THE EFFECT OF HANDEDNESS AND GENDER ON PERFORMANCE IN COGNITIVE ABILITY TASKS.

Project submitted for partial fulfillment of the degree of

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CERTIFICATION

This is to certify that the thesis entitled, ' **The Effect of Handedness and Gender on Performance in Cognitive Ability Tasks**' is being submitted in partial fulfillment of requirements for the award of the degree of Master of Arts in Psychology, presented in the Thapar School of Liberal Arts & Sciences, Thapar Institute of Engineering and Technology, Patiala is a bonafide work carried out under the supervision of Dr. Santha Kumari, Professor & Program Chair, Thapar School of Liberal Arts & 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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CANDIDATE'S DECLARATION

I hereby declare that the work presented in this thesis entitled, **'The Effect of Handedness and Gender on Performance in Cognitive Ability Tasks**' submitted in partial fulfillment of requirements for the award of the degree of Master of Arts in Psychology, presented in the Thapar School of Liberal Arts & Sciences, Thapar Institute of Engineering and Technology, Patiala, is an authentic record of my work carried out under the supervision and guidance of Dr. Santha Kumari, Professor & Program Chair, Thapar School of Liberal Arts & Sciences, Thapar Institute of Engineering and Technology, Patiala and referred other researchers' work which is duly listed in the reference section.

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

Date-

Place-

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This is to certify that the above statement by the student concerned is correct and true, accurate, and to the best of my knowledge.

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DECLARATION

I, Meeshita Sharda (862102011), a student of M.A. Psychology (2021-2023), School of Liberal Arts & Science, Thapar University, Patiala, have completed the project entitled, ' **The Effect of Handedness and Gender on Performance in Cognitive Ability Tasks.**'

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ABSTRACT

Handedness refers to the dominant hand an individual uses to perform daily tasks, which can be left or right. This phenomenon has been the subject of extensive research, as it has been linked to differences in brain lateralization and cognitive functioning. The impact of Handedness on cognitive performance has been studied using a variety of performance tasks, including motor skills, memory, language, spatial reasoning, speed, executive function, and many more. The current study investigates the Effect of Handedness and Gender on the performance of Cognitive Ability Tasks. For this purpose, a sample of 29 Left-handers and 31 Right-handers in the age range of 16 to 30 years was obtained. The Standardized measures administered to participants were: Handedness Inventory, 3-Dimensional space perception (Subscale of GATB) for Spatial Ability, Digit Symbol Search Test for Motor Speed, and Trail Making Test for Executive functioning. Data were analyzed using SPSS, through which Descriptive Statistics, Independent T-Test, and ANOVA were computed. The results show a significant difference in the performance of left-handers and right-handed individuals in various Cognitive tasks. It also shows that there is no significant gender difference.

Keywords: Handedness, Spatial Ability, Motor speed, and Executive Functioning

CHAPTER-1

INTRODUCTION

1.1 Handedness

Have you ever considered which hand you use more frequently for daily tasks? Perhaps you are right-handed and have never given it much thought, or you are left-handed and have noticed how much more difficult specific tasks can be in a world designed for the right-handed majority. Handedness, or a preference for using one hand over the other, is a fascinating aspect of human behavior that has long confused scientists and excited laypeople. Despite being such a common and seemingly simple trait, Handedness is a complex and multi-faceted trait influenced by genetic and environmental factors. So, whether you are a lefty, a righty, or somewhere in the middle, there is much to learn and appreciate about Handedness. The word's primary meaning is an individual's skill with the hand. Since earlier times, the right and left have been associated with opposing moral, religious, and political attributes. At least one derogatory meaning has been associated with the terms left or left-handed (Springer & Deutsch, 1989). On numerous occasions, the Bible refers to the right hand as the hand of moral preference. According to Hardyck and Petrinovich (1977), honors, virtues, and powers are ascribed to the right hand, while there is no good reference to the left hand in the Bible. Left-handedness was considered inferior, and this bias may have played a role in the life of the left-handed person. Until the 1920s, adverse publicity about left-handedness had led educators to encourage all students to use their right hand regardless of preference.

The use of both hands is widespread in very young children. Hand preference appears to be determined early on by which hand is closest to the object being sought after; for example, young children may use their left hand to reach for any object on their left side out of convenience, regardless of their preference for either hand in the future. Most kids prefer one hand over the other, and by the time they are three, they are right- or left-handed; therefore, it states that our handiness develops by age three (Ingram, 1975). Handedness is the preference for using one hand over the other for manual tasks. While most cultures favor right-handedness, left-handedness is estimated to affect 10% of the population (Coren, 1992). Handedness, also known as the tendency to be more skilled and at ease using one hand instead of the other for tasks like writing and throwing a ball, is known as Handedness, also known as hand preference. Although it varies by nation, in Western nations, between 85% and 90% of people are right-handed, while 10% and 15% are left-handed. Both ambidextrousness (the capacity to perform tasks equally well with either hand) and mixed-handedness (the preference for using different hands for various tasks) are uncommon. The general population is estimated to be 90% right-handed and 10% left-handed (American Psychological Association, 2021).

According to the APA Dictionary of Psychology (2021), Handedness is the preference for using one hand rather than the other for fine motor activities. Handedness consistently uses one hand to perform specific tasks. The preference usually is related to a dominant effect of the motor cortex on the opposite side of the body. They are also called hand dominance or manual dominance.

Various types of "handedness" describe the tendency to favor using one hand over the other when performing manual dexterity-demanding tasks. There are three main categories of Handedness:

1. Right-handedness: This is the most prevalent type of Handedness, where people prefer to use their right hand for activities like writing, using scissors, or tossing a ball.

2. Left-handedness: This is the second most prevalent type of Handedness, where people prefer to use their left hand for activities like writing, using scissors, or throwing a ball.

3. Ambidexterity: This is a rare form of Handedness in which people are equally at ease using either hand for manual labor. Ambidextrous people can easily switch hands and don't favor one hand over the other.

It is important to remember that Handedness is a fluid characteristic that can change over time. Furthermore, some people are mixed-handed, meaning some tasks are performed with their right hand, while others are performed with their left hand.

Handedness or Hand Preference has piqued the interest of scientists from various disciplines, including neuroscience, psychology, anthropology, and genetics because it has implications for understanding brain development, cognitive processes, cultural norms, and genetic variations.

Handedness was first associated with brain organization by a French neurologist Paul Broca 135 years ago (as cited by Dimond, 1972). Broca proposed that the superiority of the left hemisphere in right-handers is responsible for both speech and manual dexterity.

He also speculated that some people might be the opposite (left-handers). Although he maintained that it was unnecessary to link speech and Handedness, the idea that the hemisphere controlling speech is on the opposite side to the preferred hand became known as Broca's rule and was influential for many years. One tends to use their right or left hand more naturally than the other. Whether a person favors their right or left hand or their left, this has been studied for many years to see what it reveals about brain function. Hand preference is most likely the result of the developmental process that separates the right and left sides of the body, known as right-left asymmetry. Due to its close connection to the brain's language development, Handedness is the most significant behavioral asymmetry. Hands become more differentiated, particularly for activities that require greater coordination and muscle control (Durost, 1934). More specifically, Handedness appears linked to differences in the brain's right and left hemispheres. McManus (1984) even suggests that Handedness is best measured simply by which hand is preferred for writing.

According to Zverev, Y. (2004), right-handedness has long been the norm, making left-handers the world's largest minority group facing cultural, social, and linguistic stigma. So, what are the advantages of being right-handed concerning the origin of Handedness? According to several authors, right-handedness evolved because using the right hand for tasks such as carrying and comforting a baby or carrying and using weapons in early warfare is more practical. In a population, there is a non-reciprocal mixture of two types of laterality in the handedness distribution, which has directional asymmetry characteristics. Given that only about 10% of people in most societies are left-handed, there is a consistent preference in human behavior for the right hand. According to this fact, rather than being the result of an unintentional preference on the part of a left-handed person, the shift to the right results from a systemic bias in favor of the right hand.

Given that brain asymmetries (or "lateralization") and language development are involved in Handedness, many researchers have proposed a link. The term lateralization refers to most people's preference for using one side of the body over the other, such as using either the right or left hand over the left. Lateralization occurs when a function or activity is specialized on one side of an organism. Examples include asymmetries in motor, perceptual, and cognitive functions. These asymmetries demonstrate that the brain's two hemispheres have different levels of specialization. Because of the asymmetries in Handedness, the brain's structure can be seen. The hemispheres of the human brain are divided into two. Through the corpus callosum, information travels between these hemispheres. A "cross-wired" brain has been observed. It suggests that while the right hemisphere controls the left side of the body, the left hemisphere is in charge of the right side. In particular, nonverbal, visuospatial, and motor functions on the left side of the body are lateralized to the right cerebral hemisphere. In contrast, the right side's language, analytical, and motor functions are lateralized to the left cerebral hemisphere. Thus, when performing verbal tasks, the left hemisphere predominates and controls behavior; the right hemisphere is more likely to predominate when performing nonverbal, visuospatial tasks.

Laterality refers to which side of the body or hemisphere of the brain is dominant. The tendency to complete tasks with one hand over the other is known as Handedness, and it is the most obvious example of laterality. People are typically classified as right-handed, left-handed, or ambidextrous (two-handed).

Research depicts a stronger connection between Handedness and hemispheric lateralization. Left-handed people, for example, are more likely than right-handed people to have a more balanced distribution of language processing between the left and right hemispheres. "Mixed-handedness" or "left-handedness with mixed cerebral dominance" (Knecht et al., 2000,123) describes this.

Studies have looked into the connection between Handedness and familial sinistrality. Familial Sinistrality, A positive history of familial sinistrality (FS +) is defined as having at least one left-handed or ambidextrous parent or sibling. The most likely effect of familial sinistrality is decreased left-hemisphere dominance for language functions in both left- and right-handers. Annett and colleagues (1979) discovered that left-handedness was more prevalent in left-handed families than right-handed families, indicating a possible genetic link. Handedness and familial sinistrality are linked to genetic and environmental factors likely to influence Handedness. According to evidence from various clinical and experimental studies by Hecaen & Sauguet (1971); Zurif & Bryden (1969). a positive history of familial sinistrality (FS +) is often associated with lessened left hemisphere dominance or bilateral language representation.

