobe lesions on several tests involving sustained attention. In a simple reaction time task, subjects were required to respond whenever they saw an 'X'. The second was a Continuous Performance Test which required subjects to respond to an 'X' and restrict from responding to any other target. The third test involved reading a story and responding to some pre-defined target. It was found that patients with the right frontal lesions took more time to give their response and missed more targets than control subject in all the three tests. The right frontal patients also got worse with time on CPT. The results indicate that the right frontal lobe plays a pivotal role in sustaining attention over time.

CHAPTER 3

RESEARCH GAP, OBJECTIVES, RATIONALE AND HYPOTHESES

3.1 Research Gap

Numerous studies have been conducted to explain handedness. These studies are usually done in Western countries and their results cannot be fully generalized to Eastern populations due to cultural differences. The present study aims to understand the effect of handedness and family sinistrality on stroop test, choice reaction test and vigilance tasks among young adults of Eastern countries. Most of the studies done with respect to handedness, stroop test, choice reaction time and vigilance did not involve family sinistrality. This study will take into account family sinistrality which aims to study its effect on stroop test, choice reaction time and vigilance task.

3.2 Objectives

- I. To study the effect of handedness on stroop interference task, choice reaction time and vigilance task.
- II. To study the effect of family sinistrality on stroop interference task, choice reaction time and vigilance task.

3.3 Rationale & Hypotheses

The existing literature shows that handedness has been explored variably. But its relation to family sinistrality is relatively new area of research. Thus, this study aims to study effect of handedness and family sinistrality on cognitive tasks like Stroop task, Choice reaction time and Vigilance task. Since handedness and family sinistrality directs our cerebral dominance, it would be interesting to find out how cognition is affected through handedness. Thus, following hypotheses has been formulated.

H₁ Left- handed participants will perform better than right-handed participants in reading congruent conditions of stroop interference task.

H₂ Left- handed participants will perform better than right-handed participants in reading incongruent conditions of stroop interference task.

H₃ Left- handed participants will perform better than right-handed participants in naming congruent conditions of stroop interference task.

H₄ Left- handed participants will perform better than right-handed participants in naming incongruent conditions of stroop interference task.

H₅ Left- handed participants will perform better than right-handed participants in choice reaction time task.

H₆ Left- handed participants will perform better than right-handed participants in vigilance task.

H₇ Individuals with family sinistrality will perform better than individuals without family sinistrality in reading congruent conditions of stroop interference task.

H₈ Individuals with family sinistrality will perform better than individuals without family sinistrality in reading incongruent conditions of stroop interference task.

H₉ Individuals with family sinistrality will perform better than individuals without family sinistrality in naming congruent conditions of stroop interference task.

H₁₀ Individuals with family sinistrality will perform better than individuals without family sinistrality in naming incongruent conditions of stroop interference task.

H₁₁ Individuals with family sinistrality will perform better than individuals without family sinistrality in choice reaction time task.

H₁₂ Individuals with family sinistrality will perform better than individuals without family sinistrality in vigilance task.

CHAPTER 4

METHODOLOGY

4.1 Sample

A total of 84 students from different courses of Thapar University, Patiala participated in the study. Out of which, 35 students were left-handed and 49 students were right handed. The age range was 18-25 years.

4.2 Design

The independent variables are handedness and family sinistrality.

The dependent variables are stroop reaction time (reading and naming), choice reaction time and vigilance.

A 2 (Handedness: left, right) x 2 (family sinistrality: present, absent) factorial design was used in the present study.

4.3 Statistical Analysis

Descriptive Statistics (Mean and Standard Deviation) and ANOVA were computed to describe the results.

4.4 Tools Used:

Handedness measures

- a) Handedness Inventory: A self-report inventory (Chapman & Chapman, 1985) was used to assess the handedness of subjects. It consisted of 14 items. Participants were asked which hand they used to perform everyday activities like “draw, write, use bottle opener, throw a snowball, use a hammer, toothbrush, screwdriver and eraser, strike a matchstick, stir paint, or swing a bat”. The subject has to respond to each item by saying whether he/she uses left hand or right hand or either hand for doing the activities mentioned. A score of ‘1’ was given when the response is ‘left’ and ‘2’ when the response was ‘right’ and ‘3’ when the response is ‘either’. The total score varied from 14 (extremely left-handed) to 42 (extremely ambidextrous).
- b) Family Sinistrality: Few items were included in the handedness inventory to study the presence or absence of family sinistrality. The presence of family sinistrality was considered if anyone in the family i.e. his/her father/mother/brother/sister/grand-father/grand-mother is left handed.

Stroop Color-Word Interference Test: Stroop color word interference test is a computer based test, administered to obtain the person's selective attention and cognitive flexibility. First, the participant reads a list of words for colors, but the words are printed in a color different to the word itself. For example, when the word “red” would be listed as text, but printed in green, the participant should say “red” and move on to the next word. The participant’s reading time of the

words on the list is then recorded. Next, the participant has to repeat the test with a new list of words, but should name the colors that the words are printed in. So, when the word “red” is printed in green, the participant should say “green” and move on to the next word. The participant’s naming time of the words on the list is recorded.

Choice Reaction Time Test: Choice reaction time refers to the time taken to give one of several responses to one of several stimuli. In this task, participants respond differentially to two stimuli by pressing one key for event A and a separate key for event B. The participants were presented with colors and tones stimuli consecutively. They have to press different key for different stimuli. For example, when the red color displays on screen they have to press red button on the keyboard and if they hear low tone then they have to press black button on the keyboard. They were told to use their one preferred hand only and to be as fast as possible.

The Six Letter Cancellation Task (SLCT): In this test, participants were presented with a worksheet which specified the six target letters to be cancelled and a ‘working section’ of letters of the alphabet arranged randomly in 33 columns and 13 rows. The participants were asked to cancel as many of the six target letters as possible in the specified time of 1.30 minutes. They were also told that they could follow a horizontal, vertical, or a random path according to their choice. Each component of SLCT measures a different measure and function of the brain. The total number of cancellations is a measure of motor skill combined with cognitive function. Net score is a measure of sustained attention which is associated with right front parietal cortex. The number of wrong cancellations is a measure of lack of focused attention and mental distraction.

4.5 Procedure

The participants were informed in detail about the study protocols and written consent was obtained from them. The handedness inventory was administered to 84 participants. Along with this, they have been asked to perform in the experiments which will measure some behavioral pattern in them. They were assured that information collected from them will be kept confidential. The subjects were made to sit comfortably in a noise-free room.

CHAPTER 5

RESULTS

For the data analysis, the mean and standard deviation was computed for all the variables. Independent variables were handedness and family sinistrality. Dependent variables were stroop reaction time (reading and naming), choice reaction time and vigilance. A 2 x 2 factorial ANOVA was also computed using SPSS 22.0 software.

5.1 Stroop reaction time: reading congruent

The mean and standard deviation was computed for stroop reaction time: reading congruent condition for left and right handers with and without family sinistrality. The values are given in table 1.

Table 1: Descriptive statistics of stroop reading congruent condition for left and right handers with and without family sinistrality.

HAND	FS	M	SD
LEFT	FS ⁺	0.791	0.084
	FS ⁻	0.865	0.128
	Total	0.825	0.112
RIGHT	FS ⁺	0.840	0.079
	FS ⁻	0.883	0.159
	Total	0.868	0.137
TOTAL	FS ⁺	0.814	0.085
	FS ⁻	0.877	0.148
	Total	0.850	0.128

(FS-family sinistrality, M-mean, SD-standard deviation)

It is clearly seen from table 1 that mean and standard deviation of left handers were 0.825 and 0.112 respectively. The mean and standard deviation of right handers were 0.868 and 0.137. Thus, it indicates that left handers took less reaction time as compared to right handers. As shown in Table 1, the mean scores of individuals with family sinistrality is lower (M = 0.814)

than that of individuals without family sinistrality ($M = 0.877$). Figure 1 illustrates the similar trend that left handers took less reaction time than right handers.

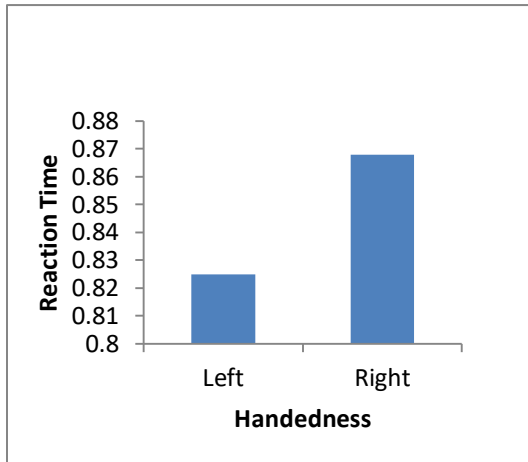


Fig.1: Mean reaction time of stroop reading (congruent condition) for left and right handers.

A 2 x 2 analysis of variance of the stroop reading congruent condition yielded the main and interaction effects as presented in Table 2.

Table 2: ANOVA Summary Table (Stroop Reading Congruent Condition).

Source	SS	df	Mean Square	F	Sig.	Partial Eta Squared
HAND	.021	1	.021	1.325	.253	.016
FS	.067	1	.067	4.193	.044	.050
HAND * FS	.005	1	.005	0.301	.585	.004
Error	1.269	80	.016			
Total	62.125	84				
Corrected Total	1.374	83				

It is evident from Table 2 that the effect of handedness is non-significant ($F(1,84) = 1.325$, $p > .05$). However, the main effect of family sinistrality is significant. ($F(1,84) = 4.193$, $p < .05$).

The interaction effect of handedness x family sinistrality is non-significant ($F(1,84) = 0.301$, $p > .05$).

5.2 Stroop reaction time: reading incongruent

For the data analysis, the mean and standard deviation was computed. Table 3 shows the mean and standard deviation scores of stroop reaction time: reading incongruent condition for both left-handers and right-handers with and without family sinistrality.