1.2 Spatial Ability

The ability to understand and use spatial information is referred to as spatial ability and mentally manipulate visual objects and their relationships in space. It involves skills such as visualizing, rotating, and manipulating objects in the mind's eye. From navigating a new city to building complex structures, the spatial ability is critical daily. It is a fascinating cognitive skill that enables us to comprehend and interact with the world in three dimensions, making it an essential component of human intelligence. The ability to understand, reason about, and remember the visual and spatial relationships between objects or spaces is called spatial ability. Spatial abilities are classified into four types: spatial or visuospatial perception, spatial visualization, mental folding, and mental rotation. These abilities have unique properties and are necessary for various tasks in specific jobs or everyday life. Spatial perception, for example, is defined as the ability to perceive spatial relationships. They concern the orientation of one's body in space quickly and accurately in the face of distracting information. Contrarily, Mental rotation is the mental ability to manipulate and rotate 2D or 3D objects in space quickly and precisely. Finally, spatial visualization is defined as complex multi-step manipulations of spatially presented data. Spatial working memory, a fourth spatial cognitive factor, mediates and supports these three abilities. Spatial working memory stores specific visual-spatial memories under attentional control to complete a task. This cognitive ability and higher-level spatial abilities, such as mental rotation, mediate these individual differences in capacity.

Lohman (1996) defines spatial ability as Spatial intelligence, or visuospatial ability, has been defined as " The ability to create, store, retrieve, and transform well-structured visual images." According to the APA dictionary, the ability to comprehend and conceptualize visual representations and spatial relationships in learning and performing tasks such as reading maps, navigating mazes, conceptualizing objects in space from different perspectives, and executing various geometric operations. Beginning in adolescence, males, on average, show a definite superiority in certain aspects of visual–spatial ability, whereas females, on average, display superiority in certain aspects of verbal ability.

Spatial ability refers to a person's ability to visualize and manipulate objects in three-dimensional space, comprehend spatial relationships, and navigate their surroundings. It is a critical skill in many fields, including architecture, engineering, mathematics, and science.

Handedness, or hand preference, is an intriguing starting point for investigating spatial ability because it is closely linked to brain lateralization and has been shown to affect spatial abilities in both males and females. In comparison, Handedness is the preference for using one hand over the other for tasks such as writing, throwing, or catching a ball. Spatial ability is a complex cognitive process involving integrating multiple neural pathways and brain regions, including the parietal lobe, hippocampus, and prefrontal cortex (Linn & Petersen, 1985). According to research, Handedness influences the development of these regions, which in turn influences spatial ability (Bishop, 2013).

Finally, Handedness is an intriguing starting point for investigating spatial ability because it is closely linked to brain lateralization and can affect spatial abilities in both males and females. However, it is essential to note that Handedness is not the only factor influencing spatial ability; other factors, such as genetics and experience, are also important.

1.3 Executive Functioning

Have you ever struggled to focus on a task or make a decision, despite your best efforts? Have you ever felt overwhelmed by a complex project, unsure where to begin? These are a few situations in which executive functioning is required. Executive functioning is a set of cognitive processes that enable people to plan, organize, initiate, and adapt their behavior to achieve specific goals. These processes are critical for success in various activities, from academic and work-related tasks to social interactions and personal decision-making. In this introduction, we will look at the concept of executive functioning, its components, and its application to various aspects of human behavior. Executive functioning can be compared to the instructor to the brain for guiding and coordinating the various cognitive processes required for effective goal-directed behavior. Executive functioning is essential in almost every aspect of our lives, from planning and decision-making to impulse control and working memory. Mental processes allow people to plan, initiate, monitor, and modify their behavior to achieve specific goals.

These processes are essential for various activities, from academic and work-related tasks to social interactions and personal decision-making. Working memory, inhibition, cognitive flexibility, and planning are all subcomponents of executive functioning. By better understanding executive functioning and how it relates to our daily lives, we can improve our ability to navigate the complex and dynamic world around us. Executive function fundamental skills include adaptable thinking, planning, self-monitoring, self-control, working memory, time management, and organization.

According to the APA dictionary, executive functioning is defined as planning, decision-making, problem-solving, action sequencing, task assignment and organization, effortful and persistent goal pursuit, inhibition of competing impulses, flexibility in goal selection, and goal-conflict resolution are higher-level cognitive processes. Language, judgment, abstraction and concept formation, logic, and reasoning are frequently used. They are frequently associated with frontal lobe neural networks, particularly the prefrontal cortex. Executive functioning deficits are seen in various disorders, including Alzheimer's and schizophrenia. The latter, for example, may impair goal selection and maintenance and the ability to exclude distractions. They were also known as central and higher-order processes and the Supervisory Attentional System. According to current trends, the central executive incorporates various functions, such as dividing attention, focusing attention, switching attention, and providing links between working memory operations and long-term memory formations. Baddeley (2007), Baddeley & Logie (1999), Friedman et al. (2008)

Handedness is a biological trait that refers to a person's preference for using their left or right hand for tasks requiring manual dexterity. On the other hand, executive functioning is a collection of cognitive processes that enable people to plan, organize, initiate, and self-regulate their behavior to achieve their goals. Handedness, or a preference for using one hand over the other for tasks like writing and grasping objects, has been linked to executive functioning, which refers to the set of cognitive processes that people use to achieve their goals. The relationship between Handedness and executive functioning is complex. It may be influenced by several factors, including the type of executive functioning measured, the population studied, and individual differences.

Baddeley (2012) Previous research has also looked into the effect of Handedness on executive function, considered the most crucial aspect of human behavior.

According to Miyake et al. (2000) and Vaughan & Giovanello (2010), some examples of executive processes include selecting strategies, inhibiting prepotent responses, updating working memory representations, shifting between tasks or mental sets, and monitoring performance. Diamond (2013) conducted a literature review on executive functions and their development, emphasizing the significance of these processes for academic achievement, social skills, and mental health.

1.4 Motor Speed

Fine motor skills are the ability or the capacity of an individual to make small, precise movements with the fingers, hands, wrists, fingers, feet, toes, lips, and tongue quickly and coordinately.

Motor skills are actions involving muscle movement in the body. They are classified as gross motor skills, which include more significant movements of arm, leg, foot, or entire body movements (crawling, running, and jumping), and fine motor skills, which are more minor actions like gripping an object between the thumb and a finger or tasting objects with the lips and tongue. Because many activities rely on the coordination of gross and fine motor skills, both types of motor skills usually develop together. This ability is required for many daily activities, including writing, typing, and using utensils. Fine motor speed and dexterity require the use of small hand muscles. The ability to manipulate small objects in a smooth, coordinated manner is required for practical writing skills.

Motor speed is a key indicator and predictor of cognitive and physical function. Fine motor speed can also impact academic performance, especially in tasks requiring speed and accuracy, such as timed tests and assignments. Motor processing speed is the rate at which the brain can process sensory and motor information to generate motor responses. It entails measuring, analyzing, and controlling motor rotational speed to ensure it is within the desired range. Problems with the brain, spinal cord, peripheral nerves, muscles, or joints can also impair these motor skills and reduce control over them. Sensors are typically used to detect the motor's rotational speed, and algorithms are used to interpret and respond to the sensor data. Processing speed is a fundamental cognitive ability required for various daily tasks such as decision-making, problem-solving, and information processing. It refers to an individual's ability to process information from their surroundings and respond quickly and accurately. Various cognitive tasks, such as rapid naming, digit symbol coding, and symbol search, can be used to assess processing speed. These tasks necessitate the individual processing information quickly and accurately while under time constraints. Other cognitive abilities, such as attention, working memory, and executive function, are also linked to motor speed. People with faster processing speeds have better attention control, the ability to hold information in working memory, and more efficient executive function. Slower processing speed, on the other hand, can harm academic and occupational performance, particularly in tasks that require quick decision-making and response. The ability to perform tasks or movements quickly is called speed ability.

Depending on the Context, it can encompass a wide range of different skills and abilities. For instance, speed ability could refer to:

1. Physical speed is the ability to move quickly, such as running, jumping, or responding to stimuli.

2. Cognitive speed: The ability to process information quickly, as problem-solving or decision-making.
3. Motor speed: The ability to perform complex movements quickly and accurately, such as playing an instrument or typing on a computer keyboard.
4. Reaction time: The ability to react quickly to stimuli such as a flying ball or a sudden change in traffic.

Motor Speed can be improved through practice and training in general, but there may be limitations based on individual factors such as genetics and age. Chiaravalloti et al. (2003) proposed that speed domains include simple and complex processing speeds. In contrast, Roberts and Stankov (1999) emphasized the importance of perceptual, inductive reasoning, decision and movement speed, and visual scanning speed. According to research by Van der Fels et al. (2015). Fine motor speed has been linked to academic achievement and overall functional performance in both children and adults,

Handedness is the preference for one hand over the other for manual tasks such as writing, grasping objects, or using tools. On the other hand, processing speed is a fundamental cognitive ability required for various daily tasks such as decision-making, problem-solving, and information processing. Research shows a link between Handedness and processing motor speed, with left-handed people having faster motor processing times than right-handed people. Because the hemispheres of the brain control movements on the opposite side of the body, left-handed people have a more direct connection between their dominant (left) hand and the right hemisphere of their brain, which is responsible for motor processing.

According to Sainburg (2014), Handedness influences motor processing speed, with right-handed people typically having faster motor processing speeds than left-handed people. The thought is that the neural circuits responsible for motor processing are more well-defined and specialized in the brain's dominant hemisphere, which is usually the left hemisphere in right-handed people.

Therefore, Motor processing speed and Handedness are two essential factors in human motor performance, and understanding their relationship can help us better understand how the brain controls movement.