Table 3: Descriptive Statistics of stroop reading incongruent conditions for left and right handers with and without family sinistrality.

HAND	FS	M	SD
LEFT	FS+	.828	.109
	FS-	.960	.174
	Total	.888	.155
RIGHT	FS+	.887	.138
	FS-	.955	.168
	Total	.932	.160
TOTAL	FS+	.856	.126
	FS-	.957	.168
	Total	.913	.159

(FS-family sinistrality, M-mean, SD-standard deviation)

As shown in Table 3, the mean and standard deviation values of stroop reading incongruent condition for left handers is lower ($M = 0.888$, $SD = 0.155$) than that of right handers ($M = 0.932$, $SD = 0.160$). Thus, it depicts that reaction time of left handers is lower than that of right handers. Also, individuals with family sinistrality ($M = 0.856$) performed better than individuals without family sinistrality ($M = 0.957$). Figure 2 demonstrates that right handers mean reaction time is more than that of left handers.

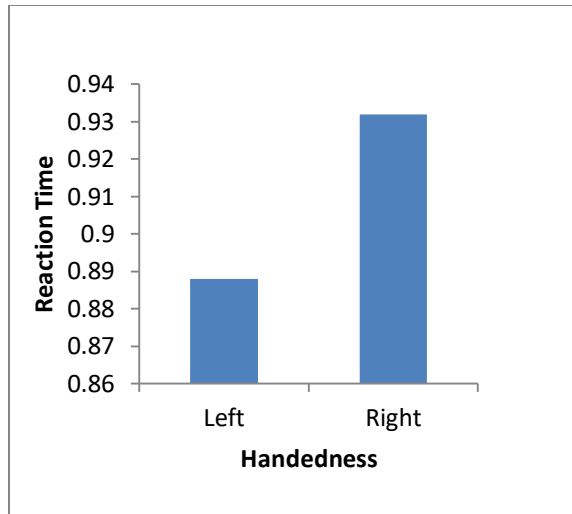


Fig. 2: Mean reaction time of stroop reading (incongruent condition) for left and right handers.

To obtain further insight a 2 x 2 factorial ANOVA was carried out. The outcomes of this analysis is presented in Table 4

Table 4: ANOVA Summary Table (Stroop Reading Incongruent Condition).

Source	SS	df	Mean Square	F	Sig.	Partial Squared	Eta
HAND	.015	1	.015	.628	.431	.008	
FS	.196	1	.196	8.45	.005	.096	
HAND * FS	.020	1	.020	.866	.355	.011	
Error	1.858	80	.023				
Total	72.263	84					
Corrected Total	2.101	83					

The F values indicate that the main effect of handedness is not significant. ($F(1,84) = 0.628$, $p > .05$). However, the effect of family sinistrality is significant. ($F(1,84) = 8.45$, $p < .05$). The interaction effect of handedness x family sinistrality is non-significant ($F(1,84) = 0.866$, $p > .05$).

5.3 Stroop reaction time for naming congruent

Computation of mean and standard deviation was carried out for stroop reaction time: naming congruent condition for both left and right handers with and without family sinistrality. Values are presented in Table 5

Table 5: Descriptive Statistics of stroop naming congruent conditions for left and right handers with and without family sinistrality.

HAND	FS	M	SD
LEFT	FS+	.762	.084
	FS ⁻	.853	.144
	Total	.804	.122
RIGHT	FS+	.859	.095
	FS ⁻	.875	.134
	Total	.869	.121
TOTAL	FS+	.808	.101
	FS ⁻	.868	.136
	Total	.842	.125

(FS-family sinistrality, M-mean, SD-standard deviation)

From the above table, it can be observed that the means for left handers and right handers are 0.804 and 0.869 respectively. The standard deviation for left handers and right handers are 0.122 and 0.121 respectively. It clearly points out that right hander's reaction time is more than that of left handers. Furthermore, the performance of individuals with family sinistrality (M = 0.80) was better than the right handers. (M = 0.868). Figure 3 highlights this trend.

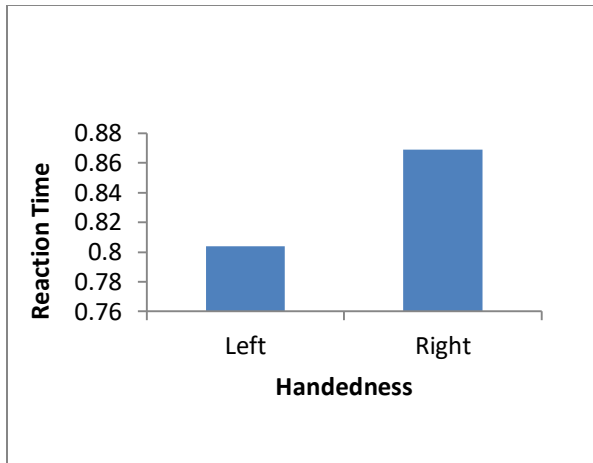


Fig. 3: Mean reaction time of stroop naming (congruent condition) for left and right handers.

A 2 x 2 analysis of variance was performed to find out the effect of handedness and family sinistrality on stroop reaction time: naming congruent condition. The outcomes of this analysis are presented in Table 6.

Table 6: ANOVA Summary Table (Stroop Naming Congruent Condition).

Source	SS	df	Mean Square	F	Sig.	Partial Squared	Eta
HAND	.068	1	.068	4.75	.032	.056	
FS	.055	1	.055	3.84	.049	.046	
HAND * FS	.028	1	.028	1.95	.166	.024	
Error	1.146	80	.014				
Total	60.948	84					
Corrected Total	1.307	83					

As noticeable in Table 6, all main effects are significant. The effect of handedness is significant ($F(1,84) = 4.75, p < .05$). Similarly, the main effect of family sinistrality ($F(1,84) = 3.84, p < .05$). However, the interaction effect of handedness x family sinistrality is non-significant ($F(1,84) = 0.195, p > .05$).

5.4 Stroop reaction time for naming incongruent

The mean and standard deviation was calculated for stroop reaction time: reading congruent condition for left and right handers with and without family sinistrality. The values are depicted in table 7

Table 7: Descriptive Statistics of stroop naming incongruent conditions for left and right handers with and without family sinistrality.

HAND	FS	M	SD
LEFT	FS+	.821	.097
	FS ⁻	.961	.182
	Total	.885	.157
RIGHT	FS+	.881	.133
	FS ⁻	.993	.244
	Total	.954	.217
TOTAL	FS+	.849	.118
	FS ⁻	.982	.224
	Total	.925	.196

It is depicted in table 7 that mean and standard deviation of left handers were 0.885 and 0.157 respectively. The mean and standard deviation of right handers were 0.954 and 0.217. Thus, it indicates that left handers took less reaction time as compared to right handers. As shown in Table 7, the mean scores of individuals with family sinistrality is lower ($M = 0.849$) than that of individuals without family sinistrality ($M = 0.982$). Figure 4 illustrates the similar trend that left handers took less reaction time than right handers.

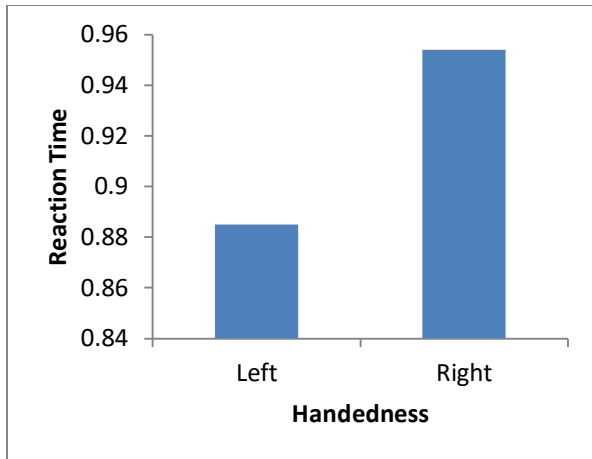


Fig. 4: Mean reaction time of stroop naming (incongruent condition) for left and right handers.

A 2 x 2 analysis of variance was computed to see the main and interaction effects between handedness and family sinistrality on stroop reaction time: naming incongruent. The results are presented in Table 8.

Table 8: ANOVA Summary Table (Stroop Naming Incongruent Condition).

Source	SS	df	Mean Square	F	Sig.	Partial Squared	Eta
HAND	.041	1	.041	1.178	.281	.015	
FS	.308	1	.308	8.774	.004	.099	
HAND * FS	.004	1	.004	.107	.745	.001	
Error	2.810	80	.035				
Total	75.188	84					
Corrected Total	3.215	83					

Table 8 shows the summary table of ANOVA between handedness and family sinistrality on stroop reaction time: naming incongruent. There is no effect of handedness on stroop reaction time for naming incongruent. ($F(1,84) = 1.178, p > .05$). However, there is effect of family sinistrality on stroop reaction time for naming incongruent. ($F(1,84) = 8.774, p < .05$). No interaction effect between handedness and family sinistrality was found out. ($F(1,84) = 0.107, p > .05$).

5.5 Choice reaction time

For the data analysis, the mean and standard deviation was computed. Table 9 shows the mean and standard deviation scores of choice reaction time for both left-handers and right-handers with and without family sinistrality.

Table 9: Descriptive Statistics of choice reaction time for left and right handers with and without family sinistrality.

HAND	FS	M	SD
LEFT	FS ⁺	.744	.077
	FS ⁻	.804	.104
	Total	.772	.094
RIGHT	FS ⁺	.849	.079
	FS ⁻	.792	.072
	Total	.812	.079
TOTAL	FS ⁺	.794	.093
	FS ⁻	.796	.083
	Total	.795	.087

From the above table, it can be observed that the means for left handers and right handers are 0.772 and 0.812 respectively. The standard deviation for left handers and right handers are 0.094 and 0.079 respectively. It clearly points out that right hander's reaction time is more than that of left handers. Furthermore, the performance of individuals with family sinistrality (M = 0.794) was slightly better than the right handers. (M = 0.796).