CHAPTER-2

REVIEW OF LITERATURE

In setting the stage for the current study, the following literature review begins with an introduction to Handedness with the spatial ability and their relation among each other, followed by handedness and executive functioning and the relationship between Handedness and fine motor speed. What works is an explanation of how Handedness is different in various performance tasks.

The current study investigates the Effect of Handedness and Gender on Performance in Cognitive Ability Tasks.

2.1 Handedness and Spatial Ability

The act or alternative for using one hand over the other when performing skilled movements is called 'Handedness.' The majority of people are right-handed, with only a small percentage of people being left-handed or ambidextrous. On the contrary, Spatial ability is the ability to understand, visualize, and manipulate spatial relationships between subjects or objects.

According to research, there may be a link between Handedness and spatial ability, with left-handed people performing better on spatial tasks than right-handed people. Research has shown that spatial reasoning tasks frequently show that left-handed people perform better than right-handed people in tasks requiring mental rotation and spatial perception, such as the mental rotation of objects.

Geschwind and Galaburda (1985) assumed that left-handers had superior visual-spatial abilities due to the dominance of their right hemisphere.

Christman and colleagues (2011) conducted one study examining the relationship between Handedness and mental rotation ability, measuring spatial ability. The study results showed that left-handed people performed better on mental rotation tasks than right-handed people, implying that left-handed people have an advantage in spatial ability.

Mc Keever (1986) investigated the effects of Handedness, sex, and familial sinistrality (FS) on language laterality and spatial and temporal organization 225 right-handers and 134 left-handers took the verbal test. All tasks were completed differently by left-handers and right-handers. Right-handers were significantly more lateralized regarding language laterality on the spatial visualization task. Left-handers had slightly higher, but statistically significant, vocabulary scores. It was concluded that each of the subject factors investigated was relevant for a comprehensive understanding of laterality and cognitive ability patterns.

In conclusion, the relationship between Handedness and spatial ability is complex and varies according to the task being asked to perform. While some studies have discovered a link between Handedness and spatial ability, others have discovered no link or even a left-handed advantage in specific spatial tasks.

2.2 Handedness and Executive Functioning

Handedness and executive functioning are two distinct but interrelated constructs that have received much attention in the scientific literature. Handedness refers to an individual's preference for performing skilled tasks with either the right or left hand. In contrast, Executive functioning refers to a set of cognitive processes involved in goal-directed behavior, such as working memory, inhibition, cognitive flexibility, and planning. Even though Handedness and executive functioning are distinct constructs, they are thought to be linked because the factors associated with Handedness can influence the development and function of brain areas involved in executive functioning. In other words, how a person prefers to use their hand may influence how efficiently they perform specific cognitive tasks.

Several studies have investigated the relationship between Executive Functioning and Handedness.

An experimental study was conducted by Chaudhary S et al. (2009) on 60 female subjects aged 18 to 25 years to determine the effect of hand dominance on cognition. The subjects were chosen through convenient sampling using inclusion and exclusion criteria and divided into 2 groups: Group A (containing right-handed individuals) and Group B (containing left-handed individuals). The Trail Making Test, modified MMSE, and VAK learning questionnaire assessed both groups' cognitive functions, i.e., attention, memory, and learning. The independent "t" test and descriptive statistics were used to analyze the data. The outcome of this experiment revealed that left-handers performed better on the Memory and attention tasks than right-handers. Most left-handers were discovered to have auditory learning styles, whereas the majority of right-handers were discovered to have visual learning styles.

According to Takeshi Hatta (2017), Many studies have used behavioral measures to investigate the relationship between Handedness and executive functioning, but the exact nature of this relationship is unknown. The D-CAT (Digit Cancellation Test) performances of 76 left-handed (42 men and 34 women) and 76 age-matched right-handed (42 men and 34 women) healthy community dwellers were used in this study to examine the relationship between Handedness and executive function. The participants' average age was 62.7 years (standard deviation = 10.3). Furthermore, the Money Road Test was used to assess visuospatial performance. Left-handed people of both sexes performed worse on both tests than right-handed people. Right-handed people showed typical laterality concerning the relationship between sex and facets of cognition, whereas left-handed people showed no clear laterality difference. Men showed no handedness difference in the executive function, and women showed no difference in the visuospatial function test.

A Research study by (Beratis, Rabavilas, Papadimitriou, & Papageorgiou, 2010) discovered differences in executive functioning between right and left-handers using the Stroop Color Work Task. This study revealed that in a group of well-educated young adults, left-handers outperformed right-handers in their ability to inhibit an overlearned response.

Research by Benbow (1986, 1988) and O'Boyle, Benbow, and Alexander (1995) found that many left-handers can discern patterns and manage well with new knowledge, indicating a link between Handedness and executive-related processes.

Oldfield (1971) investigated the relationship between handedness and brain lateralization. In this study, he discovered that left-handed people had more right-hemisphere specialization than right-handed people. This finding implies that left-handedness is associated with a different pattern of brain organization than right-handedness, which has implications for executive function.

2.3 Handedness and Motor Speed

Handedness and fine motor speed are two aspects that have drawn much attention in psychology. Fine motor speed refers to the ability to perform precise movements with small muscles, such as those in the fingers and hands. In contrast, Handedness refers to the preference for one hand over the other when performing tasks requiring manual dexterity.

The review of literature that follows provides an overview of the research on the relationship between fine motor speed and Handedness.

Nalçaci E et al. (2001) aimed to re-examine the relationship between Handedness and asymmetry in hand performance and the gender difference in motor asymmetry. A total of 310 medical students volunteered to be subjects. To measure handiness, a 13-item Chapman and Chapman questionnaire was adapted. A finger-tapping task was used to assess fine motor performance. In this task, subjects had to tap a mouse button as quickly as possible with their index finger for 10 seconds. The results of the finger-tapping task and handedness scores were significantly correlated. The correlation between hand speed and handedness score in the total sample revealed that the distribution of hand preference is associated with left-hand speed but not right-hand speed. The findings confirm that right-handed females have more asymmetric motor functions than right-handed males.

In another study, Jeannie Judge & John Stirling (2017) researched 22 righthanded and 22 lefthanded participants who completed the Waterloo Handedness Questionnaire and tasks on a well-established manual dexterity test. When the task required the coordination of both the left and right hands, left-handers performed significantly better on the Purdue pegboard test, according to the analysis of variance. According to multiple regression analysis, the Purdue pegboard assembly task predicts self-reported hand preference and Handedness when classified by the Waterloo Handedness Questionnaire. Left-handers demonstrated a more negligible performance difference between hands, implying an advantage in using their nonpreferred hand. However, this did not improve performance on a bimanual placement task. These findings suggest that left-handers perform better when hand actions must be alternated to complete a task. The superior performance of the nonpreferred hand in left-handers may be investigated in the future to develop behavioral predictors of Handedness.

Palmer and Tinker (1986) investigated a sample of 199 college students to determine the relationship between Handedness and fine motor speed. According to the study, left-handed people have slower fine motor speeds than right-handed people. The study also discovered that left-handed and right-handed people's fine motor speeds differed more noticeably for tasks requiring greater precision.

Parish, A.P. (2011). Studies addressing the development of physical skills are even less common than studies examining educational adaptation for Handedness. This study aimed to evaluate if the congruence between instructor and student handedness is significant, given that PE teachers and students commonly rely on demonstrations to facilitate learning. It was predicted that left-handers who observe a right-handed demonstration would score much higher on performance and form than right-handers who observe a left-handed demonstration. Results showed that left-handers performed significantly better than right-handers on target accuracy ($F (3, 68) = 4.38$, $p = .007$), shot form ($F (3, 68) = 2.87$, $p = .043$), and body positioning ($F (3,$

68) = 4.51, $p = .006$). Left-handed college students appear to be able to learn crucial information from an opposite-handed demonstration, but right-handers are not as skilled. Future studies should look at younger children instead of college students because they have less adjusting experience (much like right-handers watching left-handed demonstrations).

Most studies show a significant connection between Handedness and fine motor speed, with left-handed people typically having slower fine motor speed than right-handed people. Left- or right-handed people may have different brains in structure and function, which could explain why they have slower fine motor skills.

CHAPTER-3

RESEARCH GAP, OBJECTIVES, AND HYPOTHESES

3.1 Research Gap

A thorough review of the literature makes it clear that the conclusions reached by various studies are quite contradictory based on a comprehensive review of the literature; that is, the performance of left-handed individuals differs significantly from that of right-handed individuals. At the same time, studies show that left-handed individuals perform similarly to right-handed individuals, which means no significant differences.

More extensive investigations across different domains are necessary to understand the differences between left-handed and right-handed individuals more thoroughly, as previous research has primarily focused on a narrow range of tasks or abilities. This study aims to establish new perspectives on TMT-A that are unavailable in the literature. The present study examines a comparative difference between the performance of left-handed and right-handed individuals in various performance tasks.

3.2 Objectives

1. To study the Effect of Performance of Handedness and Gender on Spatial Ability.
2. To study the Effect of Performance of Handedness and Gender on Executive Functioning/ Mental Flexibility.
3. To study the Effect of Performance of Handedness and Gender on Motor Speed.

3.3 Rational & Hypotheses

The existing literature suggests that Handedness has been studied in various ways. The suggested hypotheses investigate potential differences in spatial ability, cognitive processing speed, attention, and cognitive flexibility between left-handed and right-handed people. They also consider the possible influence of gender on these differences. Each hypothesis is supported by existing research on brain lateralization, motor control, and cognitive processes associated with Handedness, gender, and the specific cognitive tests mentioned. Thus, the following hypotheses have been formulated:

H_1: There is a significant difference in the performance of Left-Handed and Right-Handed individuals on the Spatial Ability Test.

H_2: There is a significant difference in the performance of the Left-Handed and Right-Handed individuals on the Digit Symbol Search Test.

H_3: There is a significant difference in the performance of Left-Handed and Right-Handed individuals on the Trail Making Test.

H_4: There exists a significant Gender Difference in the performance of Left-Handed individuals and Right-Handed individuals on the Spatial Ability Test.

H_5: There exists a significant Gender Difference in the performance of Left-Handed individuals and Right-Handed individuals on the Digit Symbol Search Test.

H_6: There exists a significant Gender Difference in the performance of Left-Handed individuals and Right-Handed individuals on the Trail Making Test.

CHAPTER-4

METHODOLOGY

4.1 Sample

The study's inclusion criteria for the current study were all young adults in Patiala, Punjab. From the age range of 16-30 years, both males and females. The study comprises 60 participants, 29 Left-handers and 31 Right – Handers. The sample was collected through a convenient sampling method.

4.2 Design

The design used for the study was Between-Group Design. A2 (Gender: Male, Female) X2 (Handedness: Left, Right) Factorial design is used for the present study.

Independent Variable- Handedness (Right-Handers, Left-handers), Gender (Females, males)

Dependent Variable –Spatial Ability (3-Dimensional space perception Subscale of GATB), Executive Functioning (Trail Making Test), and Motor Speed (Digit Symbol Search Test).

4.3 Tools Used

Three different performance tasks were administered. These tests were the 3-Dimensional space perception Subscale of GATB (General Aptitude Test Battery), Digit Symbol Search Test, and Trail Making Test. To identify the 'Handedness' or 'hand preference,' a 'Hand Inventory' form was used.

1. 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 to perform everyday activities like "draw, write, use a bottle opener, throw a snowball, use a hammer, toothbrush, screwdriver, eraser, strike a matchstick, stir the paint, or swing a bat." The subject must respond to each item by indicating whether they perform the tasks listed with their left, right, or both hands. A score of (1) was given when the response was 'left,' (2) when the response was 'right,' and (3) when the response was 'either.' The total score varied from 14-18 (extremely left-handed) to 26-30 (extremely right-handed) and 30-42 (extremely ambidextrous)

2. 3-Dimensional space perception subtest of GATB (General Aptitude Test Battery):

The Dolke (1976) test was modified for use in India to assess spatial ability. This test consists of 40 items, line drawings of flat metal strips that can be folded, rolled, or bent along the dotted lines. The subject had to indicate from the given alternatives which form could approximate the given item when folded, rolled, or bent. Performance on this test involves correctly visualizing and rotating using mental imagery, the consequences of folding, rolling, and bending a two-dimensional image in three dimensions. The score was determined by the number of problems correctly solved in the six minutes.

3. Trail Making Test (TMT):

Partington and Leiter originally developed the Trail Making Test in 1983 as a divided attention test. Later, this test was integrated into the Halstead-Reitan neuropsychological battery (Reitan & Wolfson, 1993). This brief paper and pencil neuropsychological test, often used for screening for cognitive impairment, mainly measures several functions, especially Cognitive flexibility, alternating attention, sequencing, visual search, and motor speed. The TMT-A and TMT-B are the two subtasks included in the version that is currently being used (Reitan, 1979). Each subtask is displayed on a sheet of white paper (A4 dimension), and participants are instructed to connect the circles randomly as quickly as possible. Part A has circles with only numbers (1-25) that must be connected numerically, while Part B has circles with both numbers (1-13) and letters (A-M) that must be connected alternately. Before each section, a pre-test with only 8 items is administered. If an error is made during the practice phase, the examiner helps to correct it and repeats the instructions. Part A is administered first, followed by Part B, in a set order. Performance is only measured by the time (s) required to complete each part. (Reitan, 1979).

4. DSST (Digit Symbol Search Test):

The Digit Symbol Search Test is a subtest of the Wechsler Adult Intelligence Scale (WAIS); Wechsler (2008) David Wechsler developed this test. This test is designed to assess information processing speed and visual perception. It is one of the three subtests contributing to Wechsler Intelligence Scales used to create processing speed indices. The examinee is asked to select one correct alternative out of 4 of the 2 Symbols given on the right. Participants respond to as many questions as possible in two minutes (i.e., 120 seconds). The instruction is to mark either the "Yes" or "No" checkbox with a pencil.

4.4 Procedure

The data was collected through the mode of convenient sampling. Informed consent was obtained from the participants before the study. This study aims to investigate the Effect of Handedness and Gender on the Performance of Cognitive Ability Tasks. Firstly, examinees were asked to fill out a 'Handedness Survey' form, which helped us to identify their 'Handedness' or 'Hand preference.' The individuals who scored 14-18 were categorized as Left-handers, and those who scored 26-30 were in the Right-Handers category. The participants were asked about their demographic details, some questions regarding their use of hands, and about familial sinistrality (whether or not one has left-handed biological relatives). The participants were asked to be honest, and their confidentiality was ensured. After that, they were asked to administer three performance Tasks- The subscale of GATB (3-Dimensional space perception), which measures Spatial ability, the Digit Symbol Search Test (DSST), which measures Motor speed; and the Trail Making Test (TMT) used for measuring Executive Functioning. At the beginning of each task, the participants are given instructions about how to go through the tests. Tests were conducted under the supervision of the examiner. After data collection, the scoring was done manually, and the results were calculated using SPSS 20.1.

4.5 Statistical Analyses

Statistical Package for Social Science (SPSS) version 20.1 was used to analyze the data. SPSS computed Descriptive Statistics (Mean and Standard Deviation), Independent T-Test, and ANOVA.

CHAPTER-5

RESULTS

To meet the objectives of the study aims to investigate the Effect of Handedness and Gender on Performance in Cognitive Ability Tasks. The results were computed using SPSS 20.1 (Statistical Package for Social Science). For calculating the results, Descriptive Statistics, Independent T-tests, and ANOVA were performed.

Table: - 1 indicates the Descriptive statistics for the variables under the study, i.e., Handedness and different dependent variables. The mean and the standard deviation of left-handed and right-handed individuals for Spatial Ability were 21.24 ± 5.20 and 15.16 ± 5.16, respectively. The mean and the standard deviation of Left-handed and Right-handed individuals for Motor Speed computed were 37.62 ± 5.55 and 29.61 ± 4.82, respectively. The mean and standard deviation of left-handed and Right-handed individuals on TMT-A (measuring Psychomotor speed) were 166.41 ± 30.37 and 221.58 ± 43.76, respectively. Lastly, the mean and standard deviation of Left-handed and Right-handed individuals on TMT-B (measuring Executive Functioning) was 45.03 ± 10.33 and 61.74 ± 13.16, respectively.

TABLE: - 1 DESCRIPTIVE STATISTICS.

Group Statistics

	Hand Group	N	Mean	Std. Deviation
GATB	Left-Handed	29	21.24	5.20
	Right-Handed	31	15.16	5.16
DSST	Left-Handed	29	37.62	5.55
	Right-Handed	31	29.61	4.82
TMT A	Left-Handed	29	166.41	30.37
	Right-Handed	31	221.58	43.76
TMT B	Left-Handed	29	45.03	10.33
	Right-Handed	31	61.74	13.16

Table: - 2 indicates the Independent T-Test for the variables under the study, i.e., Handedness and different dependent variables. An Independent T-test was performed to compare the means of Handedness on Spatial Ability (GATB). There was a significant difference between the mean of Handedness on Spatial Ability ($t(58) = 4.54$, $p \leq 0.001$). Another Independent T-test was performed to compare the mean of Handedness on Motor Speed (DSST). There was a significant difference between the mean of Handedness on Motor Speed ($t(58) = 5.98$, $p \leq 0.001$).

An Independent T-test was performed to compare to mean of Handedness on TMT-A (Psychomotor speed). There was a significant difference between the mean of Handedness on TMT-A ($t(58) = 5.64$, $p \leq 0.001$).

An Independent T-test was performed to compare the mean of Handedness on Executive functioning. The difference between the mean of Handedness on Executive Functioning (TMT-B) was very significant. ($t(58) = 5.49$, $p \leq 0.001$).

TABLE: - 2 INDEPENDENT T-TEST

		Mean	Std. deviation	T- value	df	Significance (2-tailed)
GATB	Left-Hand	21.24	5.20	4.54	58	.001
	Right-Hand	15.16	5.16			
DSST	Left-Hand	37.62	5.55	5.98	58	.001
	Right-Hand	29.61	4.82			
TMT A	Left-Hand	166.41	30.37	5.64	58	.001
	Right-Hand	221.58	43.76			
TMT B	Left-Hand	45.03	10.33	5.44	58	.001
	Right-Hand	61.74	13.16			

Table: - 3 indicates the Descriptive statistics for the variables under the study. The descriptive statistics show the difference between the 'Hand Group' (Left-handed and Right-handed) and the Gender group (Females and Males) in Spatial ability. The mean and the standard deviation for Left-handed females(N=14) and Left-handed males (15) were 22.00 ± 3.94 and 20.53 ± 6.21, respectively, and the mean and standard deviation for the Total Left-handed individuals (N=29) were 21.24 ± 5.20, respectively. The mean and the standard deviation for Right-handed females (N=13) and Right-handed males (N=18) were 12.62 ± 4.44 and 17.00 ± 4.96, respectively. The mean and the standard deviation for the Total Right-handed individual (N=31) was 15.16 ± 5.16, respectively. The total number of Females (N=27) for both Left and Right-handed, the mean and standard deviation was 17.48 ± 6.30, respectively. On the contrary, the overall number of Males (N=33) for both Left and Right-handed, the mean and standard deviation was 18.61 ± 5.75, respectively. Therefore, the mean and standard deviation of all the participants (N=60) with effect on Spatial Ability was 18.10 ± 5.98, respectively.

TABLE: - 3 DESCRIPTIVE STATISTICS (GATB).

Hand Group	Gender Group	N	Mean	Std. deviation
	Female	14	22.00	3.94
Left- Handed	Male	15	20.53	6.21
	Total	29	21.24	5.20
	Female	13	12.62	4.44
Right-Handed	Male	18	17.00	4.96
	Total	31	15.16	5.16
	Female	27	17.48	6.30
	Male	33	18.61	5.75
Total	Total	60	18.10	5.98

Dependent variable: GATB, Independent variable: Handedness, Gender Group.