A 2 x 2 analysis of variance of the choice reaction time yielded the values listed in Table 10.

Table 10: ANOVA Summary Table for Choice Reaction Time.

Source	SS	df	Mean Square	F	Sig.	Partial Squared	Eta
HAND	.042	1	.042	6.250	.014	.072	
FS	3.622E-5	1	3.622E-5	.005	.942	.000	
HAND * FS	.066	1	.066	9.859	.002	.110	
Error	.537	80	.007				
Total	53.791	84					
Corrected Total	.637	83					

The F values in Table 10 indicate that the effect of handedness on choice reaction time is significant. ($F(1,84) = 6.25, p < .05$). However, it was not significant in the case of family sinistrality. ($F(1,84) = 0.005, p > .05$). Furthermore, the interaction effect between handedness and family sinistrality came out to be significant. ($F(1,84) = 9.85, p < .05$). Figure 5 highlights the interaction effect between handedness and family sinistrality.

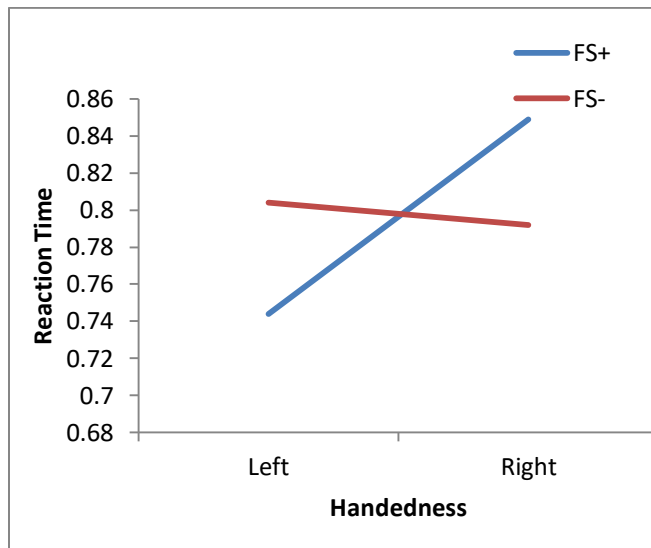


Fig.5: Mean choice reaction time for left and right handers.

5.6 Vigilance

Computation of mean and standard deviation was carried out for vigilance task for both left and right handers with and without family sinistrality. Values are presented in Table 11.

Table 11: Descriptive Statistics of six letter cancellation test for left and right handers with and without family sinistrality.

HAND	FS	M	SD
LEFT	FS ⁺	40.737	13.207
	FS ⁻	40.000	13.286
	Total	40.400	13.052
RIGHT	FS ⁺	38.529	10.296
	FS ⁻	42.906	8.894
	Total	41.388	9.532
TOTAL	FS ⁺	39.694	11.807
	FS ⁻	41.938	10.509
	Total	40.976	11.071

As shown in Table 11, right-handers with mean value = 41.38 performed better in vigilance task than left-handers with mean value = 40.40. It was also observed that individuals without family sinistrality (M = 41.93) performed better on vigilance task as compared to individual with family sinistrality.

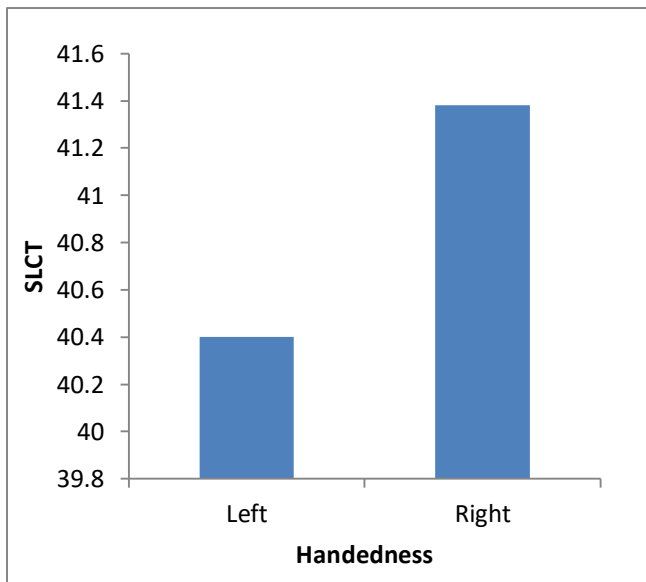


Fig.6: Mean value of six letter cancellation test for left and right handers

To obtain further understanding, a 2 x 2 factorial ANOVA was carried out. The outcomes of this analysis are presented in Table 12.

Table 12: ANOVA Summary Table for Six Letter Cancellation Test.