Table: - 4 shows the ANOVA summary table for the variables under the study. It is evident from the table that there is a significant difference in the Hand group, i.e., there is a difference in the performance of Left-handers and Right-handers on spatial ability tasks. The value of (F $(1,60) = 24.73$, $p \leq .001$, $\eta p\ 2= 0.31$). The Large size effect implies a large variance in the spatial ability attributable to Handedness. However, there is no significant difference between Gender groups. The interaction effect between the Hand group and the Gender group is not significant.

TABLE: - 4 ANOVA SUMMARY TABLE

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Hand Group	616.74	1	616.74	24.73	.001	.31
Gender Group	31.47	1	31.47	1.26	.266	.02
Hand*Gender Group	126.54	1	126.54	5.07	.028	.08
Errors	1396.81	56	24.94			
Total	21768.00	60				
Corrected Total	2111.400	59				

Table 3 and Figure 1 show that Right-handed Males performed better than Right-handed females on the Spatial Ability Task. However, Right-handed males and females performed worse than Left-handed males and females on the Spatial Ability Task.

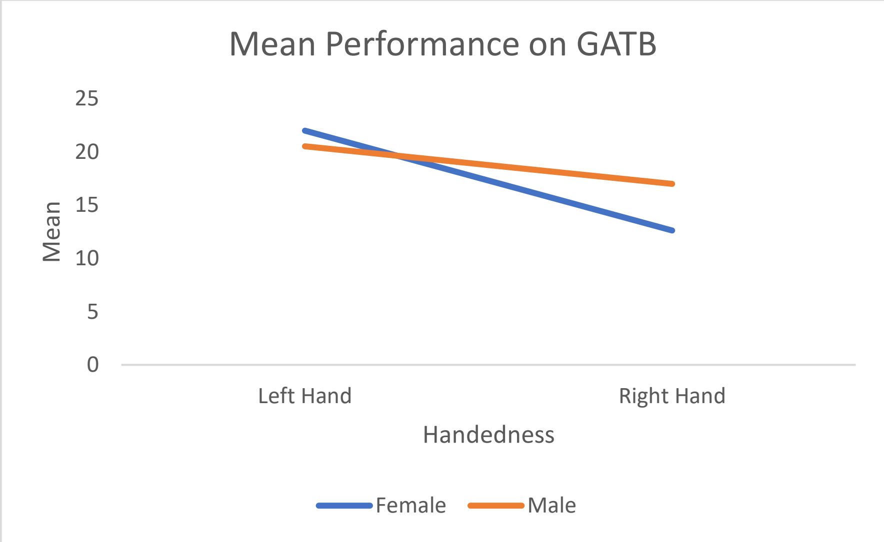

Figure: - 1 Performance on GATB task for left-handers and right-handers

Table: - 5 shows the Descriptive statistics for the variables under the study. The descriptive statistics show the difference between the 'Hand Group' (Left-handed and Right-handed) and the Gender group (Females and Males) in Motor Speed. The mean and standard deviation for Left-handed females (N=14) and Left-handed males (15) were 36.71 ± 4.49, and 38.47 ± 6.42, respectively, and the mean and standard deviation for the Total Left-handed individuals (N=29) was 37.62 ± 5.55 respectively. The mean and the standard deviation for Right-handed females (N=13) and Right-handed males (N=18) were 30.31 ± 5.72 and 29.11 ± 4.16, respectively. The mean and the standard deviation for the Total Right-handed individual (N=31) was 29.61 ± 4.82, respectively. The total number of Females (N=27) for both Left and Right-handed, the mean and standard deviation was 33.63 ± 5.99, respectively. On the other hand, the total number of Males (N=33) for both Left and Right-handed, the mean and standard deviation was 33.36 ± 7.04, respectively. Therefore, the mean and standard deviation of all the participants (N=60) with their effect on the performance on Motor speed was 33.48 ± 6.54, respectively.

TABLE: - 5 DESCRIPTIVE STATISTICS (DSST)

Hand Group	Gender Group	N	Mean	Std. deviation
	Female	14	36.71	4.49
Left- Handed	Male	15	38.47	6.42
	Total	29	37.62	5.55
	Female	13	30.31	5.72
Right-Handed	Male	18	29.11	4.16
	Total	31	29.61	4.82
	Female	27	33.63	5.99
	Male	33	33.36	7.04
Total	Total	60	33.48	6.54

Dependent variable: DSST, Independent variable: Handedness, Gender Group.

Table: - 6 indicates the ANOVA summary table for the variables under the study. It is evident from the table that there is a significant difference in the Hand group, i.e., there is a difference in the performance of Left-handers and Right-handers on Fine motor speed tasks. The value of (F (1,60) = 33.67, $p \leq .001$, ηp 2= 0.37). The Large size effect implies a large variance in the fine motor speed attributable to Handedness. However, there is no significant difference between Gender groups. The interaction effect between the Hand group and the Gender group is not significant.

TABLE: - 6 ANOVA SUMMARY TABLE.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Hand Group	918.22	1	918.22	33.67	.001	.37
Gender Group	1.14	1	1.14	.04	.839	.001
Hand*Gender Group	32.14	1	32.14	1.17	.282	.02
Errors	1527.14	56	27.27			
Total	69789.00	60				
Corrected Total	2520.98	59				

Table 5 and Figure 2 show a significant difference between the performance of Left-handed and Right-handed individuals on the Motor Speed Task. The Left-handed participants performed better than the Right-handed. There are no significant Gender differences.

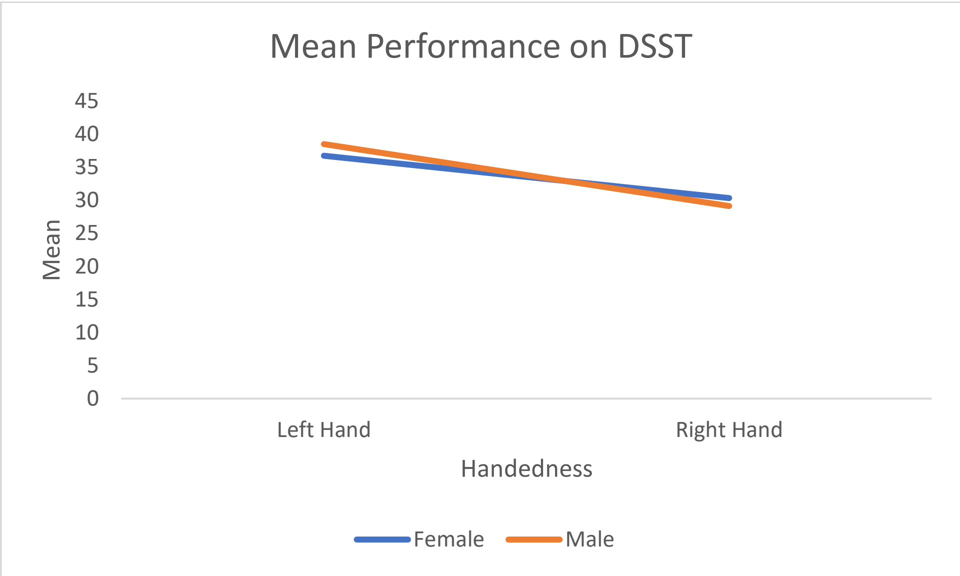

Figure: - 2 Performance on DSST task for left-handers and right-handers

Table: - 7 clearly shows the Descriptive statistics for the variables under the study. The descriptive statistics show the difference between the 'Hand Group' (Left-handed and Right-handed) and the Gender group (Females and Males) in TMT-A (psychomotor speed). The mean and the standard deviation for Left-handed females (N=14) and Left-handed males (15) were 172.29 ± 33.20 and 160.93 ± 27.46, respectively, and the mean and standard deviation for the Total Left-handed individuals (N=29) were 166.41 ± 30.37 respectively. The mean and the standard deviation for Right-handed females (N=13) and Right-handed males (N=18) were 232.85 ± 52.19 and 213.44 ± 35.91, respectively. The mean and the standard deviation for the Total Right-handed individual (N=31) was 221.58 ± 43.76, respectively. The total number of Females (N=27) for both Left and Right-handed, the mean and standard deviation was 201.44 ± 52.53, respectively. On the other hand, the total number of Males (N=33) for both Left and Right-handed, the mean and standard deviation was 189.58 ± 41.47, respectively. Therefore, the mean and standard deviation of all the participants (N=60) with their performance effect on TMT-A was 194.92 ± 46.73, respectively.

TABLE: - 7 DESCRIPTIVE STATISTICS (TMT-A)

Hand Group	Gender Group	N	Mean	Std. deviation
	Female	14	172.29	33.20
Left-Handed	Male	15	160.93	27.46
	Total	29	166.41	30.37
	Female	13	232.85	52.19
Right-Handed	Male	18	213.44	35.91
	Total	31	221.58	43.76
	Female	27	201.44	52.53
	Male	33	189.58	41.47
Total	Total	60	194.92	46.73

Dependent variable: TMT-A, Independent variable: Handedness, Gender Group.

Table: - 8 clearly shows the ANOVA summary table for the variables under the study. It is evident from the table that there is a significant difference in the Hand group, i.e., there is a difference in the performance of Left-handers and Right-handers on TMT-A (psychomotor speed). The value of ($F(1,60) = 33.28$, $p \leq .001$, $\eta p\ 2 = 0.37$). The Large size effect implies a large variance in the trail-making test (TMT-A) attributable to Handedness. However, there is no significant difference between Gender groups. The interaction effect between the Hand group and the Gender group is not significant.

TABLE: - 8 ANOVA SUMMARY TABLE.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Hand Group	47252.07	1	47252.07	33.28	.001	.37
Gender Group	3495.59	1	3495.58	2.46	.122	.04
Hand*Gender Group	239.46	1	239.46	.17	.683	.003
Errors	79489.93	56	1416.46			
Total	2408415.00	60				
Corrected Total	128864.58	59				

Table 7 and Figure 3 show a significant difference between the performance of Left-handed and Right-handed individuals on the Trail Making Task. Left-handed individuals have performed better than Right-handed. However, there exists no significant Gender difference.

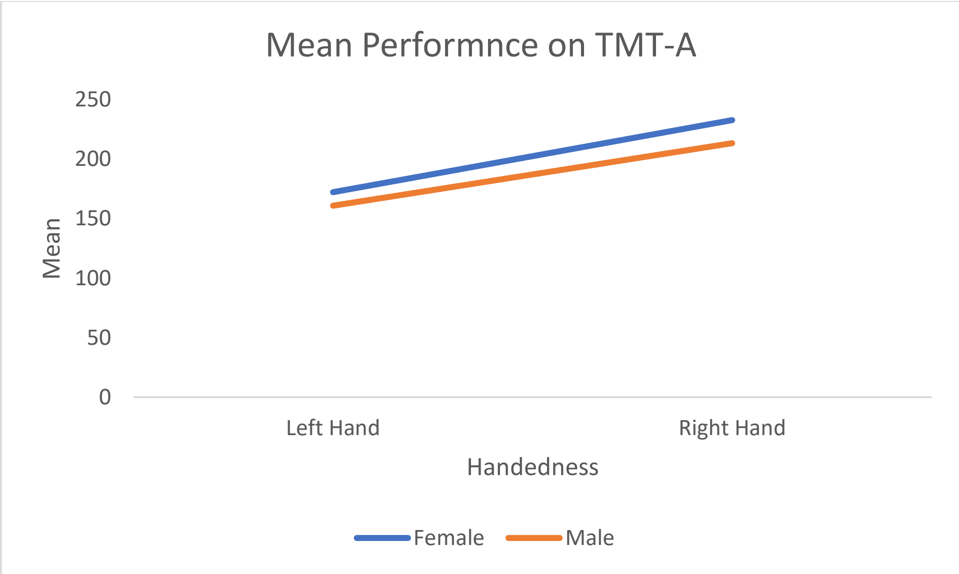

Figure: - 3 Performance On TMT-A task for left-handers and right-handers

Table: - 9 shows the Descriptive statistics for the variables under the study. The descriptive statistics show the difference between the 'Hand Group' (Left-handed and Right-handed) and the Gender group (Females and Males) in TMT-B (Executive functioning). The mean and the standard deviation for Left-handed females (N=14) and Left-handed males (15) were 46.64 ± 9.75 and 43.53 ± 10.97, respectively, and the mean and standard deviation for the Total Left-handed individuals (N=29) was 45.03 ± 10.33, respectively. The mean and the standard deviation for Right-handed females (N=13) and Right-handed males (N=18) were 59.15 ± 15.71 and 63.61 ± 11.07, respectively. The mean and the standard deviation for the Total Right-handed individual (N=31) was 61.74 ± 13.16, respectively. The total number of Females (N=27) for both Left and Right-handed, the mean and standard deviation was 52.67 ± 14.21, respectively. On the other hand, the total number of Males (N=33) for both Left and Right-handed, the mean and standard deviation was 54.48 ± 41.86, respectively. Therefore, the mean and standard deviation of all the participants (N=60) with their performance effect on TMT-B was 53.67 ± 14.48, respectively.

TABLE: - 9 DESCRIPTIVE STATISTICS (TMT-B)

Hand Group	Gender Group	N	Mean	Std. deviation
Left-Handed	Female	14	46.64	9.76
	Male	15	43.53	10.97
	Total	29	45.03	10.33
Right-Handed	Female	13	59.15	15.71
	Male	18	63.61	11.07
	Total	31	61.74	13.16
Total	Female	27	52.67	14.21
	Male	33	54.48	14.86
	Total	60	53.67	14.48

Dependent variable: TMT-B, Independent variable: Handedness, Gender Group.

Table: - 10 clearly shows the ANOVA summary table for the variables under the study. It is evident from the table that there is a significant difference in the Hand group, i.e., there is a difference in the performance of Left-handers and Right-handers on TMT-B (Executive Functioning). The value of ($F(1,60) = 27.59$, $p \leq .001$, $\eta p\ 2= 0.33$). The Large size effect implies a large variance in the trail-making test (TMT-B) attributable to Handedness. However, there is no significant difference between Gender groups. The interaction effect between the Hand group and the Gender group is not significant.

TABLE: - 10 ANOVA SUMMARY TABLE.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Hand Group	3925.09	1	3925.09	27.59	.001	.33
Gender Group	6.71	1	6.71	.05	.829	.001
Hand*Gender Group	211.61	1	211.61	1.49	.228	.03
Errors	7964.92	56	142.23			
Total	185174.00	60				
Corrected Total	12367.34	59				

Table 9 and Figure 4 show a significant difference between the performance of Left-handed and Right-handed individuals on the Trail Making Task. Left-handed individuals have performed better than Right-handed individuals. There exist no significant Gender differences.

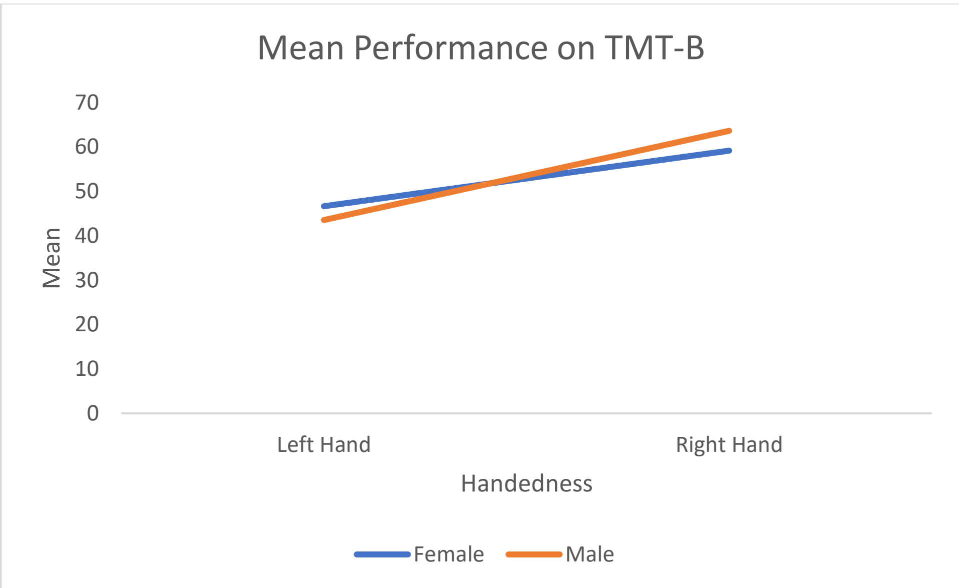

Figure: - 4 Performance On TMT-B task for left-handers and right-handers

CHAPTER-6

DISCUSSION

The current study aims to study the Effect of Handedness and Gender on Performance in Cognitive Ability Tasks.

Regarding the effect of Handedness, that is, the difference in the performance of Left-handed compared to the performance of Right-handed individuals on the Spatial Ability task, it was hypothesized that there exists a significant difference in the performance of Left-handed and Right-handed individuals on Spatial Ability Task. The results show a significant difference in performance, and thus the hypothesis is accepted. A study by Christman and colleagues (2011) conducted one study examining the relationship between Handedness and mental rotation ability, measuring spatial ability. The study showed that left-handed people performed better on mental rotation tasks than right-handed people, implying that left-handed people have an advantage in spatial ability.

It was hypothesized that there exists a significant Gender difference in the performance of Left-handed individuals and Right-handed individuals on the Spatial Ability Task. The results showed a significant difference in gender performance; thus, the hypothesis stands accepted. Barbara Sander S, James R. Wilson, and Steven G. Vandenberg (1982) conducted a large-scale study of cognitive abilities to test the hypothesis that handedness-related differences exist in spatial visualization. Females in both handedness groups scored higher on the verbal than on the spatial factor, and this difference was exaggerated among left-handers; males in both handedness groups scored higher on the spatial than on the verbal factor, which was also greater among left-handed subjects. Thus, the variation in spatial but not verbal ability with Handedness resulted in a greater disparity between spatial and verbal scores for left-handed subjects than right-handed subjects.

The third hypothesis stated that there exists a significant difference in the performance of Left-handed and Right-handed individuals on the Digit Symbol Search task (which measures Fine motor speed). The outcome showed a significant difference in performance. Hence hypothesis is accepted. A study was conducted in 2017 by Jeannie Judge and John Stirling, participants who completed the Waterloo Handedness Questionnaire and tasks on a recognized manual dexterity test included 22 righthanded and 22 lefthanded people. Left-handers performed noticeably better on the Purdue pegboard test when the task required the coordination of both the left and right hands. These results suggest that left-handers perform better when hand actions must be alternated.

Furthermore, it was hypothesized that there exists a significant Gender difference in the performance of Left-Handed individuals and Right-Handed individuals on the Digit Symbol Search Test. The results showed no significant gender differences; thus, the hypothesis stands Rejected. A study by Thomas, J. R., & French, K. E. (1985) conducted a meta-analysis of 64 research that discussed how gender affected motor development in childhood and adolescence. Based on data from 15,518 females and 15,926 males 3–20-year-olds, the findings produced 702 effect sizes. For 12 out of 20 tasks (such as balance, catching, grip strength, shuttle run, throwing velocity, and tapping), age was regressed on effect size, and the relation was significant. A typical curve of gender disparities between ages was followed by five of the activities. Gender differences were not correlated with age for 8 tasks, and effect sizes were modest. Results are examined regarding how biological and environmental factors have shaped gender differences.