Source	SS	df	Mean Square	F	Sig.	Partial Squared	Eta
HAND	2.380	1	2.380	.019	.890	.000	
FS	64.567	1	64.567	.520	.473	.006	
HAND * FS	127.432	1	127.432	1.026	.314	.013	
Error	9936.638	80	124.208				
Total	151214.000	84					
Corrected Total	10173.952	83					

It is evident from Table 12 that neither the main effects nor the interaction effect are significant. [Handedness: (F (1,84) = 0.019, $p > .05$), family sinistrality: (F (1,84) = 0.520, $p > .05$), interaction: (F (1,84) = 1.026, $p > .05$)]

CHAPTER 6

DISCUSSION

The aim of the study was to find that how handedness (left and right) and family sinistrality (present and absent) affects stroop test, choice reaction time and vigilance.

6.1 Stroop Test

Regarding the effect of handedness on stroop reaction time for reading congruent condition, it was hypothesized that left-handed individuals will perform better than right-handed individuals in reading congruent conditions of stroop interference task. The result shows no significance difference and consequently the hypothesis is rejected. However, the descriptive statistics involving mean and standard deviation shows slight difference between left-handers and right-handers. It indicates that left handers took less reaction time to respond to a reading congruent stimulus as compared to right handers. This happens because handedness is linked with cognitive function shifts, which leads to a stroop interference on left-handers. The results did not show significance level maybe because of small sample size. Studies done by Bugg, et.al; (2007); Graf, Uttl, & Tuokko, (1995) and Mariagrazia Capizzi (2017) are in-line with our findings.

To study the effect of handedness on stroop reaction time for reading incongruent condition, it was hypothesized that left-handed individuals will perform better than right-handed individuals in reading incongruent conditions of stroop interference task. The hypothesis is rejected because the result shows that there is no significant difference between left-handers and right-handers. Though, the descriptive statistics involving mean and standard deviation shows slight difference between left handers and right handers. It portrays that right-handers took more reaction time to respond to a reading incongruent stimulus as compared to left-handers. This happens because handedness is linked with cognitive function shifts, which leads to a stroop interference on left-handers. Because of small sample size, the results did not show significance level. Studies conducted by Bugg, et.al; (2007); Graf, Uttl, &Tuokko, (1995) and Mariagrazia Capizzi (2017) are in-line with our findings.

It was also hypothesized that left-handed individuals will perform better than right-handed individuals in naming congruent conditions of stroop interference task. The result shows that there is significant difference and consequently the hypothesis is confirmed. Thus, there is difference between left handers and right handers when they respond to a stimulus. Left-handers took less reaction time to respond to a naming congruent stimulus as compared to right handers. This happens because cognitive function alterations are affected by handedness and thus it leads to a smaller stroop interference of left-handers. Studies reported by Bugg, et.al; (2007); Graf, Uttl, &Tuokko, (1995) and Mariagrazia Capizzi (2017) are in-line with our findings.

Stroop reaction time is affected by handedness. To put a light on that it was hypothesized left-handed individuals will perform better than right-handed individuals in naming incongruent conditions of stroop interference task. The result shows no significance level. Thus, the hypothesis is rejected. Although, we did not get any significance level between handedness and naming incongruent conditions but the descriptive statistics involving mean and standard deviation shows some difference between left handers and right handers. According to that, left handers took less reaction time to respond to naming incongruent stimulus as compared to right handers because right handers have large stroop interference effect. Maybe, small sample size caused hindrance in obtaining the desired results. Studies reported by Bugg, et.al; (2007); Graf, Uttl, &Tuokko, (1995) and Mariagrazia Capizzi (2017) are in-line with our findings.

To study the effect of family sinistrality on stroop interference task (reading and naming), it was postulated that left- hander's performance will be better than right-handers in all the conditions of stroop interference task i.e. reading and naming with congruent and incongruent conditions. The results show significance level in all the conditions of stroop task. Thus, all the hypotheses postulated to study the effect of family sinistrality on stroop task are confirmed. Descriptive Statistics indicate that performance of individuals with family sinistrality was better than individuals without family sinistrality. Studies conducted by Hardyk and Petrinovich (1977) states that left handers with family sinistrality show bilateral organization for many cognitive functions. Studies done by Dee, (1971) and Harshman et al., (1983) also shows that left handers with family sinistrality differ significantly in many ways from left handers without family sinistrality.

6.2 Choice Reaction Task

Regarding the effect of handedness on choice reaction time, it was hypothesized that left-handers will perform better than right-handers in choice reaction task. The result shows that it is significant and consequently our hypothesis is accepted. Thus, there is difference between left handers and right handers when they respond to a stimulus. The descriptive statistics involving mean and standard deviation also shows the difference between left handers and right handers. It was observed that left-handers took less reaction time to give a response to a choice reaction stimulus as compared to right handers. Studies reported by Kotaro Takeda, Nobuaki Shimoda, Yutaka Sato, Misao Ogano & Hiroyuki Kato are in-line with our findings.

Another hypothesis was formulated to study the effect of family sinistrality on choice reaction task. It states that individuals with family sinistrality will perform better than individuals without family sinistrality in choice reaction time task. The result shows that there is no significant difference between individuals with family sinistrality and without family sinistrality. Thus, our hypothesis is rejected. However, there is interaction effect between handedness and family sinistrality on choice reaction time. It means that left handers with family sinistrality have less reaction time when compared with left handers without family sinistrality. While right-handers with family sinistrality shows more reaction time as compared to right-handers without family sinistrality.