It was hypothesized that there exists a difference in the performance of Left-handed and Right-handed individuals on the Trail making tasks (TMT-A, TMT-B). TMT-A measures psychomotor speed, whereas TMT-B measures Executive functioning. It was hypothesized that a significant difference exists in the performance of left-handed and right-handed individuals on the trail-making test. The results for TMT-A and TMT-B were computed separately. Therefore, results showed a significant difference in the performance of both left- and right-handed individuals on TMT-A and TMT-B. In a study conducted by Bramble and Rachel M. (1998). They administered TMT on 143 subjects, a widely used neuropsychological screening tool. None of the subjects chosen for the study had a history of a head injury, neurological impairment, psychiatric issues, or drug abuse. A questionnaire was used to determine Handedness, and left-handed participants whose hands were "hooked" or inverted were paired with right-handed participants who were identical in age, sex, race, and years of education. The study showed that left-handed participants performed significantly better on Trails A and A+B. Increased visual scanning speed, faster visuomotor processing, or a higher motivation to succeed are a few hypothesized explanations.

Finally, it was hypothesized that there exists a significant Gender Difference in the performance of Left-Handed individuals and Right-Handed individuals on the Trail Making Test. The results show no significant gender differences; thus, the hypothesis is Rejected. A study by Alexandre St-Hilaire et al. (2018) aims to provide regression-based normative data for TMT-A and TMT-B, tailored for a significant sample of French-speaking adults from Quebec (Canada). A sample of 792 participants, aged 50 to 91, comprised the normative sample. Equations for calculating the Z-scores for TMT-A and TMT-B and a contrast score that contrasted the performance of TMT-A and TMT-B were provided based on multiple linear regression. Age-based percentiles are shown for the total number of errors that were recorded. The Trail Making Test (TMT) is primarily used to measure executive functions (part B) and the speed at which people process visual information (part A). The test is accurate at spotting cognitive decline as people age. The results indicate that a significant predictor of performance on the TMT-A was age, whereas the TMT-B performance was independently correlated with age and education. The performance of either group was unaffected by gender. The contrast score between TMT-B and TMT-A could only be accurately predicted by education. Due to the rarity of two or more errors on the TMT-B in the normative sample, examiners should exercise caution when two or more errors are noted.

The current study provides evidence for the influence of Handedness and Gender on Cognitive Ability Tasks. The Left-handed individuals performed better than Right-handed individuals on Spatial Ability Tasks, with Left-handed individuals having an advantage. Gender differences were observed in the performance of both Handedness groups. Gender differences were observed in the Spatial Ability Task. Left-handed individuals also performed better on Fine Motor Speed tasks and Executive Functioning. However, no significant Gender differences were found in the performance of Left- and Right-handed individuals on the Fine Motor Speed and Trail Making Test tasks. These findings contribute to our understanding of the complex interplay between Handedness, gender, and cognitive performance.

CHAPTER-7

CONCLUSION, IMPLICATION, LIMITATION, AND SCOPE FOR FUTURE RESEARCH

7.1 Conclusion

In conclusion, the present study investigates the performance differences between Left-handers and Right-handers on various tasks, including spatial ability, fine motor speed, and executive functioning. The results suggest that Left-handers performed better than Right-handers on spatial ability, fine motor speed, and executive functioning tasks. The study also found no significant gender difference in the performance of Left-handed and Right-handed individuals in the Trail Making Test and Digit symbol search test. These findings indicate that Handedness is an essential factor that can impact an individual's performance on cognitive tasks. However, gender did not play a significant role in the performance of Left-handed and Right-handed individuals' Trail Making Test and Digit Symbol Search Test. These findings can provide valuable insights into the neurocognitive processes associated with Handedness and its impact on cognitive abilities.

7.2 Implications

This research offers an important understanding of the function of Handedness and gender in determining cognitive and motor performance, which plays an important role in studying cerebral dominance. It highlights the need for further research in this area to understand better the underlying mechanisms that contribute to these differences and to develop interventions that can help individuals overcome any potential disadvantages associated with their Handedness or gender.

7.3 Limitations

There were limitations in this study. The sample size was very small, which made it difficult to give generalized results. The present study was based on a non-randomized sample. Therefore, future studies should ensure that the sample is collected randomly to generalize the results. The number of females and Males for Handedness was also less, so the study did not find any significant gender difference. Handedness changes with age, according to age data has not been stratified.

7.4 Scope for Future Research

The current study offers insightful information about how left-handed and right-handed people perform differently on various performance tasks. Further study in this area is still needed, though. Increasing the number of participants for left-handed and right-handed with increasing the sample size for males and females can help get better results. Studying the performance of ambidexterity (ability to use both hands with equal skills) can help us shed light on Handedness's role in cognitive and motor tasks.

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APPENDIX-A

CONSENT FORM

CONSENT FORM

Greetings!

I am Meeshita Sharda, a student at Thapar Institute of Engineering and Technology Patiala, Punjab. I am pursuing a Master's in Psychology as a part of my dissertation. I am conducting A Comparative study that investigates the difference in the performance of Handedness and Gender in the context of various performance tasks. Your Participation in this research is completely voluntary. I would be grateful if you could spare some time to respond to the survey. It will take just 15-20 minutes of precious time. All the information you provide will be kept confidential, and no harm (physical or psychological) is associated with the research study.

If you have any questions or want to know your results, you can contact me via e-mail address: msharda_ma21@thapar.edu.

Thank you for participating in the study.

I, ____________________ (Frist Name) ____________________ (Last Name), Understanding that my participation in this experiment is voluntary, I hereby consent to participate in the study.

____________________ Date

____________________ Signature of the participant

APPENDIX-B

HANDEDNESS SURVEY

1. Name ______

2. Address
   a) College ______

   b) Permanent ______

3. Sex Male Female

4. Date of Birth Date Month Year

5. Approximate parental income per month

6. No. of brothers and sisters

7. Occupation ______

8. No. of years of Education ______

9. Major area of Education :
   (tick the appropriate)
   a) Pure Science (Physics, Chemistry)
   b) Engineering/Medicine
   c) Mathematics/Computer Science
   d) Architecture
   e) Fine Arts (Music, Painting, Dance)
   f) Social Science (Psychology, Sociology, Economics, Political Science, Management)
   g) Language/Philosophy
   h) Physical Education

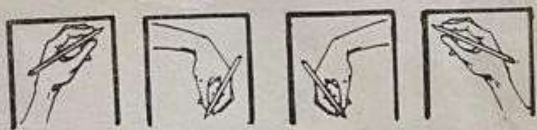
1. Please tick (√) the box below, that best describe your hand preference

Strongly Left-handed	Moderately Left-handed	Ambidextrous (Use both hands equally)	Moderately Right handed	Strongly Right-handed

2. Please tick (√) the hand you prefer to use for the following activities :

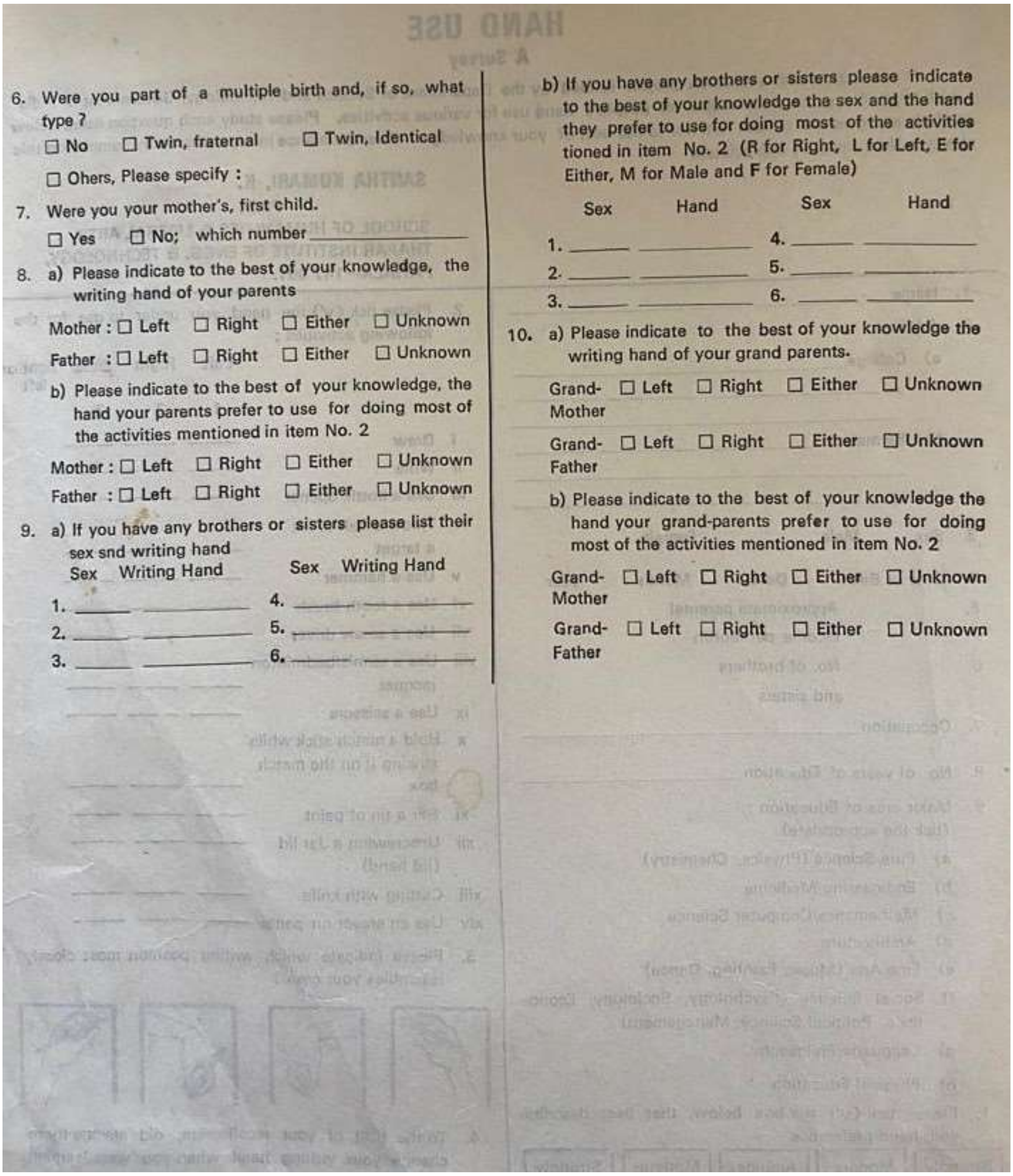
	Left 1	Right 2	Either right or left 3
i Draw			
ii Write			
iii Use a bottle opener			
iv Throw a ball to hit a target			
v Use a hammer			
vi Use a tooth brush			
vii Use a screw driver			
viii Use a tennis/badminton racquet			
ix Use a scissors			
x Hold a match stick while striking it on the match box			
xi Stir a tin of paint			
xii Unscrewing a Jar lid (lid hand)			
xiii Cutting with knife			
xiv Use an erasor on paper			

3. Please indicate which writing position most closely resembles your own ?



4. To the best of your recollection, did anyone try to change your writing hand when you were learning to write ?
   ☐ No ☐ Yes Why ? ______

5. What is your national (ethnic) background ?
   ______



6. Were you part of a multiple birth and, if so, what type ?
☐ No ☐ Twin, fraternal ☐ Twin, Identical
☐ Ohers, 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 snd 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 tioned 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

3-Dimensional space perception subtest of GATB

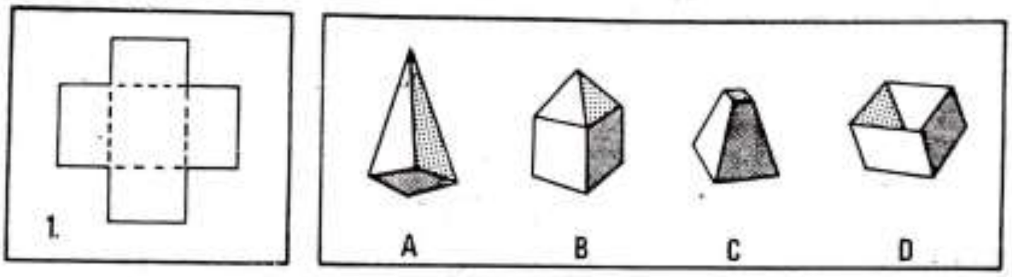
FORM B

PART 3

INSTRUCTIONS

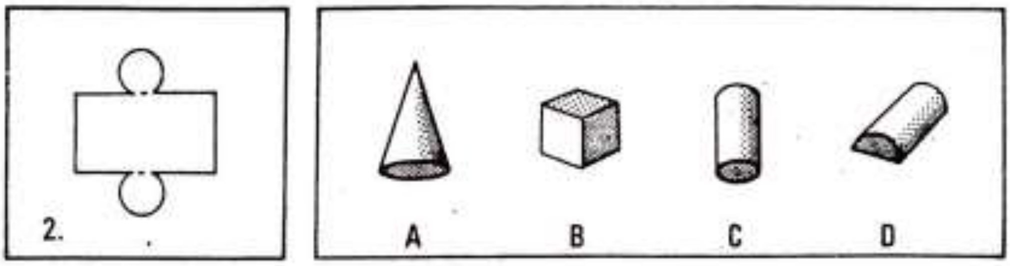
On this page are some exercises in finding objects made from pieces of metal.

Look at exercise 1 below.



At the left is a drawing which represents a flat piece of metal. The dotted lines show where the metal is to be bent. At the right are drawings of four objects. Notice that only object D can be made by bending the metal piece in figure 1. Look at the Practice box in the Part 3 section of the answer sheet. Notice that in the row for practice exercise 1 the space under the letter D has been tick (✓) marked.

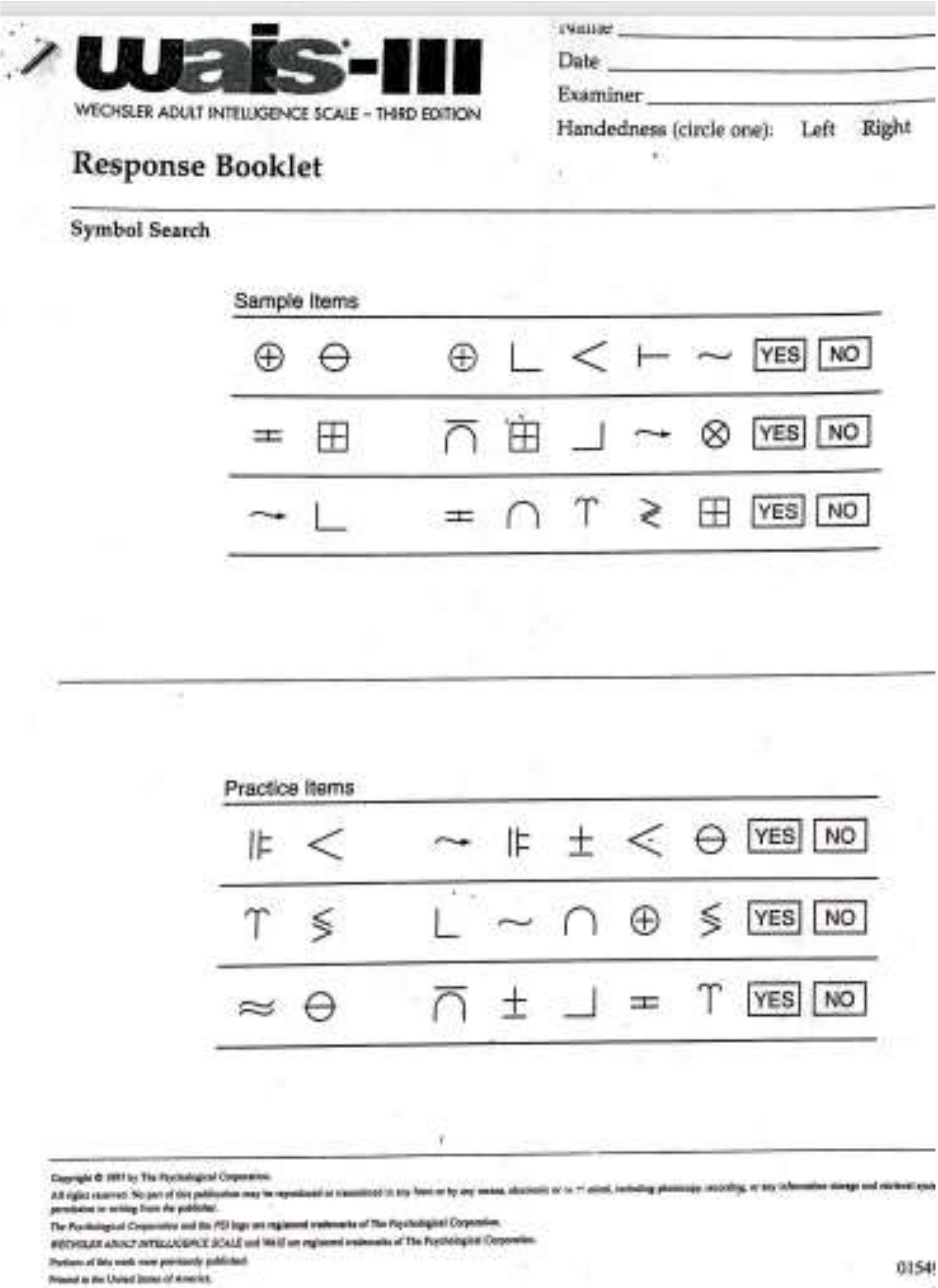
Look at exercise 2.



At the left is another drawing of a flat piece of metal. Only object C can be made from figure 2, this time by both rolling and bending the metal. Therefore, in the row for practice exercise 2 on the answer sheet, the space under letter C has been tick (✓) marked.

APPENDIX- D

Digit Symbol Search Test (DSST)



APPENDIX- E

Trail Making Test (TMT)

CTMT

Comprehensive Trail-Making Test

Record Booklet

Section I. Identifying Information

Name ____________________

Female ☐ Male ☐

	Year	Month	Day
Date of Testing	____	____	____
Date of Birth	____	____	____
Test Age	____	____	____

Referred by ____________________

Reason for Referral ____________________

Examiner ____________________

Section II. Record of Trail and Composite Index Scores

Trail	Raw Score Time in Seconds	T-Score	%ile	Descriptive Rating
Trail 1	____	____	____	____________
Trail 2	____	____	____	____________
Trail 3	____	____	____	____________
Trail 4	____	____	____	____________
Trail 5	____	____	____	____________
T-Score Sum		☐		
CTMT Composite Index		◯	____	____________

Section III. Profile of Scores

T-Score	Trail 1	Trail 2	Trail 3	Trail 4	Trail 5	Mean of 5 Trails	T-Score	Composite Index	I-Score
85	+	+	+	+	+	+	85	+	85
80	+	+	+	+	+	+	80	+	80
75	+	+	+	+	+	+	75	+	75
70	+	+	+	+	+	+	70	+	70
65	+	+	+	+	+	+	65	+	65
60	+	+	+	+	+	+	60	+	60
55	+	+	+	+	+	+	55	+	55
50	—	—	—	—	—	—	50	—	50
45	+	+	+	+	+	+	45	+	45
40	+	+	+	+	+	+	40	+	40
35	+	+	+	+	+	+	35	+	35
30	+	+	+	+	+	+	30	+	30
25	+	+	+	+	+	+	25	+	25
20	+	+	+	+	+	+	20	+	20
15	+	+	+	+	+	+	15	+	15

Section IV. Calculation of Significance

1. Divide the *T*-score sum for all trails by 5: ______
2. Subtract the mean trail score from each individual trail score:
   - Trail 1: ______
   - Trail 2: ______
   - Trail 3: ______
   - Trail 4: ______
   - Trail 5: ______
3. Compare the difference score to the values listed in the table below. If the difference score equals or exceeds the tabled value, a real difference may exist and is not a reflection solely of chance or errors of measurement.

	.05	.01	Significant Yes/No
Trail 1	12.38	15.79	______
Trail 2	11.38	14.51	______
Trail 3	12.20	15.56	______
Trail 4	12.54	15.99	______
Trail 5	12.54	15.99	______

Significance levels corrected for 5 comparisons