6.3 Vigilance Task

The hypothesis was formulated to find out the effect of handedness on vigilance task. It states that left-handed individuals will perform better than right-handed individuals in vigilance task. The results show that there is no significant difference between left and right handers. Thus, our hypothesis is rejected. The descriptive statistics of six letter cancellation test shows that there is slight difference between left and right handers. It shows that right-handers performs slightly better than left-handers in this test. According to these results, it can be said that right handers have better vigilance than left handers.

To prove that vigilance is affected by family sinistrality, the following hypothesis was postulated. It states that individuals with family sinistrality will perform better than individuals without family sinistrality in vigilance task. The result shows that there is no significant difference between individuals with family sinistrality and without family sinistrality. Thus, our hypothesis is rejected. However, the descriptive statistics of the test shows that performance of right handers is slightly better than that of left handers.

CHAPTER 7

CONCLUSION, IMPLICATIONS, LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

7.1 Conclusion

The findings of this study indicate that left handers performed better than right handers in stroop task for reading and naming conditions by taking less reaction time. Similarly, left-handers performed better than the right-handers in choice reaction task was by taking less reaction time. However, there was no difference between left handers and right handers for six letter cancellation test. It was also concluded that individuals with family sinistrality performed better than individuals without family sinistrality in stroop task for both reading and naming conditions. On the same line, individuals with family sinistrality performed better than individuals without family sinistrality in choice reaction time task. However, there was no difference reported

between individuals with family sinistrality and individuals without family sinistrality in six letter cancellation test.

7.2 Implications

Studies on handedness and family sinistrality have important role to play in the study of cerebral dominance. The present study aims to study the effects of handedness and family sinistrality on stroop task, choice reaction time and vigilance task. Thus, this area of research is relatively new and has implications for researchers, clinicians. It can also be used by cognitive experts to design new instruments keeping in mind the handedness difference.

7.3 Limitations

There were many limitations of this study. The sample size was very small which makes it difficult to give generalize results. The ratio of males to females was also very less because of which gender differences could not be taken into account. Because of small sample size, there was disproportionate of left- handers and right-handers. For vigilance task, instead of six letter cancellation test, an experiment would have been better.

7.4 Scope for Future Research

This study has great scope for future research. Increasing the sample size and keeping the equal ratio of males to females and left to right, it can yield better results. Writing hands styles (inverted or non- inverted), degree of handedness can be explored more.

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APPENDIX A

Dear Friends,

I, a post-graduate student of School of Humanities and Social Sciences, Thapar University, Patiala is conducting a project related to some behavioral patterns of students. In this connection I request you to kindly participate in the experiments. The information collected from you would be kept strictly confidential. If you are interested in knowing the results then drop in your email address.













CONSENT FORM

I, _____ , student of _____ stream, hereby give my consent to participate in this study.

Signature

APPENDIX B

HANDEDNESS AND FAMILY SINISTRALITY

<p>1. Name _____</p> <p>2. Address _____</p> <p style="margin-left: 20px;">a) College _____</p> <p style="margin-left: 20px;">_____</p> <p style="margin-left: 20px;">b) Permanent _____</p> <p style="margin-left: 20px;">_____</p> <p>3. Sex Male Female</p> <p>4. Date of Birth Date Month Year</p> <p>5. Approximate parental income per month</p> <p>6. No. of brothers and sisters</p> <p>7. Occupation _____</p> <p>8. No. of years of Education _____</p> <p>9. Major area of Education : (tick the appropriate).</p> <p style="margin-left: 20px;">a) Pure Science (Physics, Chemistry)</p> <p style="margin-left: 20px;">b) Engineering/Medicine</p> <p style="margin-left: 20px;">c) Mathematics/Computer Science</p> <p style="margin-left: 20px;">d) Architecture</p> <p style="margin-left: 20px;">e) Fine Arts (Music, Painting, Dance)</p> <p style="margin-left: 20px;">f) Social Science (Psychology, Sociology, Economics, Political Science, Management)</p> <p style="margin-left: 20px;">g) Language/Philosophy</p> <p style="margin-left: 20px;">h) Physical Education</p> <p>1. Please tick (✓) the box below, that best describe your hand preference</p> <table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <tr> <td style="width: 15%;">Strongly Left-handed</td> <td style="width: 15%;">Moderately Left-handed</td> <td style="width: 15%;">Ambidextrous (Use both hands equally)</td> <td style="width: 15%;">Moderately Right-handed</td> <td style="width: 15%;">Strongly Right-handed</td> </tr> </table>	Strongly Left-handed	Moderately Left-handed	Ambidextrous (Use both hands equally)	Moderately Right-handed	Strongly Right-handed	<p>2. Please tick (✓) the hand you prefer to use for the following activities :</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;"></th> <th style="width: 10%; text-align: center;">Left</th> <th style="width: 10%; text-align: center;">Right</th> <th style="width: 10%; text-align: center;">Either</th> <th style="width: 10%; text-align: center;">right or left</th> </tr> <tr> <th></th> <th style="text-align: center;">1</th> <th style="text-align: center;">2</th> <th style="text-align: center;">3</th> <th></th> </tr> </thead> <tbody> <tr><td>i Draw</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>ii Write</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>iii Use a bottle opener</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>iv Throw a ball to hit a target</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>v Use a hammer</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>vi Use a tooth brush</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>vii Use a screw driver</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>viii Use a tennis/badminton racquet</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>ix Use a scissors</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>x Hold a match stick while striking it on the match box</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>xi Stir a tin of paint</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>xii Unscrewing a Jar lid (lid hand)</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>xiii Cutting with knife</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> <tr><td>xiv Use an eraser on paper</td><td>_____</td><td>_____</td><td>_____</td><td></td></tr> </tbody> </table> <p>3. Please indicate which writing position most closely resembles your own ?</p> <table style="width: 100%; text-align: center;"> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </table> <p>4. To the best of your recollection, did anyone try to change your writing hand when you were learning to write ?</p> <p><input type="checkbox"/> No <input type="checkbox"/> Yes Why ? _____</p> <p>5. What is your national (ethnic) background ? _____</p>		Left	Right	Either	right or left		1	2	3		i Draw	_____	_____	_____		ii Write	_____	_____	_____		iii Use a bottle opener	_____	_____	_____		iv Throw a ball to hit a target	_____	_____	_____		v Use a hammer	_____	_____	_____		vi Use a tooth brush	_____	_____	_____		vii Use a screw driver	_____	_____	_____		viii Use a tennis/badminton racquet	_____	_____	_____		ix Use a scissors	_____	_____	_____		x Hold a match stick while striking it on the match box	_____	_____	_____		xi Stir a tin of paint	_____	_____	_____		xii Unscrewing a Jar lid (lid hand)	_____	_____	_____		xiii Cutting with knife	_____	_____	_____		xiv Use an eraser on paper	_____	_____	_____					
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xiv Use an eraser on paper	_____	_____	_____																																																																																							
																																																																																										

6. Were you part of a multiple birth and, if so, what type?

No Twin, fraternal Twin, Identical

Others, Please specify :

7. Were you your mother's, first child.

Yes No; which number _____

8. a) Please indicate to the best of your knowledge, the writing hand of your parents

Mother : Left Right Either Unknown

Father : Left Right Either Unknown

b) Please indicate to the best of your knowledge, the hand your parents prefer to use for doing most of the activities mentioned in item No. 2

Mother : Left Right Either Unknown

Father : Left Right Either Unknown

9. a) If you have any brothers or sisters please list their sex and writing hand

Sex	Writing Hand	Sex	Writing Hand
-----	--------------	-----	--------------

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

b) If you have any brothers or sisters please indicate to the best of your knowledge the sex and the hand they prefer to use for doing most of the activities mentioned in item No. 2 (R for Right, L for Left, E for Either, M for Male and F for Female)

Sex	Hand	Sex	Hand
-----	------	-----	------

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

10. a) Please indicate to the best of your knowledge the writing hand of your grand parents.

Grand-Mother : Left Right Either Unknown

Grand-Father : Left Right Either Unknown

b) Please indicate to the best of your knowledge the hand your grand-parents prefer to use for doing most of the activities mentioned in item No. 2

Grand-Mother : Left Right Either Unknown

Grand-Father : Left Right Either Unknown

APPENDIX C

SIX LETTER CANCELLATION TEST

Name: _____ Course: _____ Date: _____ Session: _____

Target letters: R L F T O Z

Cancel the above six letters with a slash in the given text, at your maximum speed.
Time allowed: 90 seconds

Q W E R T A Y U I O P A S D F G H L J K M Z X C V B N T M Y S Q C
B M C Z K L J G D A P I Y B R W Q E T U O L N J G D X V N O M J B
P H L O K M I J N U H B I Y G V T F C R D X E S Z C W A Q W I X E
L P M K O N J R I B H U V G Y C F T X D N Z S E A Q P W K E V F K
P O I D U Y T R E V W Q Z X C V B N M L K J H G F D S F A B P G O
A M P N O B I V U C Y X T I Z G R E W Q L K J H F X D S E R U C H
A D S F G J H K L Z C X V B W M N Q J E W R T U Y I O P M H N F Z
Z P L K O M J I N Y H U B G Y V F T C D R X S E Z A Q W Y A Z G V
Q P W O E I R U T Y A L S K D J F H G Z M X N C B V D H U P A R W
Z X C V B N M A S D F G H J K L Q W E R T Y U I O P Q L R F S U X
S Q A Z W S X O E D C R F V T G B Y H Q N U J M I K L O P K L T S T
M N B V C X Z L K J H G F D S A P O I U Y T R E W Q A E I O U R A

Total attempted:

Incorrect:

Net score:

