LATERALITY AND COGNITIVE INTERFERENCE IN STROOP LIKE TASKS AMONG RIGHT AND NON-RIGHT HANDERS

Ph.D. THESIS

by

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE – 247 667 (INDIA)
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ROORKEE

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "**LATERALITY AND COGNITIVE INTERFERENCE IN STROOP LIKE TASKS AMONG RIGHT AND NON-RIGHT HANDERS**" in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Humanities and Social Sciences of the Indian Institute of Technology Roorkee, Roorkee is an authentic record of my own work carried out during a period from July, 2013 to October, 2018 under the supervision of Dr. Ram Manohar Singh, Department of Humanities and Social Sciences, Indian Institute of Technology Roorkee, Roorkee and Dr. Indiwar Misra, Department of Psychology, Dr. Bhim Rao Ambedkar College, University of Delhi, Delhi.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institution.

(ASHWINI KUMAR)

This is to certify that the above statement made by the candidate is correct to the best of our knowledge.

(Ram Manohar Singh)
Supervisor

(Indiwar Misra)
Supervisor

The Ph.D. Viva-Voce examination of **Mr. Ashwini Kumar**, Research Scholar, has been held on **......................**.

Chairman, SRC **Signature of External Examiner**

This is to certify that the student has made all the corrections in the thesis.

Signature of Supervisor (s) **Head of the Department**

Dated:

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ABSTRACT

This study investigates Stroop-like incongruency effect when emotional face, geometrical shape and color patches, are presented as paired stimuli in the form of image and word in split visual and parallel visual field to right-handed and non-right-handed individuals. The sample comprised 80 right-handers and 69 non-right handers males of 17-25 years of age. Self-report 10-items questionnaire were administered to determined handedness level. To access inconruency effect reaction time and accuracy were measured based on Stroop-like task with the help of JAVA based program in which pair of stimuli presented for 180 milliseconds on computer screen in the form of images (Emotional faces, Geometrical shapes and Color patches) and words (Emotional words, Geometrical shapes name and Color names) under three experiments over the 120 trials (60 split visual field and 60 parallel visual field) in congruent and incongruent conditions. Results reveal that in both visual field presentations i.e. split visual field and parallel visual field, non-right handers were faster in reaction and greater accuracy compared to right handers. So, the results demonstrated that, non-right handers had less incongruence effect in both types of stimuli i.e. word and images as compared to right handers in almost all the three experiments. The nature of stimuli was different in all three experiments but the incongruence effect was reported consistently as right handers had high incongruence effect during the recognition of different stimuli under both kinds of visual presentations. Further right handers were faster displaying high accuracy for word stimuli when stimuli presented in right visual field than the non-right handers in the all three Experiments. For image stimuli the right handers showed better performance when stimuli were presented in left visual field than the non-right handers in all three Experiments. These findings were strong under split visual field presentations than parallel visual field presentation. Surprisingly all these findings were quite consistent in the three experiments involving emotional, geometrical and color stimuli. The results of the current study deliver sufficient support to proposed two hypothesis, as well as it also supports different findings and theories that discussing an interaction of handedness and perception or cognitive functions. Further this study also gives different insight to understand the effect of handedness on Stroop like task as well as hemispheric dominance on perception of verbal and nonverbal materials. Apart from handedness, visual field is also a factor that effects visual perception that was also explained in this study.The findings that emerge from the study can be organized in a theoretical- conceptual framework. They are suggestive of the fact that the pattern of recognition of word and image stimuli varied across right and non-right handers. It also varied across the two visual fields, i.e. split visual field and parallel visual field. Non-right handers emerged as non-dominant or bilaterally dominant groups of people and these people have lower level of incongruence generated interference as compared to the right handers. With the findings of this study it can also be stated that individual ways of perceiving stimuli are quite strong and consistently influence one's perception. It appears that in Stroop like experiments the different visual field presentation methods can be helpful to decipher perceptual style and lateralization pattern.

Key words: Handedness, Stroop-like task, laterality, Parallel visual field, Split visual field.

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LIST OF ABBREVIATION

LVF	Left Visual Field
RVF	Right Visual Field
SD	Standard Deviation
M(SD)	Mean (Standard Deviation)
M	Mean
ANOVA	Analysis of Variance
df	Degree of Freedom
NRH	Non Right Hander
RH	Right Hander
Cong	Congruent Condition
Incong	Incongruent Condition
SVF	Split Visual Field
PVF	Parallel Visual Field

Chapter-1

Introduction:

The brain is a very complex organ in human body in terms of its function and structure. It has been studied extensively during the last 150 years in various aspects through different tools, technique and methodologies (Dax, 1836). Human brain is a single structure but it comprises two halves that are known as hemispheres. Right side of the brain is known as right hemisphere and left side of brain is called left hemisphere. A variety of researches have suggested that these two hemispheres look almost similar in structure but their functions are quite different. The functions of two hemispheres are defined in a number of ways in which level of information processing within the hemisphere as well as between the hemispheres to make them understandable. To explore the functional speciality of both the hemispheres researcher are still engaged in the study of this area (Bogen, 1977; Bradshaw & Nettleton, 1981;Chall& Mirsky, 1978; Lennon, 1984; Thompson, Bogen & Marsh, 1979; Tandanobu, 1978; Tandanobu, 1978;Uzzaman, 2017). Hemispheric asymmetry got significant attention after sixties and it has supported Hippocrates' observation that "the human brain, as in the case of all other animals, is double" (Bogen, 1969, p.137). The history related to asymmetry of hemispheric functions is well addressed by Corballis and Beals (1976) and Bogen (1969).

1.1 Hemispheric Specialization

Hemispheric functional differences came into existence in late 1960 when these two hemispheres were separated through surgery and their functions were separately assessed by Sperry (1975) at California Institute of Technology and by Bogen (1969) with their colleagues in a medical institute (Duke 1968 and Galin, 1974; Gazzaniga, 1970; Sperry, 1968). They found that human brain consists two distinctive hemispheres but similar in their structures known as right and left hemispheres. All researches related to the functioning of human brain came up with new evidence that these two-hemispheres work differently in terms of encoding, organizing and processing of information. The two cerebral hemispheres are capable to function differently from each other as well as they work in different ways when they interact with each other. Hemispheric specializations can also be understood in terms of functional dominance. Each hemisphere has some specialized function but some function they share in a way that one dominates the other as active or passive style of functioning.

1.2 Cerebral Dominance

In the human brain both the hemispheres have their specified functions but in some way one hemisphere is more passive or less cognitive than other. This concept is known as cerebral dominance. Majority of researches in the area of hemispheric specialization propose that in majority of the people left hemisphere is considered dominant for verbal task as right hemisphere dominates in performance on visuo-spetial task (Dimond, 1971;Gazzaniga, 1970; Klatzky, 1970;Levy & Reid, 1976; Marshall, 1973; Sperry 1973). Apart from verbal ability left hemisphere is also specialized for manual skills (Corballis, 1980) and an excellent performer of motor activities in common population (Zangwill, 1976). Past researches were dedicated to explore left hemisphere more in detail as compared to right hemisphere. The reason for exploring left hemisphere was its relationship with language ability that has direct relation with human intelligence is reflected in an argument by Sperry (1973) as modern society focuses on the development and greater use of intelligence took more attention to explore left hemisphere and to neglect right hemisphere. Right hemisphere had explained in past studies as silent, non-dominant and minor hemisphere. In the last forty-years attention shifted to language dominant hemisphere to non-dominant language hemisphere, the right hemisphere, and the interaction between these two to understand different cognitive abilities (Wexler, 1980).

The development of human brain is unique and it has exclusive way to perform all important tasks that make us possible to survive on earth and to adjust with environment. In the way to adjustment with outer world brain receives, processes and interprets information through the specialized neuro-anatomical interactions. The structure of human brain developed in such a way that two independent mental systems exist together in two sides like left and right sides (Gazzaniga & LeDoux, 1978; Joseph, 1982, 1988;Levy, 1983; Sperry, 1966, 1982). For instance, "expressive speech, linguistic knowledge and thought, mathematical and analytical reasoning, as well as the temporal-sequential and rhythmical aspects of consciousness, are associated with the functional integrity of the left half of the brain in most of the population. By contrast, the right cerebral hemisphere is associated with nonverbal environmental awareness; visual-spatial perceptual functioning, including analysis of depth; figure ground and stereopsis; facial recognition; and maintenance of the body image, as well as perception, expression, and mediation of most aspects of emotionality" (Joseph, 2013, p. 01).

1.3 Left Hemisphere Summary

The left side of the brain or left hemisphere specialized for classification and association of different stimuli in terms of information into unique temporal units as well as to control voluntary motor activities like movement of hand, finger and arms (Beaumont, 1974; Heilman, Rothi, & Kertesz, 1983; Kimura, 1977; Luria, 1980; Mateer, 1983). This hemisphere also specialized for coding, decoding linguistic materials in sequential as well as in linear time frame (Efron, 1963; Lenneberg, 1967; Mills &Rollman, 1980). All linguistic components control and regulate by this hemisphere for understanding and communicating meaningful content during communication. So, for making sentences, the use of syntax, spelling, writing, reading, comprehension, memory related to verbal content mange by the left hemisphere (Albert, et, all. 1972; Carmazza & Zurif, 1976; DeRenzi, Zambolini, &Crisi, 1987; Efron, 1963; Goodglass & Kaplan, 1972;Hecaen& Albert, 1979; Heilman & Scholes, 1976; Luria, 1980; Levine, 1983; Milner, 1970; Zurif& Carson, 1970). Dichotic listening research suggests that left hemisphere dominant in general population for all types of verbal content including backward speech, nonsense syllables and perception of actual and authentic words to compose meaning out of verbal materials (Blumstein & Cooper, 1974; Studdert-Kennedy, 1967; Shankweiler & Kimura, 1961; Shankweiler, 1970). In addition, it has been summarized in various studies that, in one part of left hemisphere control and regulate speaking and other part of this hemisphere is lateralized for understanding speech and these two areas of left hemisphere known as Broca and Wernick areas respectively.

1.4 Right Hemisphere Summary

Language generally recognized with vocabulary and grammar but there are some other important factors that also shape our linguistic ability that is expression and comprehension of a speaker in terms of his or her feeling, attitude, situation and significance of content. So the language is descriptive as well as emotional. Listener grasps not only the material or content that has been delivered by speaker but also how it has been delivered and also about the feeling of speaker.

Feeling normally communicates with different voice and expressions. For different feelings like, sadness, scared, disguised, happiness, empathy and others have different representations by changing voice tone, amplitude, melody and on putting extra stress on some words. When these expressions don't follow the line of content then listener can find difficulty to recognize content in real manner. For dealing with our day to day life problem or for better adjustment with situation person's emotional intelligence matters a lot it helps individuals to easily read other's emotion or express own emotion effectively (Singh & Singh, 2008). Sometimes people find it difficultto express own emotions with their linguistic content. Researches indicate that after damaging in particular area of right hemisphere of brain or intact right half of the brain anesthetized by following sodium amytal procedure. Right hemisphere superiority has been widely accepted in different studies on normal or brain-damaged subjects in interpreting, processing, distinguishing of vocal inflectional nuances together with strength, stress and pitch contours, highness, lowness of tone, accent, emotional character, rate of recurrence, amplitude, tune, length and tone (Bowers, Coslett, Bauer, Speedie, & Heilman, 1987;Blumstein & Cooper, 1974;Carmon&Nachshon, 1973; Heilman, Scholes, & Watson, 1975;Ley & Bryden, 1979; Mahoney & Sainsbury, 1987;Shapiro & Danly, 1985; Speedie, & Heilman, 1987; Safer & Leventhal, 1977; Ross, 1981). This speciality of right hemisphere, people can not only recognize, what is the feeling of a person about their speech but also why a person is saying something as well as in what context person speaking something even vocabulary and some other linguistic features are not present (Blumstein & Cooper, 1974; Dwyer & Rinn, 1981).

1.5 Hemispheric Interaction

Researches concerning hemispheric interaction is one of the popular topics of core branch of since to even social psychology like including cognitive psychology to neuropsychology (Banich & Shenker, 1994). These researches try to understand how both the hemispheres of brain work together to distribute and process cognitive information. Through the understanding of inter hemispheric interaction we can have a better viewpoint of the patients who have brain damage because of any trauma, cognitive disorders and brain diseases. In cognitive processing how brain processes information for appropriate reaction or adjustment with the environment, inter hemispheric interaction and lateralization research findings contribute a lot (Mohr, Endrass, Hauk, & Pulvermuller, 2007).

The studies in different domains focussing on the functional differences of hemispheres or specialization of two hemispheres suggest a new dimension to study hemispheric differences. Left hemisphere is superior in analytical skills. Therefore this hemisphere specializes for language functioning. Language ability is one of the manifestations of analytical ability. Similarly right hemisphere processes and deals with information synthetically and holistically, so right hemisphere specialized for those things which required holistic approach like for visuo-spatial performance. In the split-brain study functional differences of hemispheres came in to existence. Some of the studies discuss hemispheric differences in terms of the nature of information they pick from different visual stimuli. In split-brain patient research when the patients were instructed to find similar stimuli. The left hemisphere split-brain patients matched the stimuli on the basis of their function and right hemisphere patients matched on the basis of appearance of stimuli. Levy (1974) has pointed out that the way in which left hemisphere deals with information may be considered as analytical whereas right hemisphere shows more inclined towards holistic approach. .

Summarizing the different cognitive abilities in the two hemispheres Levy (1986) has stated that the left hemisphere is typically involved to process information in sequential manner and it can be categorized as sequential and analytical while right hemisphere tends to process information in holistic manner. In other words right hemisphere can be categorized as spatial and nonverbal. Her work suggests that the two hemispheres develop in mutually exclusive manner in terms of their function so that they interfere to each other in a limited manner. This suggestion supports a lot to the formulation of concept of hemispheric functional specificity and lateralization.

In human beings handedness is the most noticeable type of cognitive and behavioural asymmetry documented by the researchers. . Handedness refers to hand preference to perform different manual tasks with one hand more effectively than the other. The brain mechanisms are displayed among left and right handed people is contralaterally. Thus the left hemisphere is related to right hand and right hemisphere relates to left hand. There is enough evidence that speaks that the right-handers differ from left-handers on a variety of cognitive and behavioural measures (Annett and Alexander, 1996; Herron, 1980; Peters, 1995).

According to Hellige (2001) language center is repeatedly found in normal left and right handed persons. Among right handed persons it was noted that around 95% had language center in the left hemisphere and only few of them, around 5%, of right handed persons had speech area in the right hemisphere. Although 60% of left handed persons have the speech center located in left hemisphere 20% in right hemisphere and rest of the 20% in both hemispheres. This organizational difference of localization of speech or language leads to individual differences in hemispheric asymmetry.

A good number of researches have concluded that when the pair of stimuli presented for very short duration of time in both hemispheres simultaneously the reaction time and accuracy is always found superior than the condition when the pair of stimuli presented to each hemisphere or single hemisphere (Davis & Schmit, 1971; Dimond & Beaumont, 1972; Merola & Liederman, 1990; Sereno & Kosslyn, 1991). These findings suggest an extra advantage of bi hemispheric collaboration in visual perception, which happens because of dividing the task of encoding and decoding processing load between the both hemispheres, and the outcome can be observed in terms of less reaction time and greater accuracy. Past research suggests that for the task that needs high level of concentration and attention, inter-hemispheric interaction is very helpful for recognition or perception of visual stimuli (Banich, 1995; Banich & Belger, 1990; Levy& Trevarthen, 1977; Merola & Liederman, 1990).

Facts for hemispheric interaction can also be seen in the different experiments on bilateral processing task in which the stimulus object or information is divided to be presented in both the visual fields i.e. left and right. The basic and standard form of representation is to show stimuli in the pair of same or different matching in which two stimuli to be matched are presented in the opposite visual fields (Banich, 1995; Christman, 1995). In this type of researches stimuli are used in the form of geometrical shapes, color patches, letters, emotional faces, digits and words. Visual presentation can be seen in congruent and incongruent conditions between pair of stimuli. The researches indicate within hemisphere advantage in two sequential tasks and between hemisphere advantage in simultaneously presented tasks. The nature of tasks is more complex in simultaneous presentation as compared to sequential presentation task. So the between hemispheric advantages can been seen on more complex visual tasks. These findings are also known as Bi lateral Distribution Advantage (BDA) which lends support to parallel processing between the two hemispheres (Davis & Schmit, 1973; Dimond & Beaumont, 1972).

1.6 Hand Preference: Handedness

Providing a compact definition of handedness is a complex task. Researchers often try to define it, with the hand preference of an individual specially for writing something. It is widely accepted by authors and researchers and this preference is also used for developing handedness index. However, arguments do come against the single criteria for determining handedness as writing is a kind of learned skill or behavor that could be influenced by different kinds of teaching skills as well as by socially accepted behaviours (Kalar, 1990). Several researchers have accepted multiple task parameters to determine handedness or the level of handedness in which wide range of tasks are entertained such as picking up an object, throwing a ball etc. The majority of researchers define handedness as the hand preference especially for writing (Mc Manus, 1985; Annett, 1985). "Within the scientific community some researchers define handedness as the other hand that is faster and more precise for manual tasks" (Khosravizadeh, 2010, p.12). Some researchers define handedness on the basis of hand preference shown by an individual during completion or performance of most of the uni-manual task.. For some of the tasks both hands have their equal role. We can perform some tasks by using both hands. In this case we generally try to find out which hand is more skilful to perform certain task or activity. So, we can say that handedness is preference of one hand for performance of skilful and manual task more effectively as compared to the other hand. On the basis of preceding discussion of handedness four types of handedness can be identified.

Right-handedness

If an individual prefers their right hand for most of the skilful and motor or manual tasks or activities for better performance they are called right handed person. Numerous studies estimate that in world population there are seventy to ninety percent people are right handed (Holder, 1997).

Left-handedness

Left handedness refers to left hand preference for performing motor and skilful tasks more effectively. Studies have suggested that in world population four to ten percent persons are left handed (Hardyck & Petrinovich, 1977). In the world population majority of people are right-handed so being a left-handed person it could be advantage as well as disadvantage like a common problem face by the left handed person is handle the tools that has been designed for right-handed persons (Dutta & Mandal, 2006).

Mixed handedness

Mixed-handed people generally perform both types of tasks like manual and skilful with the help of their right hand and left hand both but not simultaneously as for some tasks they use right hand and for other tasks they prefer left hand. Mixed handed person keeps switching their hands as per the nature of task or according to the nature of task. The population of mixed handed persons is less than five percent in the world.

Ambidexterity

A real ambidextrous person is capable to perform any kind of manual and skilful task equally with either hand. True ambidexterity is exceptionally rare.

1.7 Common Features of Handedness

Researchers have been widely accepted some basic feature of handedness discussed by Marchant and McGrew (1998) although these features are not completely accepted by the previous literatures due to some limitations has been drown as well as because of various ethnographical studies focused the difference in the ways of dealing with environment in different context. Functional asymmetry of two hemispheres usually associated with the concepts of handedness. Therefore hemispheric functions directly associate with handedness as contralaterally and handedness sometimes explain as s side bias within human (Mandal & Dutta, 2000).

Uniqueness

Past researches in the field of psychology suggest that handedness is a unique feature seen only in human beings and not in other species. Other living species are not logical to distinguish on the ground of left and right handedness. However, some of the researches challenge these views (MacNeilage et al. 1980). It was argued that handedness is spread throughout all living species especially among the simians also (Marchant and McGrew, 1998). This argument can hamper the confidence of claim to handedness as uniqueness in human beings as concluded by McGrew and Marchant (1998). Still there are not enough supporting data that can strongly support the idea about the presence of handedness in other species rather than only in human beings. One more thing we should consider here that the same kind of uncertainty can be seen among the researchers regarding laterality in other species. Corballis (2009) claimed that there is some empirical evidence that supports the view about lateralization in other species. As Rogers (2007) has noted that in human beings some lateralized actions may appear as unique, however cerebral lateralization does not appear like that. This argument supports the facts analyzed by Sun and Walsh (2009) that point out around more than 90% biasness in preference for one hand over the other.

Universality

Universality is related to the fact that in all cultures or societies throughout the globe right hand dominance can be seen in performance on the task and activities that need some skill or motor function as data suggest that almost 90% percent of the population shared same pattern to perform certain task. It is interesting to see even in small sample researches that neither culture nor schooling affect the chances of handedness in different populations (Marchant & McGrew, 1998).

1.8 The ground for handedness

Bishop (2001) has tried to explain handedness with the help of two sets of explanations. First explanation focuses on a non-genetic explanation, in which environmental factors influence handedness. Vuoksimaa et al. (2009) has pointed out that the major factors which directly influenced to handedness is external factors or we can say environmental factors. The second explanation is offered by Bishop (2001) which favours genetic biasness that influences handedness among the people. He also discussed that due to genetic biasness people are more right handed. Genetic biasness usually moulds or shapes different types of handedness and its occurrence have been discussed in some theoretical studies. McManus (2009) has argued that even a single gene can influence or control handedness and language lateralization within an individual. In the last one decade various qualitative researches have proposed possibility of transfer of handedness from parents to their offspring (Sommer, 2008). In support of genetic biasness for handedness Bishop (2001) carried out two different studies in which twins samples were used that supports a significant genetic justification for base of handedness. Li et al. (2003) have explained that due to various theoretical approaches as well as differences in methodology used cerate contradictions or inconsistencies in the explanation of basis of handedness. Researchers also refer to extraneous variables like ability of individual, experience, gender and age as factors that contribute to inconsistencies (Nuttall, 2003). So, we can say that there is no single factor to explain the basis of handedness. It seems reasonable to entertain both non-genetic and genetic factors as explanationsof handedness. Mandal and associates (Mandal, Pandey, Singh, & Asthana, 1992) showed a high number of right handers among the population because of social resistance of left hand use in everyday activities. These studies indicated the salience of hand activity in the understanding of a culture specific component within the general pattern of handedness.

1.9 Facets of Lateralization

Lateralization concepts explain as the particular function of our body regulate preferentially by one hemisphere or one side of body. Some functions that are recognized as lateralized functions in human beings comprise language, handednes, facial expression, visual skills as well as face recognition sometimes spontaneous shifting of sideward. There are some well established methods for detecting hemispheric differences or asymmetry includes: (1) Researches based on brain damaged persons as well as in some of the patients who are suffering from epilepsy by operating their corpus callosum, (2) In normal individual using auditory tasks like Dichotic listing and by using visual task like tachistoscopic visual tests, (3) Direct observations of manual asymmetry and somatosensory functions, (4) Studies related with electrophysiological comprise euro-physiological mapping and different EEG and (5) Different anatomical studies (Falk, 1986). Researches using all the above mentioned techniques or tools are reported in case of human beings but for non human primates mainly on chimpanzee or ape, only few methods are useful.

Studies and assumption about dominance of cerebral hemispheres and its structure as well as function have been the core area among the researches almost from last 150 years (Dax, 1836) and still it has taken considerable attention and interest (Bogen, 1977; Bogen and Marsh, 1979; Bradshaw and Nettleton, 1981; Chall and Mirsky, 1978; Tandanobu, 1978; Thompson, Tandanobu, 1978). Research, theory and assumptions about hemispheric differences in terms of functions or cerebral dominance have been explored (Dax, 1836) and these are still interesting topics among researchers (Bogen, 1977; Bradshaw & Nettleton, 1981; Chall & Mirsky, 1978; Tandanobu, 1978; Thompson, Bogen & Marsh, 1979; Tandanobu, 1978).

Human brain has unique ability for expressing, perceiving and processing information with the help of different highly specialized cells or neurons that facilitate these functions of brain by different neural communications. Indeed, Human brain prepared in such a way it's two half established and functioned as a two different independent capable mental systems located in both sides i.e. right and left sides (Gazzaniga & LeDoux, 1978; Joseph, 1982, *1988a,b;* Levy, 1983; Sperry, 1966, 1982).

1.10 Theories on Lateralization

Visual specialization theories constitute an important area of research in neuropsychology; they explore different aspect of visual processing within and between hemispheres of brain. The right hemisphere has been said to be the global processor or holistic analyzer of visual stimuli whereas left hemisphere is specialized for the processing of information in detail (Springer & Deutsch, 1981; Bradshaw & Nettleton, 1981). Microscopic function of brain like visuospatial task, language, hand preference for motor co-ordination and some other tasks are relatively more lateralized in one of the two hemispheres of the brain (Gazzaniga, 1995; Mesulam, 1990). Variety of researches specialized in neuropsychological and neuro-imaging studies have indicated that the left hemisphere is specialized for language and fine motor regulation and control of hand (Kimura, 1974; Springer, 1990). In contrast, researches on brain damaged person especially in right-side produced hemispatial attention neglect, this reflected that the right hemisphere is strongly lateralized for the ability of visuospatial attention (Heilman, 1980). A popular view on lateralization of emotions has stated that right hemisphere of the brain is dominated for the processing of emotions whereas left hemisphere is lateralized for cognitive functions. Good number of behavioural researches have concluded that the left side of the face is more expressive of emotions as compared to its right side among healthy humans (Sackeim et al., 1978). Similar to face, the left ear easily recognizes emotional materials as compared to right ear when information is presented to both ears (Erhan et al., 1998), and stimuli displayed in the left visual field (first exposed with right hemisphere) are assessed as more emotional (Levine and Levy, 1986) and manifested as autonomic reactions (Spence et al., 1996).

The "Valance lateralization hypothesis" states that both hemispheres process emotions but each hemisphere has its own specialization for specific emotions in the lateral cortex of frontal lobe. The left hemisphere is for positive emotions whereas right hemisphere predominantly processes negative emotions (Davidson, 1992; Gur et al., 1994;Sackeim et al., 1978, 1982; Robinson & Starkstein, 1989). Neuropsychological studies anticipated largely about hemi-facial asymmetry in the expression of emotions (Asthana, 2001). Another hypothesis talks about the effect of gender on lateralization of emotions. It is concerned with gender differences in lateralization of emotion. A number of studies have concluded that females show less functional lateralization than males (Crucian, 1996; Bowers and LaBarba, 1988; Hines et al., 1992; Hines et al., 1992; Witelson and Kigar, 1988; Russo et al., 2000; Steele, 1998). “Anatomically, men show greater temporal cortex asymmetry. Men and women may also show different patterns of lateralization in emotional processing.” (Wager et al., 2003, p. 514).

The “Right-Hemisphere Model” suggests that the right cerebrum largely served for the perception and expression of emotions. About 100 years ago researcher established a direct link between right hemisphere and processing of emotion. Mills (1912a, 1912b) had reported decreased level of emotional expression among those who had unilateral right sided lesion.

The Valance model also suggests that the frontal lobe of right and left hemispheres underlie the processing of negative and positive emotions, respectively. Although support for the right hemisphere hypothesis keeps on to gather in present days (Sato et al., 2004), various studies illustrated before (mainly those discussed about perception of emotion) establish hemispheric differences as a function of negative verses positive emotions. As example, it is well recognized that the person who have difficulty in perceiving negative emotion had injury to the right hemisphere (Adolphs et al., 1996; Borod et al., 1998). Similarly, happy emotional faces are more easily recognized by normal persons than other emotional faces (Everhart & Harrison, 2000; Everhart et al., 2003), even though right hemisphere injured person typically recognizes the happy emotional faces (Adolphs et al., 1996).

Another model talks about the asymmetry of processing of emotions in different ways . Known as “Approach-Withdrawal” model, it states that there are two factors that primarily process in left and right anterior regions, one is emotional driving approach and second one is withdrawal related behaviour. The valance hypothesis is largely included within y the approach withdrawal model of emotion processing which posits that within left-and right-anterior brain regions processed emotions which are approach behaviors and withdrawal behaviours, respectively. There is some overlap between approach withdrawal model and valence hypothesis as most positive emotions bring out approach behaviour whereas negative emotions extract withdrawal behaviour.

1.11 Handedness and Lateralization

Traditionally hand preference or handedness has been associated with the indicator of brain lateralization. However, this kind of approach is relevant to specialized certain kind of complex task and not for simple ones. Hand preference is a marker of brain lateralization and hand preference indicates the hemisphere which is most likely to undertake the task determines which hand to be used by an individual. Within the brain and behaviour research handedness is frequently analyzed as a by-product of brain lateralization in human beings. However, what remains unclear is the fact that why these things do not affect all human beings universally. Nearly about five to fifteen percent people are found as left handers (Bosman, 2004).

Among the human beings it has been largely accepted that brain lateralization for language and handedness are strongly interconnected. This relationship can be seen in a way that left-hemisphere dominance for language more in right handed persons as compared to left handed persons. In the same way enough data suggest that the language dominance is high in right hemisphere in left-handers than the right-handers. However, the real and actual nature of such relationships is still not clear. In the continuation of this claim, it is important to point out that some advantages have been accounted for left-handers, for which the possibility of right hemisphere dominance for language is more than that of right-handers. However, the precise nature of such a link is still unclear. Deutsch and Springer, for example, assert that "for the thirty percent of left handed persons whose speech is in the right-hemisphere, because of proximity of the brain parts which are at work for verbal and non-verbal abilities, these two types of skills are more interconnected and interwoven" (Field, 2004, p.111). Handedness is related to cognitive abilities and researches show that handedness has relationship with mathematical abilities. A verity of theories have been proposed to make clear about differences in different performances that are in form of skilled and non-skilled with dominance with different abilities like sports, mathematical or music (Gobet & Campitelli, 2007). However, this relationship is not consistent and still it is controversial although the effect of handedness on mathematical ability has been a matter of considerable interest in contemporary researches (Sala et al., 2017).

1.12 Differences between Left- and Right-handers

The difference between right and left hander is documented by researchers in different ways in which one base is anatomical difference between these two types of people. Some researchers believe that the difference in the form and size of corpus callosum in right and left-handed people is critical. The chances are high about in left handed persons that their corpus callosum would be larger. Apart from anatomical differences some studies also point out behavioural and physiological differences among these people. There is good number of studies which support limited left hemisphere dominance in language tasks among left-handers as compared to right handed person (Thilers, McDonald & Herlitz, 2007). Such findings support the hypothesis that the organization of brain among left handers is different from right handers as left handed individuals show bilateral or right hemisphere dominance in performing linguistic tasks. Gender differences were analyzed among right and left handed persons in their cognitive skill by Thilers et al. (2007). in this research they have found that in different skills like in episodic memory as well as in verbal fluency right handed females performed better whereas in some visuospatial tasks right handed males displayed greater cognitive ability as compared to their counterparts. Among the left-handers these gender differences are minimal. They argue about these findings that, due to right hemisphere involvement in left handed people limited gender differences are observed. These findings support the fact that right hemisphere or bilateral dominance as a phenomenon can be seen typically among females so that they can perform better on verbal tasks because right hemisphere or bilateral dominance enhances cognitive ability in an individual for verbal task like verbal fluency and verbal episodic memory. So, we can say that the brain organization of left handed people is almost same as female's brain organization especially considering the language functions. It has also been noted that females have limited language lateralization as compared to males.

However, there are also studies that indicate opposite findings about gender differences in language lateralization. With the help of different methods of observation, such findings fail to observe gender differences among individuals especially in the context of linguistic functions (Thilers, 2007). Apart from all these disparities reported above, however, it is also to be pointed out here, that in the majority of the studies carried out so far, small evidence has been found that recommend the superiority of right-handers over left-handers in terms of different cognitive skills. There are nevertheless, differences between the two groups in terms of cognitive skills. The results of the studies are complex, in that some report higher cognitive achievements on the part of right-handers while on the contrary there is evidence of left-handedness as being a favour (Thilers et al., 2007).

In some of the studies researchers have analysed cognitive styles in place of cognitive skills. Thus Coren (1995) tried to differentiate these groups of people in terms of two kinds of cognitive styles, convergent and divergent and have drawn an association between types of handedness and style of thinking. For observation he took top-down and bottom-up processes to know the convergent and divergent thinking. He came up with conclusion that left handedness is closely associated with divergent thinking style. This finding is in line with the idea that in left handers normally right hemisphere dominant and right hemisphere more lateralized for holistic approach as compared to left hemisphere (Ruebuck, 2006). About cognitive functioning and information processing among the left-handers, strong findings support that two hemispheres work in different ways. The tendency to associate right hemisphere with visual task is an example of the above view. Although, the present findings of the researches in this area are still not inconsistent about superiority of right-handers to left-handers. Some studies also point out about reading disability and problem related to speech are more prominent in those people who have less consistency in cerebral asymmetry as generally reflect in left-hander or mixed hander or non-right hander (Corballis et al., 2009). In contrast, with other research findings, claim that there are no differences in IQ among left and right-handed persons (Petrinovich, Goldman, McManus & Mascie-Taylor, 2009). Some studies have revealed that the intellectual deficits in ambidextrous but they have not seen any differences in intellectual abilities especially in terms of IQ among the left and right-handed persons (Corballis et al., 2009). A large numberof studies suggest that the intellectual disabilities normally seen are more prevalent among those who have no hand dominance or hand preference (Crow, Done& Leask, 2001).

1.13 Stimulus Recognition

Recognition of stimuli depends upon variety of things, like how does information received by our sense oranges. Encoding is very important part of this as it is predictive of information and allocation of visual attention. According to the probability distribution it is one of the marvellous achievements of our visual system (Chou & Yeh, 2018).Then comes processing and ultimately retrieval or recall. Some studies suggest that those who are expert recall random material better than the non-experts (Gobet & Oliver, 2016). As study suggests the human visual system can estimate mean size of a set of items effectively (Li &Yeh, 2017). When we perceive objects, two kinds of processing take place especially for vision in which first is identification of objects and localization of objects (Uddin, Ninose & Nakawizo, 2004). In our daily life we interact with either two or three dimensional environment. The studies of two-dimensional environment suggest that the objects are directionally localized more precisely when the observer's attention and/or direction of gaze shifts toward the object (Uddin, 2006).

The perceptual processing of face images has been subject of scientific study since the time of Charles Darwin and Francis Galton, in the mid-19th century (Chen, Kao & Tyler,2006). Psychophysiological and functional neuroimaging studies have frequently and consistently shown that emotional information can be processed outside conscious awareness (Lee, Kim, & Lee, 2016). Highly emotionally charged and less emotionally charged stimuli process two hemispheres differently as there is common view among researchers that the right hemisphere is more specialized for emotional materials and also for face recognition. The hemispheric bias also known as the left-side bias (LSB) effect observed in face perception suggests to be an expertise marker for visual object recognition (Liu, Yeh &Hsiao, 2018). Face recognition and discrimination between the two faces may be one of the most developed perceptual skills of visual object processing (Chen, Kao & Tyler, 2006). We perceive emotions on desire-based as well as belief based orientation as study suggests that there are significant developmental and ecological differences in recognition and attribution of desire based and belief-based emotions (Babu & Rath, 2007). The nature of emotions also affects the processes of recognition of emotion faces. A left visual-field advantage in the perception of sad emotion and no lateral advantage in the perception of happy expression were observed Asthana and Mandal (2001). The left visual-field superiority (a right-hemisphere function) was found for sad facial emotions. A hemispheric advantage in the perception of happy expression was not found in their study. Perception of emotion is also related to emotional intelligence (Singh, 2004). The context also influences our perception of emotions. Some studies have focused on ability-based emotional intelligence in Indian context (Gupta & Singh, 2013).Emotional intelligence has strong association with our day-to-day life performance as it helps to manage and enhance job performance as well (Singh & Malik, 2012). Perception of emotion not only depends of emotional intelligence but also on personality traits (Singh & Pathardikar, 2010). For word stimuli our brain processes face perception differently as we know reading is one of the well-practiced visual tasks for modern man (Kao, Chen & Chen, 2010).

1.14 The Stroop Effect

In the year of 1935, J.R. Stroop was published a very popular article on interference in attention and perceptual task. This article was not so popular on that period of time but now in the current days it influenced to the scholar in more extent. So there is question why Stroop task consistently attract attention of researcher? "Perhaps the task is seen as tapping into the primitive operations of cognition, offering clues to the fundamental process of attention. Perhaps the robustness of the phenomenon provides a special challenge to decipher. Together these are powerful attractions in a field of complex phenomena where the subtlest variation may exert a dramatic effect" (McLeod, 1991, p. 163).

Performing two cognitive tasks concurrently can be difficult, if not impossible to accomplish. For example, if someone is talking while we are listening to a lecture, it is likely that we will lose important pieces of information from at least one of the sources. The findings from dichotic listening experiments support this claim (Kimura, 1967; Moray, 1959). In an early experiment, researchers showed written materials in the form of attended and unattended message words it observed that subjects were unable to recall words in the unattended message even if the message had been repeated 35 times (Moray, 1959). In the case of two controlled tasks, where attention is required (such as listening to two different messages simultaneously), dividing attention between the two cognitive tasks can lead to seriously impaired performance (Andrade et.al., 1996). On the other hand, some tasks can be performed simultaneously with practice, such as driving a car and reading exit signs. We are often able to accomplish simultaneous tasks because one of the tasks becomes automatic through practice, thereby not requiring full attention (Solso, 1995). LaBerge and Samuels (1974) have shown that attention and automatic processing work together, allowing multiple tasks to be performed simultaneously. Conscious attention is directed toward activities that have not been practiced or are considered novel, whereas automatic processing occurs for the activities that have been practiced (such as reading).

Automatic responses do not require individual attention. Reading, writing, and even driving a car become automatic responses due to over-practice (Andrade et al., 1996). Posner and Snyder (1975) suggested that for cognitive reactions to be considered automatic they should happen without any conscious effort and also it should not disturb other cognitive activity. Interference can also occur because of automatization of any task. For an adult reader, for example, reading a word may become so automatic that it is often hard to repress even if one is instructed to attend to a non-word stimulus.

One of the most famous experiments demonstrating how the automatic nature of reading can cause interference was conducted in the year of 1935 as Stroop experiment. In the original Stroop (1935) study there were three experiments. In the first experiment subjects were told to read a group of color name words written by using different color ink and also directed to read all names of color words printed in black color. Stroop found no significant difference in performance under these two conditions. Stroop's second experiment used the same color words presented with colored patches. The participants were then asked to name the colored patch, not the word. Under these conditions there were significant increases in reaction time when participants were asked to name the color of the patch compared to reading the words. In other words, naming the color took longer than reading the word. The third experiment was similar to the second experiment except instead of using colored patches he used colored swastikas, and again the RT for naming the colorof the swastikas was longer than responding to the word. In addition, Stroop had his participants practice naming the color for eight days and then retested them. Stroop found a reverse effect, meaning that the RT was faster for naming the color than for the word response; however, this effect disappeared immediately after testing. The phenomenon that Stroop found, slower RTs for naming the colorof printed ink compared to reading the color word, has become known as the Stroop Effect. According to MacLeod (1991) Stroop Effect, has been investigated in over 700 experiments. The phenomenon continues to attract attention today. General opinion seen among different researchers is that competent readers perceived the word stimuli without any conscious efforts. LaBerge and Samuals (1974) have suggested that both attention and automaticity help explain a skilled reader's inability to ignore words. As Besner and Stolz (1999) have stated, "reading the word is said to be automatic in the sense that readers cannot refrain from computing the meaning of the word despite the explicit instructions that they should not, and despite the fact that such computation impairs color identification performance" (p. 449).

Stroop and Stroop-like effects (where incongruent stimuli are measured against a congruent condition) have proved to be robust and replicable (Dyer, 1973; Schmit& Davis, 1974; Ehri, 1976; Rosinski, Golinkoff, & Kukish, 1975; Smith & Magee, 1980; Goolkasian, 1981; Glaser & Glaser, 1982; David, 1992; Brega& Healy, 1999). The major theoretical difficulty regarding the Stroop effect revolves around the fundamental source of the observable fact. The two core explanations presented to describe the Stroop effect are automaticity and relative speed of processing. The automaticity explanation is that both automatic and controlled processes are involved in the Stroop task. Automatic cognitive processing occurs from long-termpractice, such as in the case of reading. Controlled processes (Andrade, Henderson, & Kamiar, 1996) refer to those that are voluntary, requiring more attention, and relatively slow; therefore, novel tasks generally rely on controlled processing. Automatic processes, on the other hand, are fast, occur without direct intention, and are generally unconscious (Shiffrin & Schneider, 1977). Automaticity includes both interference and facilitation (Cohen, McClelland, & Dunbar, 1990). Interference refers to the extent to which one process encumbers performance of another, whereas facilitation indicates the extent to which one process assists performance of another (David, 1992). Through practice and maturation, reading progresses from controlled process to one that is automatic, lessening its demands on attention resources and attention shift against memory averaging (Uddin, Kawabe & Nakawizo, 2005). In an early work Cattell (1886) reported one of the first studies that provided support for automatic processing during reading. He found that people were faster in reading words than in naming the corresponding objects or their properties, including their color. Forty-nine years later, Stroop (1935) furthered Cattell's research by creating tasks involving color naming and reading. According to the automaticity explanation, the Stroop effect results from difficulty ignoring the word when asked to name the color of the word because reading has become an automatic process.

Andrade, Henderson, and Kamiar (1996) sought to show whether reading automaticity is truly suppressed if participants are asked to name the color of the word when the word is misspelled (e.g. *grean* instead of *green).* The typical Stroop effect was found: response times for color naming were slower when the color was incongruent with the color word; however, response times for incorrectly spelled words were *faster* for naming the color of the word compared to response times for correctly spelled words. The results showed that when words were misspelled reading became less automatic, causing less interference with naming the ink color of the color word. Besner and Stolz (1998) presented their participants with sentences containing misspelled color words. The purpose of their study was to see if phonological recoding could be controlled, or whether it is computed even when the words are irrelevant to the task (color naming). They asked participants to press a key that indicated the print color.

The sound of the color word was always congruent with the required response (e.g., *Bloo* for *Blue).* The results of the study showed a Stroop effect. Both the correct and incorrect spelling of the color word interfered with the participants' naming of the color of the word. Color perception is a very complex process of human brain because we are very habitual with color identification and discrimination so we don't realise with complexity of its processing. Generally, we interact with two kinds of colors one is synthetic color and the real color and study suggests that there is substantial interaction between synthetic colors and real colors in perceptual grouping (Kim, Blake & Palmeri, 2006). As people with grapheme-color synesthesia perceive specific colors when viewing different letters or numbers (Kim, Blake, & Kim, 2013)

The second explanation, relative speed of processing, is that the two processes involved in color naming and word reading are accomplished in parallel, but that word reading is carried out faster. The assumption is that the faster process of reading interferes with the slower process of naming colors (MacLeod & Dunbar, 1988). Dunbar and MacLeod (1984) have referred to the speed of processing explanations as "horse-race models." In the case of the Stroop paradigm, speed of processing is affected by the color word being written in a different color. The conflicting word information arrives at the decision process stage earlier than the color information and results in confusion. However, when the task is to report the word, such confusion is rare because the color information lags behind the word information, and a decision can be made before the extraneous color information arrives. Not all researchers agree with this explanation. Glaser and Glaser (1989), for instance, addressed the question of speed of processing during a Stroop-like task. They presented their participants with the color 400msec before the presentation of the word. Even with the additional time to process the color presented, the reverse Stroop effect did *not* occur (meaning the reaction time was not faster naming the color even though the color was presented 400msec before the word). This finding, according to Glaser and Glaser (1989), suggests that the speed of processing account of the Stroop effect is insufficient. If the speed of processing the color is not enhanced by additional exposure time, then there must be a unique quality of word perception that is different from color perception. Words appear to be more salient than color to the adult reader even after additional exposure time is given to color. Stroop-like experiments have been conducted with picture and word stimuli. For example, Rosinski, Golinkoff, and Kukish (1975) presented the participants with a picture with either an incongruent or a congruent word inside. They found that RTs were slower when participants were asked to name the picture when the word was incongruent with the picture than when the word was congruent with the picture. In a similar study, Lupker (1979) also found a Stroop-like. He explained the Stroop phenomenon as response competition. Compton and Flowers (1977) presented participants with geometric shapes and words in both congruent and incongruent conditions. They found shapes interfered with the response to the word in the incongruent condition. In the present study, Stroop-like tasks were administered to 60 participants. Geometric shapes and geometric words were used to determine whether differential hemispheric effects would occur when presented in the three visual fields. Before the four experiments were conducted, a baseline for reaction times for geometric words and geometric shapes was administered to the participants.

Literature review stated that there is no clear and conclusive picture about laterlization pattern among different handed persons. A verity of researchers examined in the same thing by using different methods in which Stroop task experiment is also widely accepted by the researches from good period of time. Above mentioned literature review moreover focused on two things, one is related with differences that has been widely accepted among different handed persons in terms of their cognitive functions and hemispheric lateralization for different tasks, second about Stroop task is the one of the technique through lateralization pattern can be drown by execution of different stimuli in different ways.

The Present Study

In view of the review of past research and theory , this study was planned to investigate the effect of lateralization on the experience of incongruity in cognitive field. In this context this study used handedness as an index of laterality and examined the differences in performance on Stroop-like task in split and parallel visual fields. More specifically the following two objectives guided the study.

- To investigate Stroop-like incongruency effect when emotional face, geometrical shape and color patches, are presented as paired stimuli in the form of image and word in split visual field to right-handed and non-right-handed individuals.
- To investigate Stroop-like incongruency effect when emotional face, geometrical shapes and color patches are presented in paired stimuli in the form of image and word in parallel visual field to right-handed and non-right-handed individuals.

Above objectives were pursued in view of following underlying principles and prepositions.

In everyday life people interact with a variety of stimuli which carry cognitive as well as affective or emotional information. The human brain is organized in such a way that the right part is more connected with emotional functioning while left part is more cognitively tuned. Previous studies have shown that our brain is divided into two hemispheres, that are quite similar in structure but differ in their functions. Hemispheric functional differences came into existence in late 1960s when these two hemispheres were separated through surgery and assessed for their functions by Sperry (1975) at California Institute of Technology and by Bogen (1969) with their colleagues at a medical institute (see also Duke,1968 ; Galin, 1974; Gazzaniga, 1970; Sperry, 1968). It was found that human brain's two hemispheres work differently in terms of encoding, organizing and processing of information. The two cerebral hemispheres are capable to function differently but act in a different manner when they interact. Hemispheric specializations can also be understood in terms of their functional dominance. Each hemisphere has some specialized function but some functions they share in a way that one dominates the other as active or passive styles of functioning. The left side of the brain or left hemisphere is found to be specialized for classification and association of different stimuli in terms of information into unique temporal units as well as to control all voluntary motor activities like movement of hands, fingers and arms (Beaumont, 1974; Heilman, Rothi, & Kertesz, 1983; Kimura, 1977; Luria, 1980 Mateer, 1983). This hemisphere is also specialized for coding and decoding linguistic materials in sequential as well as linear time frames (Efron, 1963; Lenneberg, 1967; Mills & Rollman, 1980).As research into the specialized functions of the two hemispheres continued, the pattern of results suggested a new way to conceptualize the hemispheric differences. The left hemisphere is specialized for language functions, as a consequence of left hemisphere's superior analytical skills, of which language is just one manifestation. Similarly, the right hemisphere's superior visuo-spatial performance is derived from its synthetic, holistic manner of dealing with information.

In contemporary life people are preoccupied with visual perception as the gadgets like T.V., Mobile, etc. demand constant processing of visual information. There is bombardment of visual information received from Internet, television and other sources. This
Information contributes to cognition, thinking and problem solving. For performing effectively at cognitive level, there is a need to manage our visual information and cognition as it is closely associated with verbal ability (Kochar et al. 2015). The complexity of today's work culture demands managing visual information so that complex tasks can also be performed efficiently. We perceive stimuli under diverse conditions in terms of verbal materials and nonverbal materials. So, for understanding verbal materials, knowledge of language is also required. Those who have knowledge of more than one language can have different level of cognitive abilities (Mohanty & Babu, 1983). Sometimes the perceived objects are presented to us in congruence with our expectation, experience and familiarity. However, an individual gets stuck when he or she interacts with two contradictory things or objects simultaneously. It happens due to hemispheric functional dominance. Thus, people face difficulty in processing and take more than usual time to recognize some objects when they are in contradiction. So, the present study was focused on the factors that affect recognition. .

In the present study experimental setting was planned on the basis of classical Stroop task (Stroop, 1935). In the classical Stroop task participant had to recognize the ink color of the font in which word stimulus was presented by ignoring the naming of the word itself. There were two condition of presentation of stimuli one was congruent and another was incongruent. In congruent condition color word and the ink of word was same (eg. RED word written with red ink) and in incongruent condition color word and ink of the word were different from each other (eg. RED word written with green ink). It was noted that in the incongruent condition participants were taken comparatively more time to recognize color ink by ignoring the meaning of the word than the normal condition. The differences between congruent and incongruent condition recognition is known as *Stroop interference*. When the color ink and word were in line the participants took comparatively less time to recognize stimuli and this is known as *Stroop facilitation*. Stroop interference justify as a consequences of response competition whereas Stroop facilitation can be justify as a consequences of response convergence.

In classical Stroop task only color words were used in different color inks. The present study attempted to investigate if Stroop like interference in some familiar things like emotional faces of human beings, geometrical shapes and color patches with their respective word labels. However, the participant had to recognize both the word and image simultaneously. The reason to design experiment in this way, was to assess, how much the participant was able to recognize words and images quickly and accurately, when the same are presented under incongruent condition (e.g., HAPPY emotional face paired with SAD emotional word). Apart from incongruence manipulation this experiment was also designed to see the differential effectiveness of the visual field. It would tell which visual field yields better recognition of the stimuli. Through visual field (right visual field and left visual field) presentations, the present experiment can also draw assumption about the nature of perception of an individual in terms of hemispheric lateralization. Handedness is linked through cerebral organisation. However its association with cognition remains unclear. Since the Stroop task is supposed to measure aspects of executive control, this study aims to investigate the role of handedness in interference in visual perception in Stroop like task.

Findings of the past researches related to the function of cerebral hemisphere have been documented in terms of dominant and non-dominant hemisphere as non-dominant hemisphere processes information only on the basis of visual processing whereas dominant hemisphere processes information in both ways attending to visual modality as well as verbal content. The existing findings implicate that when visual and verbal materials are in incongruent or in conflict then the processing of these information in the dominant hemisphere may require more time to resolve the conflict for appropriate recognition whereas in the non-dominant hemisphere the information is processed only one the basis of visual information without any consideration for the verbal content (Schmit, 1974). Varieity of studies carried out by the different researchers (e.g. Egeth & Epstein 1972; Dimond & Beaumont 1972; Davis & Schmit 1971; Filbey & Gazzaniga 1969; Cohen 1972) to know the function of both hemispheres as well as to know the ways of processing information within and between brain hemispheres with the help of different experimental works in normal human adult. These researches have also suggested the same patterns regarding information processing in the dominant and non-dominant hemisphere as non-dominant hemisphere receives less interference in information processing because of its single way of processing i.e. visual only compared to dominant hemisphere (both ways of processing visual and verbal content simultaneously). These assumptions have been used in different studies by Devis and

Schmit (1973) and Posner and Mitchell (1967) in the transformation of information in between hemisphere to see interhemispheric interaction.

1.15 Incongruence effect in Stroop-like Experimental Setting

The Stroop task involves in recognizing font color when color word presented in conflicting condition with ink color. The meaning of color word cannot ignored by participants during recognition of color ink when different color word presented. Different types of Stroop like tasks were developed to identify lateralization pattern among different individuals in terms of their gender and handedness by using different stimuli like geometrical word/shapes, color words/color patches and in some of the cases emotional faces/emotional words. Different types of familiar objects have been the part of Stroop like task experiment to see the lateralization pattern and to observe level of interference when stimuli present in incongruent conditions. Huge number of research finding suggests that in every incongruent condition people takes significantly more time to recognize stimuli than the congruent conditions. To explain Stroop interference different explanations have been proposed among two groups of theories are Translation theories and Automatic theories.

Translation Theories

Translation theories discussed that the major relationships between Stimulus and Response or S-R is an important aspect through which we can explain different central aspects of Stroop effect. Printed or written words have similar features than the spoken words since they are belong with same modality like linguistic as written word directly or easily mapped with vocal responses whereas color perception and spoken words are not in same modalities they are from different modality so during perception of color ink first translation process requires to convert color ink to vocal responses and actions (Glaser & Glaser, 1989; Sugg & McDonald, 1994; Virzi & Egeth, 1985). These justifications leads to different predictions that have tested and confirmed by different researches and literatures.

Automaticity Theories

Automaticity theories talks about the process that take place during recognition of color word or color ink depends upon relative automaticity in which brain process information automatically by differentiating objects like which things have to attend and which are things have to be ignored based dimensions (Cohen et al., 1990; Logan, 1980; MacLeod & Dunbar, 1988). Automaticity explain in which extent the stimuli provoked unintentionally responses. Higher the extent of automaticity greater the activation of response or faster the response. These assumptions justify the Stroop interference by explaining the fact that verbal responses to words are more automatic than the verbal response to color. In Stroop task when incongruent condition presented to participant automaticity in repose to recognition of color get affected so participants usually takes more time to recognize color ink or commits error more than the normal conditions. So lower the automaticity higher will be reaction time.

1.16 Locus of Stroop Effect

The locus in which more Stroop interference occurs has been a core concern of researchers and can be seen as a major central discussion topics in literature. Some research findings suggests that Stroop interference occurs in the beginning of processing of information when the perceptual coding take place (Hock & Egeth, 1970).

Other researches explains the major central locus of Stroop effect by involving decoding codes or translation of codes (Glaser & Glaser, 1989; Kornblum, Hasbroucq, & Osman, 1990; Sugg & McDonald, 1994; Treisman & Fearnley, 1969; Virzi & Egeth, 1985).

Different argument is also there in which researches discuss about the late stage in which response usually generate (Cohen et al., 1990; Duncan-Johnson & Kopell, 1980, 1981; Logan, 1980; Morton, 1969; Morton & Chambers, 1973; Posner & Snyder, 1975; Warren & Marsh, 1979). Huge number of studies have locus of Stroop effect in response selection how the person select and ignore stimuli for better recognition. Various arguments have been documented in this regards in which vocal, written and different nature of responses are the locus of Stroop effect. For different types of responses selection process are almost same but completion of perceptual recognition can be differ from each others. So in Stroop task there are two phases one is related with selection of response and second one is related with execution of response. If Stroop interference occurred during, before and after response selection we can expect same level of interference in different types of responses but if person has ability to execute response effectively of execution process begging during recognition of task then the different level of interference can be observed for different response. Stroop interference would be observe by analyzing at what extent incongruent conflict has been resolve by execution of response. Stroop effect happen because of process sing of information during or before response selection, then the effect of Stroop task should be appear only in beginning stage. In other conditions if Stroop effect occurs due to execution process than participants should always take more time in incongruent condition to recognize actual stimuli as compared to neutral or baseline condition and initial response should not differ. If the response selection and execution both have impact on recognition then the initial recognition and duration should be higher in incongruent condition stimuli.

Stroop effects have been observed in different setting and by using different stimuli. As in the study related to hemispheric lateralization incongruent pair of stimuli also presented in different visual field like in right visual field or in left visual field to see hemispheric dominance. Researches related to Stroop asymmetry has been also taken enough attention of researchers and they have come with different explanations and conclusions. One of the common explanation came in this regard that those hemisphere initially receive information or process information of verbal materials is supposed to need the dominance hemisphere. There for if the information first reach to non dominate hemisphere then in this case first information transfer to dominate hemisphere so that person usually take more time to recognize stimuli than the condition when the stimuli presents in dominant hemisphere. In the Stroop task especially in incongruent condition subject has to ignore the irrelevant information if it processes in dominate hemisphere then it would be tough to ignore irrelevant information there for it takes more time to recognize and chances to commit error will increase. So by different visual field presentation lateralization pattern can also be identify.

The present experiments attempt to explore these suggestions by measuring reaction times for emotional faces, emotional words, geometrical shapes, geometrical words, colour patches and colour-name responses under the various experimental conditions.

One the basis of above discussion and theoretical supports as well as on literature reviews following research questions has been generated and hypothesis has been formed.

1.17 Research Questions

RQ_1: What are the differences in pattern of hemispheric lateralization among differently handed people?

RQ_2: What is the nature of relationship between cognitive interference and stimulus congruence in the people with varying hand preferences? Which kind of hand preference (right/non-right handed) would be associated with greater tolerance for interference?

1.18 Hypotheses

<u>H1: Handedness and Pattern of Lateralization</u>

On Stroop like task the right-handers would show greater degree of right visual field dominance for verbal stimuli and left visual field dominance for image stimuli as compared to non right handers. This would lead to more accurate recognition and faster response for verbal stimuli and image stimuli, respectively.

<u>H2:Handedness and Incongruence Effect in Split and Parallel Visual Fields</u>

On Stroop like task the right-handers would appear to be more susceptible to incongruence effect under split as well as parallel visual fields than their non right hander counterparts. This would lead to poor recognition and slow response in split as well as parallel visual fields.

Chapter-2

Method

2.1 Sample

One hundred forty nine male young adults from the age range of 17-25 years participated in the study. They were enrolled in undergraduate and post graduate courses at the Indian Institute of Technology, Roorkee and in different colleges of University of Delhi, Delhi. The males were included following the observation by Gazzaniga (1987) in a similar study on Stroop like task that researchers should test only males as male brains are more lateralized than female brains (Silvers, 2010). The participation in the study was voluntary. Based on handedness questionnaire scores, there were 80 right-handers and 69 non-right handers which included left-handers and mixed-handers. The profiles of these groups are presented in Tables 2.1.

Table 2.1Profiles of the participants

Sub Groups	Sample Size (N)	Chronological Age (in Years) M (SD)
Right-hander	80	18.78 (1.48)
Non right-hander	69	18.81 (1.42)
Total	149	18.79 (1.45)

The right-handers and non-right handers did not significantly differ in their age and the numbers of years studies in educational institutes. None of these participants had a history of any brain injury or any medical condition or neurological complaint that could affect the performance on the task All participants had no self-reported difficulty in vision as well as hearing. Their vision and hearing capacity were examining prior to experiment. Participants were explained about experiment and their consents were taken prior to the experimental process.

2.2 Measures

The measures used to assess various variables under study are described below.

Hand Preference or Handedness

Hand preference was measured by a 10-item self report questionnaire. These items were used in previous studies (Mandal et al., 2001; Coren& Duncan, 1980; Suar et al., 2007) in Indian samples and have been found adequate. Ten items included the following tasks : using a knife, picking up a book, picking up a heavy suitcase, brushing teeth, throwing a boll to hit a target, opening a jar lid, using an eraser on paper, hammering on a nil, and writing on paper- were taken from past studies to assess hand preference. Thus the items covered unimanual skilled (hammering), unskilled (picking up a book), and culturally pressured (writing) and unpressured (throwing) behaviours. For each item 5 possible alternatives/choice were given to the participants: "Always left (=1)", "Usually left (=2)", "Equally both (=3)", "Usually right (=4)", and "Always Right (=5)". Raw score of the current sample were used to estimate reliability and degree of bias. Summing the responses and divided by the number of items i.e. 10 estimated an individual's average score.

The total composite scores on 10 items were added and divided by the number of items to estimate the extent of handedness. Participants scored between 1 to 3.5 were accepted as non-right handed and those between 3.51 to 5 were accepted as right-handed. The measure had high internal consistency (Cronbach alpha = .97).

2.3 Stimuli

The stimuli used in the study were based upon the classical experiment of Stroop task effect (Stroop, 1935; 1938). Five emotional faces and their names were used as image and verbal stimuli in Experiment-I similarly five geometrical shapes and their name used in Experiment-II and in Experiment-III five different color patches and their name were used. The images of emotional faces/geometrical shapes/color patches were displayed in 5cm squire shape area and emotional words/ geometrical shapes name/ color patches name were presented in Times New Roman 24 font.

Pair of stimuli consisting of one image and one word was displayed on the screen under following conditions.

Split visual field

The pair of stimuli was shown to the participant in split visual field condition. According to Patel and Hellige (2009) the split visual field involves presentation of stimulus in one visual field at a time either in Left visual Field (RH) or in Right Visual Field (LH). Emotion face (image) and emotion word were presented in same way as described above either in left visual field (RH) or in right visual field (LH). Further the pair of stimuli selected not randomly but in two different sub conditions i.e. congruent and incongruent. In the congruent condition pair of stimuli was selected with similar emotional face image and its emotional word. In contrast, unmatched pair of stimuli was used in the incongruent condition. An example of congruent pair consists of happy emotional image with HAPPY word. The incongruent pair consisted of happy emotional face image with FEAR word.

Parallel Visual Field

In this condition pair of stimuli was presented in both visual fields simultaneously. The pair of stimuli shown to the participant by using parallel visual field presentation involved one stimulus in one visual field and other in other visual field. For example in the pair of happy emotional face image and HAPPY word, image was presented in left visual field at the same time word was displayed in other visual field i.e. right visual and vice versa. In parallel visual field condition again pair of stimulus was displayed in congruent and incongruent condition. A Lenovo G500 laptop with 15.6 inch (39cm) diagonal screen was used. The apparatus involved in this experiment was based on a software developed using Java script. This software was designed for display of stimuli in different conditions as well as for measuring reaction time and accuracy. Java based program was designed in such a way that reaction time (in milliseconds) for each response and accuracy of response could be observed easily without having any discrepancy and biasness.

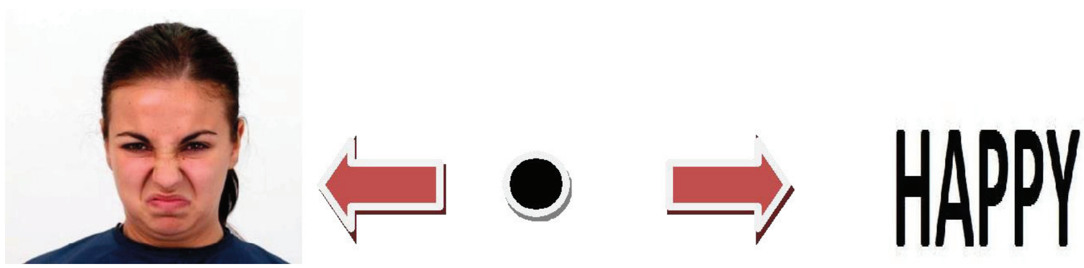
In total three experiments were conducted as described below.

Experiment-I

In the very first experiment, emotional faces (images of human face) presented with five emotions namely Happy, Sad, Fear, Disgust and Neutral. The emotions faces were used as image and their names used as verbal stimuli. In this experiment pair of stimuli was shown to a participant 40 times in which 20 times in congruent condition and 20 times in incongruent condition. Out of each twenty presentations, ten were in the split visual field and ten were in parallel visual field.

Experiment (Part-I) in Split Visual Field Incongruent Condition

Experiment (part II) with Parallel Visual Field in Incongruent Condition



Experiment-II

The same group of participants took part in Experiment-II. All other conditions were same but the pairs of stimuli were different. They consisted of Geometrical shapes and geometrically formed words. There were five different geometrical shapes and their names were used as image and verbal stimuli. The five image stimuli used as images consisted of Circle, Triangle, Square, Rectangle and Pentagon. Their names in words were used as verbal stimuli. Presentation conditions of stimuli were similar to those mentioned in Experiment-I. Thus there were 40 presentations for each participant in which 20 were in congruent and 20 in the incongruent condition. Out of each twenty presentations, ten were in the split visual field and ten were in parallel visual field.

Experiment-II (Part-I) in Split Visual Field Incongruent Condition

Experiment (part II) with Parallel Visual Field in Incongruent Condition

Experiment-III

This experiment was conducted with the same group of participants who had participated in Experiments-I and II. However, the pairs of stimuli were different. In this experiment the stimuli consisted of Color patches and color names. There were 5 different color patches and their verbal names constituting image and verbal stimuli, respectively. The 5 image stimuli consisted of patches of Red, Green, Blue, Black and Brown. The names of the colours were served as verbal stimuli. Presentation conditions of stimuli were similar to those mentioned in Experiment-I. Thus there were 40 presentations given to each participant out of whom 20 were in the congruent condition and 20 were in incongruent condition. Out of each twenty presentations, ten were in the split visual field and ten were in parallel visual field

Experiment-III (Part-I) in Split Visual Field Congruent Condition

Experiment-III (part II) with Parallel Visual Field Incongruent Condition

2.4 Procedure

Each experiment took about an hour to complete experiment. Initially the participants were given tests for checking vision capacity. They were asked to visually observe some stimuli and respond about their colors as well names to ensure their vision. Similar tasks were also used to check their vision clarity. Participants were permitted to bear glass whenever they needed. The distance between computer screen and participant was around 1.5 fit (45 cm). Participants were seated in such a way that the computer screen and their eye were at the same horizon.

Ten stimulus presentations were given to participants to create familiarity with stimuli and the task. After completing these trials, doubts related to experiments were resolved. The participants were informed about the procedure of experiment. At the beginning of the experiment a dot appeared at the center of the screen in different color and participant had to observe and see the dot. This dot appeared for 2000 milliseconds. This defined the fixation point. Fixation point regularly appeared before the each trial/ presentation through fixation point a participant could concentrate at the center of the screen. Fixation dot followed by pair of stimuli randomly in two visual field conditions i.e. in split visual filed and parallel visual field with congruent and incongruent sub conditions as described earlier. The pair of stimuli was displayed on screen only for 180 milliseconds followed by four alternative options.

Participants had to respond through one key by using A, S, D and W keys for verbal stimuli and 1, 2, 3 and 4 for image stimuli. There was no time limit to respond but it was instructed that you have to respond as quickly as possible with accuracy.

The following instruction was given "You will be informed to focus on a fixation point once the trial begins a pair of stimuli will appear in the visual fields of your eyes. Your task is to respond correctly as quickly as possible with the use of a key as told to you". Participants were also informed that at the end of experimental session a completion massage would be displayed on the computer screen.

In total 120 trials were given to each participant in which 40 for each experiment. Reaction time and accuracy data were recorded by software in MS office excel sheet. The reaction time was recorded in milliseconds and accuracy recorded in the form of "true" and "false".

Similar procedures were followed in all three experiments but the types of stimuli were different as mentioned in respective experiments.

2.5 Experimental Design

The study involved a 2 x 2 x 2, Handedness (right, non-right) x Congruency (congruent, incongruent) x Visual Field (left visual field, right visual field) factorial design with repeated measures on the last two factors. Thus, the two groups (right hander and non-right hander) performed under four different treatment conditions 1) Congruent LVF, 2) Congruent RVF, 3) Incongruent LVF, and 4) Incongruent RVF. The above mentioned design was followed in two different conditions of presentation i.e. in Split-visual field and Parallel visual field. The design has been displayed in Figure 2.1

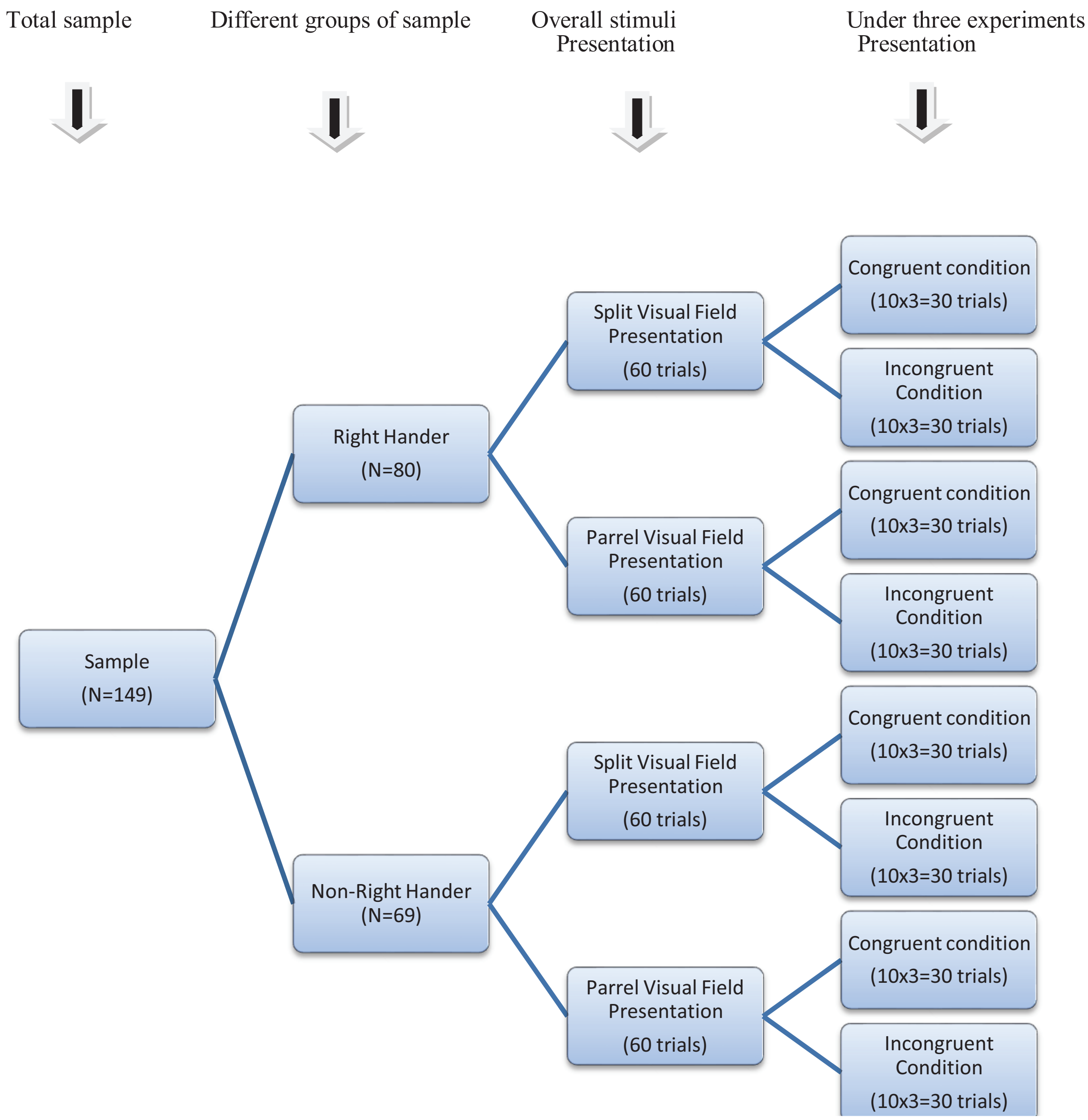


Figure 2.1: Schematic depiction of experimental design used in this study

Chapter-3

Results

This study used Stroop-like Task to investigate the effects of congruence of stimuli, visual field of stimulus presentation for image and word stimuli of three kinds i.e. emotional faces, geometrical shapes and color patches on recognition and response latency for the presented stimuli among right and non-right-handed individuals. This was done under two experimental settings i.e. split visual field and parallel visual field conditions. With a view to have parsimony in analysis the data under two visual field conditions were analyzed separately. The scheme of analysis thus adopted may summarized as follows.

1. Split Visual Field Emotional Faces Images Stimuli.
2. Split Visual Field Emotional Faces Word Stimuli.
3. Split Visual Field Geometrical Shapes Images Stimuli.
4. Split Visual Field Geometrical Shapes Word Stimuli.
5. Split Visual Field Color Patches Images Stimuli.
6. Split Visual Field Color Patches Word Stimuli.
7. Parallel Visual Field Emotional Faces Images Stimuli.
8. Parallel Visual Field Emotional Faces Word Stimuli.
9. Parallel Visual Field Geometrical Shapes Images Stimuli.
10. Parallel Visual Field Geometrical Shapes Word Stimuli.
11. Parallel Visual Field Color Patches Images Stimuli.
12. Parallel Visual Field Color Patches Word Stimuli.

The above scheme was followed for the analysis of two sets of data i.e., response tendency and correct recognition. The analysis was undertaken following a 2x2x2 factorial mixed model ANOVA with repeated measures on the last two factors. Thus there were following factors two types of handedness (Right handers/non-right handers), two levels of congruence (congruent/incongruent), and two types of visual field (left visual field/right visual field) separately for two kinds of stimuli (Image/Word). The first factor was between factor while the other two were within factors and required repeated measures analysis. With a view to have clarity in presentation the results obtained are presented in two major sections i.e. split visual field and parallel visual fields. Within each of these there are two major subsections pertaining to response latency and accuracy of recognition. Mean scores were computed for each subject of each treatment condition; i.e. congruent, incongruent presented in right or left visual fields.

3.1 Split Visual Field: Response Latency (Images)

The descriptive statistics of reaction time for correct recognition for all three experiments of image stimuli for the two group right handed and non-right-handed sample are presented in Tables 3.1, 3.2 and 3.3.

The mean reaction time showed that, non-right handers were faster to recognize image stimuli as compare to right hander in almost all conditions in Experiment-I processing of emotional faces (see Table 3.1). In the processing of geometrical shapes as Experiment-II non-right hander were faster in incongruent conditions (see Table 3.2) and as similar as Experiment-I, in color patches processing non-right hander were shown faster responses in all conditions excepts left visual field congruent condition (see Table 3.3).

3.1.1 Processing Emotional Faces

Table 3.1 Means and SDs of response latencies (millisecond) for emotional faces by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	7198.72	4431.45	6855.58	6742.96
	SD	1107.31	1337.37	1365.48	1100.62
Non right	M	6863.0	6871.88	5304.46	5185.48
	SD	1566.68	1407.92	2211.37	2137.96

3.1.2 Processing Geometrical Shapes

Table 3.2 Means and SDs of response latencies (millisecond) for geometrical shapes by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	5019.95	5117.77	6470.96	5442.48
	SD	1307.07	704.68	1537.45	1249.27
Non-right	M	5448.44	5426.44	6021.08	4995.78
	SD	1372.712	606.96	1446.35	1156.74

3.1.3 Processing Color Patches

Table 3.3Means and SDs of response latencies(millisecond) for color patches by handedness, congruence and presentation field under split visual field conditions.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	5595.41	5358.00	6184.0	6774.76
	SD	1634.86	1205.99	1283.8	1700.17
Non-right	M	4798.82	6250.36	5113.1	6823.71
	SD	1146.21	1832.32	1179.2	1206.39

Between groups analysis were found significant in experiment-I as $F\ (1,\ 147) = 9.558,\ p<.01$ but it was not significant in Experiment-II as $F\ (1,\ 147) = 2.557,\ p>.05$ and in experiment-III as $F\ (1,\ 147) = 0.143,\ p>.05$ (see table 3.4)

Table 3.4 Summaries of ANOVAs separately performed on score of reaction time for Emotional, Geometrical and Color Stroop-like task (Image):

		Reaction Time					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	24067429.089	9.558*	3170871.027	2.557	256456.748	0.143
Congruency (B)	1	33900370.858	12.089*	19086051.276	12.965**	87438533.134	45.18**
Visual Field (C)	1	108188959.014	47.08*	42547520.968	37.722**	184220391.86	93.23**
AxB	1	59575156.535	5.925*	82231731.334	55.858**	36319101.346	18.76*
AxC	1	281584666.838	7.00*	1484231.310	1.316	54113653.63	27.38**
BxC	1	62577565.446	28.09**	13338134.315	10.463*	5622403.721	2.85
AxBxC	1	71993333.129	32.32**	4492120.318	3.524	311980.308	0.158
Within	147	2227457.365		1274812.472		1970131.226	

*p<0.05, **p<0.01

There was significant main effect of congruence found in experiment –I, *F (1, 147) =12.089, p<.01* in experiment-II, *F (1, 147) = 12.965, p<.01* as well as in experiment-III, *F (1,*
147) = 45.185, p<.01. Mean reaction times were faster in congruent condition in all three experiments for image stimuli as compared to incongruent condition for the both groups i.e. right-handers and non-right handers (See table 3.5).

After computing 2(Right handers/non-right handers) x 2(congruent/incongruent) x 2 (left visual field/right visual field) factorial mixed model ANOVA with repeated measures on the last two factors, mean and standard deviation of main and interaction effects are presented in table 3.5.

Table 3.5 Summary of mean and standard deviation separately performed for main effect on reaction time for Emotional, Geometrical and Color Stroop-like task (Image):

		Reaction Time (milliseconds)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M SD	6356.77 1193.82	5953.76 1853.14	5587.95 1139.19	5441.67 1058.59	5880.67 1433.28	5839.06 1277.61
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M SD	5394.41 1295.88	5916.12 751.08	5335.37 915.99	5694.25 1281.79	5475.79 1398.29	6243.95 1312.61
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M SD	6582.49 1551.35	5728.04 495.613	5782.73 1236.24	5246.89 961.54	5302.37 1207.23	6417.36 1503.67

In regard to the effect of visual field on reaction time the F values were significant for all the three types F *(1, 147) = 47.080, p<.01, F (1, 147) = 37.722, p<.01 and F (1, 147) = 93.236,p<.01* respectively. The mean reaction time for left visual field (M=5728.05, SD=4595.61)was faster than the right visual field (M=6582.49, SD=1551.35) in the first experiment but in second experiment opposite pattern was seen as left visual field (M= 5246.90, SD=961.54) and right visual field (M= 5782.73, SD=1236.24) in the third experiment as left visual field (M= 6417.36, SD=1503.67) reaction time was greater than the right visual field (M= 5302.37, SD=1207.23) reaction time.

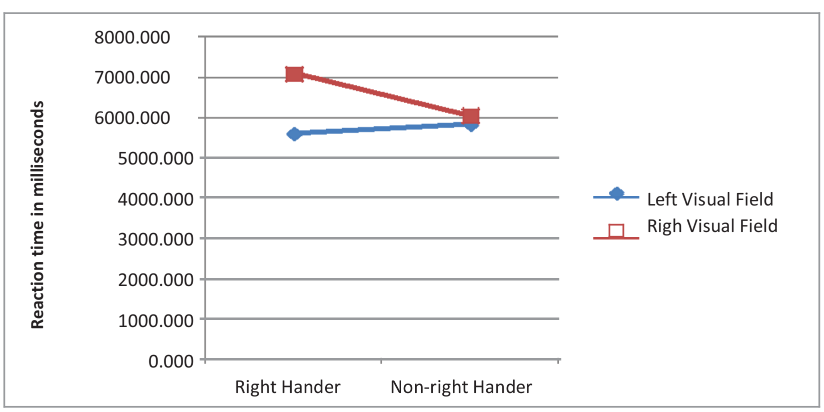


Fig 3.1Mean reaction time for correct identification as a function of interaction of handedness and visual field.

Fig 3.1 shows that under two different visual field conditions, non-right handers were shown consistency in their reaction time but right handers differed across the visual fields. As right handers took comparatively less time in image recognition in left visual field as compare to right visual field. This interaction shows that visual field had differential effect on performance.

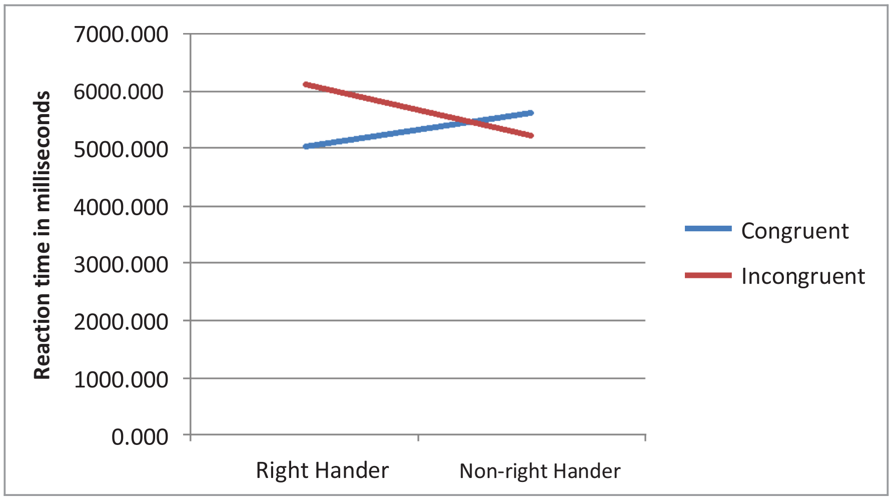


Fig 3.2 Interaction of Handedness x Congruency with Reaction for Correct Repose as the Dependent Measure in Experiment-II

Above diagram presents that under incongruent condition non-right handers were taken less time compare to right handers but surprisingly in congruent condition of the experiment-II non-right handers took more time in congruent conditions as compare to their response in incongruent conditions. This interaction shows that incongruent effect varied with the types of handedness.

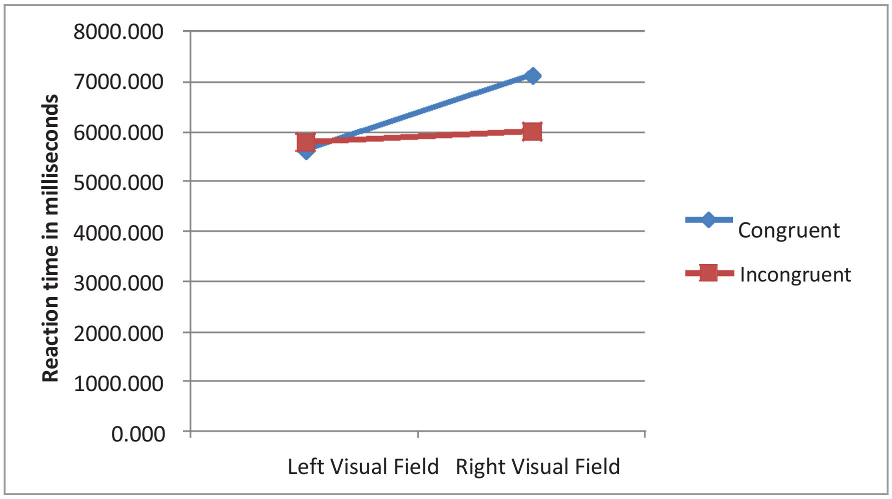


Fig 3.3 Interaction of Visual Field x Congruency with Reaction for Correct Repose as the Dependent Measure in Experiment-I

Fig 3.3 shows that under incongruent condition the reaction time was invariant across both visual fields but under congruent condition the participants were faster in left visual field and slow in case of right visual field. The interaction shows that the effect of congruence varied with the field of stimulus presented.

The interaction effects were also analysed in the combination of Handedness x visual field, Handedness x Congruency, Visual field x Congruency as well as Handedness x Visual field x Congruency for reaction time in all three experiments. It was observed that in experiment one all these interaction effects were highly significant but in experiment two and three, the interaction between Handedness x Visual field x Congruency effect was not found significant. As per experiment one interaction between Handedness x visual field $F(1, 147) = 7.00$, $p<.05$, Handedness x Congruency $F(1, 147) = 5.925$, $p<.05$, Visual field x Congruency $F = 28.09$, $p<.01$ as well as Handedness x Visual field x Congruency $F(1,147) = 32.32$, $p<.01$ were found significant and it has been plotted in figure 3.1, 3.2, 3.3 and 3.4.

These results indicate that the visual field and congruency had considerable impact on recognition of image stimuli. Both the groups were showed better recognition for image stimuli in the left visual field presentation as compared to right visual field presentation. Congruence also emerged as a factor that affected recognition. It was noted that both groups took more time under incongruent condition compared to congruent condition.

3.2 Split Visual Field: Response Latency (Words)

The descriptive statistics for reaction time of correct recognition for processing of word stimuli in all three experiments like emotional word, geometrical word and color name for right hander and non-right hander are shown in table 3.6, 3.7 and 3.8.

On word stimuli, as similar as image stimuli the mean reaction time showed that, non-right handers were faster to recognize word stimuli as compare to right hander in almost all conditions in experiment-I processing of emotional faces (see table 3.6) but in the processing of geometrical words in experiment-II non-right handers were slower as compare to right handers (see table 3.7) and as similar as experiment-I, in color names processing non-right hander were shown faster responses in all conditions (see table 3.8).

3.2.1 Processing Emotional Words

Table 3.6 Means and SDs of response latencies(millisecond) for emotional faces by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	5451.35	7996.90	7473.74	9177.81
	SD	1332.92	1792.20	1361.51	1807.04
Non right	M	4927.24	7339.57	6351.27	8625.44
	SD	1332.9	1400.90	1362.01	1433.59

3.2.2 Processing Geometrical Words

Table 3.7 Means and SDs of response latencies (millisecond) for geometrical shapes by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	7191.4	9494.34	8488.09	9043.51
	SD	1686.60	1776.50	1409.08	1257.71
Non right	M	7963.01	8289.60	9506.40	9277.61
	SD	1626.26	965.29	1509.95	1257.71

3.2.3 Processing Color Words

Table 3.8Means and SDs of response latencies(millisecond) for color patches by handedness, congruence and presentation field under split visual field conditions.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	8260.98	8660.49	8950.81	9516.02
	SD	1092.89	965.46	1174.55	1260.86
Non right	M	7312.34	8182.09	7592.37	8850.20
	SD	1191.22	1376.63	1242.50	1045.69

With a view to examine Stroop interference and functional laterality pattern the values of reaction time for word stimuli were analysed in all the three experiments by using 2x2x2 Handedness (right/non-right) x Congruency (congruent/incongruent) x Visual field (right visual field/ left visual field) mixed design repeated ANOVA.

As per between group analysis, the results were found significant in experiment I and as in experiment-I $F(1, 147) = 35.325, p<.01$ in experiment-III $F(1, 147) = 79.537, p<.01$ but in experiment- II it was not found significant as $F(1, 147) = 2.545, p>.05$ *(see table 3.9).*

Table 3.9 Summaries of ANOVAs separately performed on score of reaction time for Emotional, Geometrical and Color Stroop-like task (Words):

		Reaction Time					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	75560967.79	35.32**	6215800.960	2.545	110321259.497	9.53
Congruency (B)	1	323845525.11	128.17**	105634962.10	55.40**	57584971.181	43.34**
Visual Field (C)	1	739589643.6	422.83**	80934914.39	41.477**	88563368.789	62.71**
AxB	1	2254599.077	.892	26314143.551	3.801*	3303337.243	2.486
AxC	1	1767811.579	1.01	70577695.28	36.16**	12524135.648	8.869
BxC	1	8888495.75	4.19*	49115879.10	25.47**	2840264.076	2.08
AxBxC	1	4581406.223	2.163	13161598.46.826		458025.17	5.336
Within	147	2117646.615		1928024.265		1363894.095	

*p<0.05, **p<0.01

In Experiment-I the main effect of congruency was significant *F (1, 147) = 128.179,p<.01*similarly Visual field had also significant effect *F (1, 147) = 422.838, p<.01.* It was found that subjects took more time in incongruent condition (M=7907.06, SD=1491.03) as compare to congruent condition (M=6428.76, SD=1464.73). In regard to visual field participants were quicker when the stimuli were in right visual field (M=6810.88, SD=1382.35) as compared to left visual field (M=7524.95, SD=1537.41). Interaction effect of Handedness x Visual field and Handedness x Congruency were not significant the F values were *F (1, 147) = 1.011, p>.05*,*F (1, 147) = 0.892, p>.05* respectively (see table 3.9).

Table 3.10 Summary of mean and standard deviation separately performed for main effect on reaction time for Emotional, Geometrical and Color Stroop-like task (Words):

		Reaction Time (milliseconds)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M	6050.90	8284.93	8554.33	8759.15	8847.07	7984.25
	SD	1347.33	1608.43	1532.47	1339.80	1123.44	1214.01
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M	6428.76	7907.06	8234.58	9078.90	8103.97	8727.35
	SD	1464.73	1491.03	1513.66	1358.61	1156.55	1180.9
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M	6810.88	7524.95	8287.22	9026.26	8029.12	8802.2
	SD	1382.35	1573.41	1557.97	1314.30	1175.29	1162.16

Above table (table 3.10) is displaying mean and standard deviation of reaction time (milliseconds) of main and interaction for all three experiments after computing ANOVAs.

In experiment-II, the main effect of congruence main effect was significant F $(1, 147) = 55.401, p<.01$ and visual field main effect was also significant F $(1, 147) = 41.477, p<.01$. It was observed that the participant had difficulty to respond in incongruent condition (M=9078.90, SD=1358.61), the value of reaction time was higher as compared with congruent condition (M=8234.58, SD=1513.66). Similar as Experiment-I, the stimuli displayed in the right visual field (M=8287.22, SD=1557.97) reaction time was lower means faster in response as compare to left visual field (M=9026.26, SD=1314.30). Interaction effect of Handedness x visual field and Handedness x Congruency were also significant F $(1, 147) = 36.169, p<.01$ and $F (1, 147) = 13.801, p<.01$ respectively (see table 3.9). Interaction effect has been presented in Figure 3.4 and 3.5.

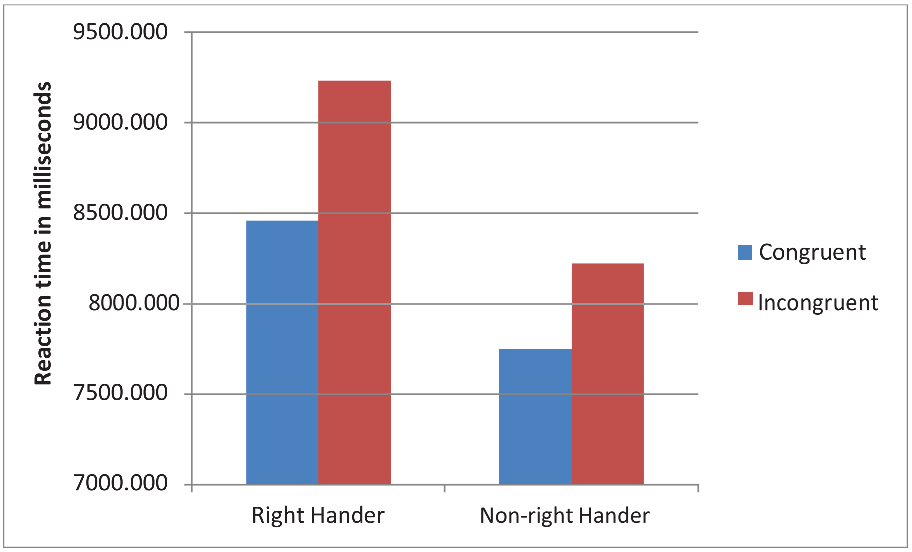


Fig 3.4 Interaction of Handedness x Congruency with Reaction for Correct Repose as the Dependent Measure in Experiment-II

Fig 3.4 shows that under incongruent condition both groups of subjects were taken more time but in between the groups, right handers took more time in both congruent and in incongruent conditions. This interaction shows that incongruent effect varied with the types of handedness.

These figures are clearly indicating that in both of the cases like congruent and incongruent conditions non-right handers took less time to recognize word stimuli as compared to right handers.

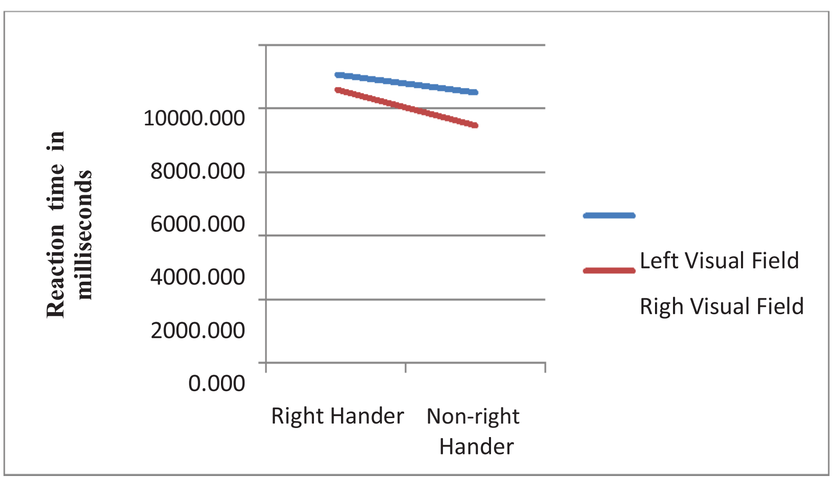


Fig 3.5 Interaction of Handedness x Visual Field with Reaction for Correct Repose as the Dependent Measure in Experiment-II

Fig 3.5 shows that under two different visual field conditions, right handers were shown consistency in their reaction time but non-right handers differed across the visual fields. As both groups of participants were taken more time for word recognition in left visual field as compare to right visual field. This interaction shows that visual field had differential effect on recognition of word stimuli.

These results show that, the recognition of verbal stimuli in terms of reaction time affected by presentation of stimuli in different visual field, congruency condition and Handedness. In contrast of above results it was observed that all samples were shown good recognition of verbal task in right visual field (LH) as compare to left visual field (RH). Congruency was also a factor that affects the response of subject in terms of reaction time as both groups took more time in incongruent condition compare to congruent condition.

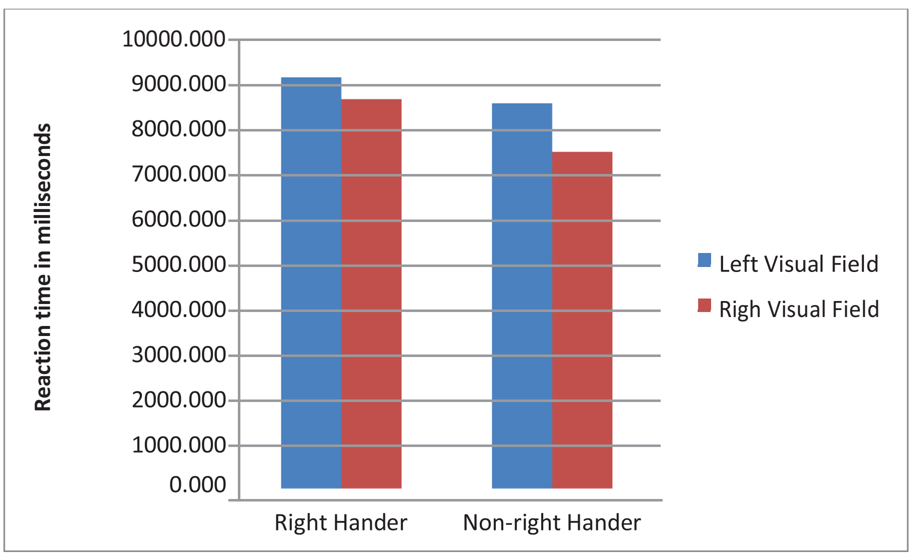


Fig 3.6 Interaction of Handedness x Visual Field with Reaction for Correct Repose as the Dependent Measure in Experiment-III

Fig 3.6 shows that the interaction between visual field and handedness in Experiment-III for word stimuli. Under two different visual field conditions, right handers were shown consistency in their reaction time but non-right handers differed across the visual fields. As both groups of participants were taken more time for word recognition in left visual field as compare to right visual field. This interaction shows that visual field had differential effect on recognition of word stimuli

In experiment-III, the results had almost same pattern like experiment –II. In this experiment main effect of congruency and visual field were found significant as $F\ (1,\ 147) = 43.34,\ p<.01$ and $F\ (1,\ 147) = 62.71,\ p<.01$ respectively. Subjects were shown better response in congruent condition and in Right Visual Field (LH) as compare to incongruent and Left Visual Field (RH). Further interaction effect was also analysed, in Handedness x Congruency results were not found significant as $F\ (1,\ 147) = 2.486,\ p>.05$ but the interaction between Handedness x Visual Field showed significant $F\ (1,\ 147) = 8.869,\ p<.01$.

Above results indicate that the visual field and congruency had also considerable impact on recognition of word stimuli. Both the groups were showed better recognition for word stimuli in the right visual field presentation as compared to left visual field presentation. Congruence also appeared as a factor that affected recognition. It was noted that both groups took more time under incongruent condition compared to congruent condition.

3.3 Split Visual Field: Accuracy (Images)

Accuracy was also observed with reaction time to see the effect of Handedness, Visual field, and Congruency in visual perception of three different kinds of stimuli like Emotional, Geometrical and Color word and their images in Stroop like experiments. The frequency of correct recognition responses was analysed by using 2 x 2 x 2 (Handedness: right, non-right x Congruency: congruent, incongruent x Visual Field: left visual field, right visual field) mixed model ANOVA with repeated measures on last two factors. The descriptive statistics of accuracy of image stimuli are presented in table 3.11, 3.12 and 3.13

3.3.1 Processing Emotional Faces

Table 3.11 Means and SDs of accuracy (out of 5 responses) for emotional faces by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	3.81	4.31	3.67	4.10
	SD	.81	.58	1.15	.88
Non right	M	3.97	4.37	3.91	4.04
	SD	.80	.48	.85	.83

3.3.2 Processing Geometrical Shapes

Table 3.12 Means and SDs of accuracy (out of 5 responses) for geometrical shapes by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	2.50	4.03	3.57	3.76
	SD	.52	.60	.56	.42
Non right	M	3.92	4.0	3.42	4.10
	SD	.39	.29	.55	.34

3.3.3 Processing Color Patches

Table 3.13 Means and SDs of accuracy (out of 5 responses) for color patches by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	2.85	3.25	2.57	4.20
	SD	.78	.85	.52	.46
Non right	M	3.62	4.25	2.25	3.65
	SD	1.02	.72	.58	.36

The main effect of Handedness was significant in the Experiment-II $F(1, 147) = 99.37$, $p<.01$ *and in Experiment-III* $F(1, 147) = 46.23$, $p<.01$, on the accuracy of recognition of image stimuli but in Experiment-I it was not significant. The mean scores of accuracies in experiment-II shows non-right hander (M=3.86, SD=.39) had higher accuracy as compared to right hander (M=3.46, SD=.52) and same pattern were seen in rest of the two experiments (see table 3.15).The main effect of congruency, $F(1, 147) = 5.023$, $p<.05$ and visual field, $F(1, 147) = 28.31$, $p<.01$ were significant in image stimuli in Experiment-I and almost similar patterns were seen experiment second and third. These findings suggest that the both groups had better accuracy in LVF (RH) than the RVF (LH) in image task as well as their accuracy was also high in congruent condition than the congruent condition (see table 3.15).

Interaction effects were also analysed in all three experiments and results were significant in Experiment-II and III in Handedness x Visual field $F(1, 147) = 33.638$, $p<.01$ and $F(1, 147) = 21.85$, $p<.01$ respectively. The interaction between Handedness x Visual field $F(1, 147) = 55.202$, $p<.01$ was also significant in Experiment-II but not in other two experiments.

Table 3.14 Summaries of ANOVAs separately performed on score of accuracy for Emotional, Geometrical and Color Stroop-like task (Image):

		Accuracy					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	1.514	2.421	22.954	99.37**	15.231	46.23**
Congruency (B)	1	3.622	5.023*	1.439	5.900	2.124	6.121
Visual Field (C)	1	19.776	28.31**	56.900	219.01**	22.352	98.14**
AxB	1	.052	.072	13.466	55.202**	1.322	2.875
AxC	1	1.400	2.004	8.739	33.638**	5.147	21.85**
BxC	1	2.014	2.90	5.09	26.106**	4.172	18.211**
AxBxC	1	.927	1.335	35.533	182.258**	12.564	38.212**
Within	147	.694		.195		.758	

*p<0.05, **p<0.01

Table 3.15 Summary of mean and standard deviation separately performed for main effect on reaction time and accuracy for Emotional, Geometrical and Color Stroop-like task (Image):

		Accuracy (frequency out of 5)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M SD	3.97 0.85	4.07 0.74	3.46 0.52	3.86 0.39	3.21 0.65	3.44 0.67
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M SD	4.115 0.66	3.93 0.92	3.61 0.45	3.71 0.46	3.49 0.84	3.16 0.48
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M SD	3.84 0.90	4.20 0.69	3.35 0.50	3.975 0.415	2.82 0.72	3.83 0.59

There was no significant interaction of Handedness x Visual field, $F\ (1,\ 147) = 2.004, p>.05$ as well as in Handedness x Congruency, $F\ (1,\ 147) = .077,\ p>.05$ for word and image stimuli in experiment-I. Some of the statistically significant interaction effect presented in figure 3.7 and 3.8

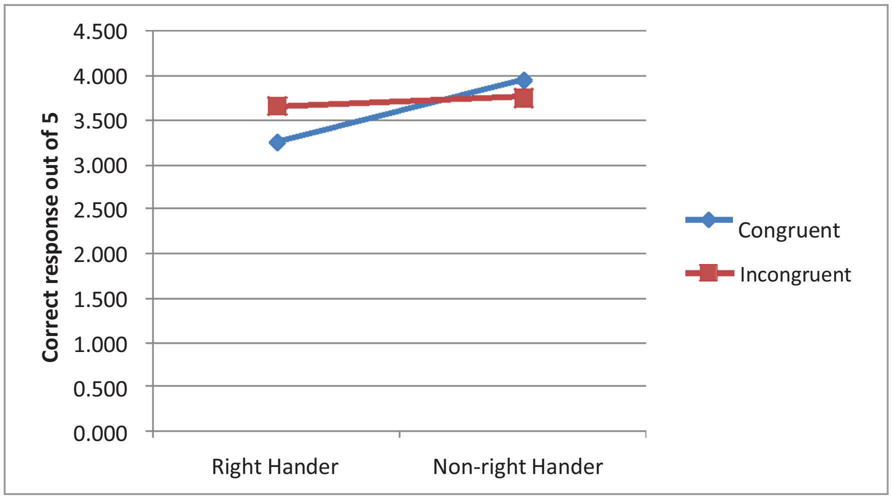


Fig 3.7 Interaction of Handedness x Congruency with Accuracy as the Dependent Measure in Experiment-II (image)

In fig 3.7 it can be observed that non-right handers have high accuracy in both congruency conditions like congruent and incongruent as compare to right hander. As both groups of participants had slightly difference in accuracies in congruent and incongruent condition. Surprisingly right handers were shown high accuracy in incongruent condition as compared to their congruent condition. This figure demonstrated that the effect of congruency on accuracy as both groups affected.

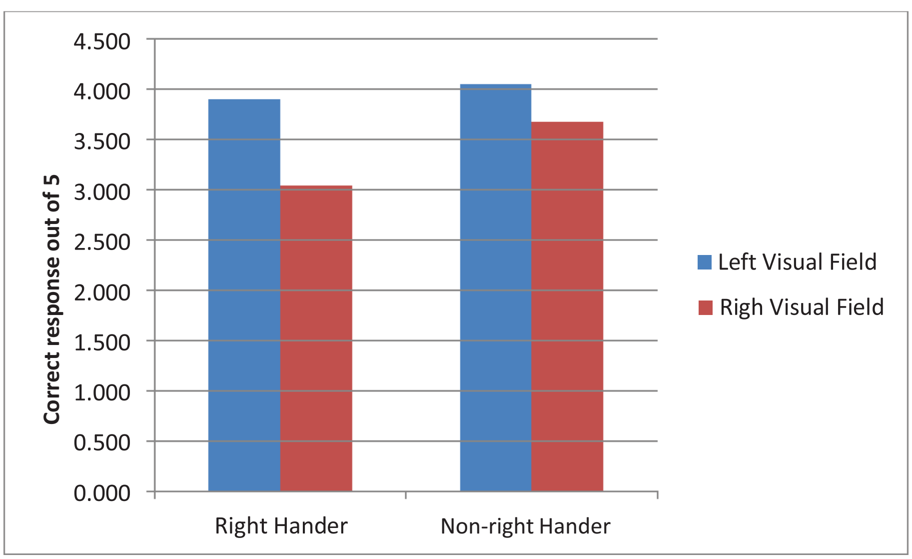


Fig 3.8 Interaction of Handedness x Visual field with Accuracy as the Dependent Measure in Experiment-II (image)

In fig 3.8 shows that visual field had differential effect on accuracy. Both groups of participants had higher accuracy in left visual field for image stimuli as compared to right visual field. This figure also demonstrated that both groups differed in their accuracy across the visual fields.

Above results indicate that in incongruent conditions subjects had low accuracy as compared to congruent condition. In between group non-right hander had competitively better accuracy in recognition of image stimuli in all three types of experiments. In the way of recognizing image stimuli both groups were shown left visual field superiority.

3.4 Split Visual Field: Accuracy (Words)

Accuracy was also observed with reaction time to see the effect of Handedness, Visual field, and Congruency in visual perception of three different kinds of stimuli like Emotional, Geometrical and Color word in Stroop like experiments. The frequency of correct recognition responses was analysed by using 2 x 2 x 2 (Handedness: right, non-right x Congruency: congruent, incongruent x Visual Field: left visual field, right visual field) mixed model ANOVA with repeated measures on last two factors (see table 3.19). The descriptive statistics of accuracy of word stimuli are presented in table 3.16, 3.17 and 3.18

3.4.1 Processing Emotional Words

Table 3.16 *Means and SDs of accuracy (out of 5 responses) for emotional faces by handedness, congruence and presentation field under split visual field condition.*

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.20	3.51	3.87	3.52
	SD	.71	.87	.87	1.23
Non right	M	4.26	3.73	3.89	3.85
	SD	.65	.91	.82	.92

3.4.2 Processing Geometrical Words

Table 3.17 Means and SDs of accuracy (out of 5 responses) for geometrical shapes by handedness, congruence and presentation field under split visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.27	3.93	4.10	4.05
	SD	.69	.76	.88	.96
Non right	M	4.28	3.73	3.89	3.85
	SD	.64	.91	.82	.92

3.4.3 Processing Color Words

Table 3.18 Means and SDs of accuracy (out of 5 responses) for color patches by handedness, congruence and presentation field under split visual field conditions.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	3.65	2.26	3.57	2.12
	SD	.52	.64	.87	.91
Non right	M	3.25	2.10	4.65	3.24
	SD	.74	..65	..55	..46

The main effect of Handedness was not significant in all three experiments on the accuracy of recognition of word stimuli. The difference in mean scores of accuracies in experiment-I was very little as non-right hander (M=3.93, SD=.82) had slightly better accuracy as compared to right hander (M=3.77, SD=.92) and same pattern were seen in rest of the two experiments (see table 3.20). The main effect of visual field, $F(1, 147) = 28.55, p<.01$was significant in Experiment-I as mean scores of accuracies of word stimuli in right visual field (M=4.05, SD=.76) was greater that the left visual field (M=3.65, SD=.98). In the same experiment congruency main effect was also significant, *F (1, 147) = 3.88, p<.05* as mean scores of accuracies of word stimuli in congruent condition (M=3.92, SD= .78) was greater that the left visual field (M=3.78, SD=.96). In the Experiment-II and III main effect of congruency and visual field were not significant.

Table 3.19 *Summaries of ANOVAs separately performed on score of accuracy for Emotional, Geometrical and Color Stroop-like task (words):*

		Accuracy					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	3.807	5.101	3.114	4.110	2.135	5.241
Congruency (B)	1	2.893	3.884*	1.057	1.68	2.225	5.265
Visual Field (C)	1	23.791	28.55**	8.926	12.440	7.232	18.325
AxB	1	.040	.054	.420	.670	.745	.956
AxC	1	2.066	2.480	.396	.552	4.125	12.568
BxC	1	6.16	6 .90**	5.87	7.93**	4.28	17.25**
AxBxC	1	.184	.205	.447	.609	.754	.958
Within	147	.893		.737		.648	

*p<0.05, **p<0.01

Table 3.20 *Summary of mean and standard deviation separately performed for main effect on accuracy for Emotional, Geometrical and Color Stroop-like task (Words):*

		Accuracy (frequency out of 5)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M	3.77	3.93	4.08	3.93	2.9	3.31
	SD	0.92	0.82	0.82	0.82	0.73	0.74
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M	3.92	3.78	4.05	3.97	2.81	3.39
	SD	0.78	0.96	0.75	0.89	0.63	0.89
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M	4.05	3.65	4.13	3.89	3.78	2.43
	SD	0.76	0.98	0.75	0.88	0.71	0.75

To see the interception effect on accuracy of word stimuli in all three experiments possible interaction effects were analysed and results presented in table 3.19. In all three experiments the interaction between Congruency x Visual field were significant as in experiment-I, $F\ (1,\ 147) = 6.50,\ p<.01,$ Experiment-II, $F\ (1,\ 147) = 7.93,\ p<.01$ *and in* Experiment-III, $F\ (1,\ 147) = 17.25,\ p<.01.$ Some of the interaction effect presented in figure 3.9 and 3.10.

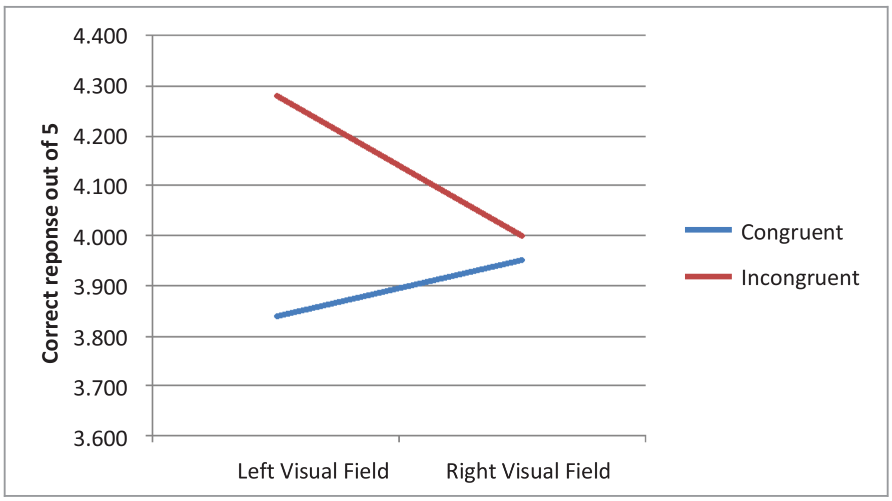


Fig 3.9 Interaction of Congruency x Visual Field with Accuracy as the Dependent Measure in Experiment-II (word)

Above figure shows that the interaction of visual field and congruency for accuracy of recognition of word stimuli in Experiment-II. This figure indicates that the big differences of accuracy in left visual field but consistence results were shown in right visual field. So, in right visual field congruencies could not impact on accuracy but it had on left visual field.

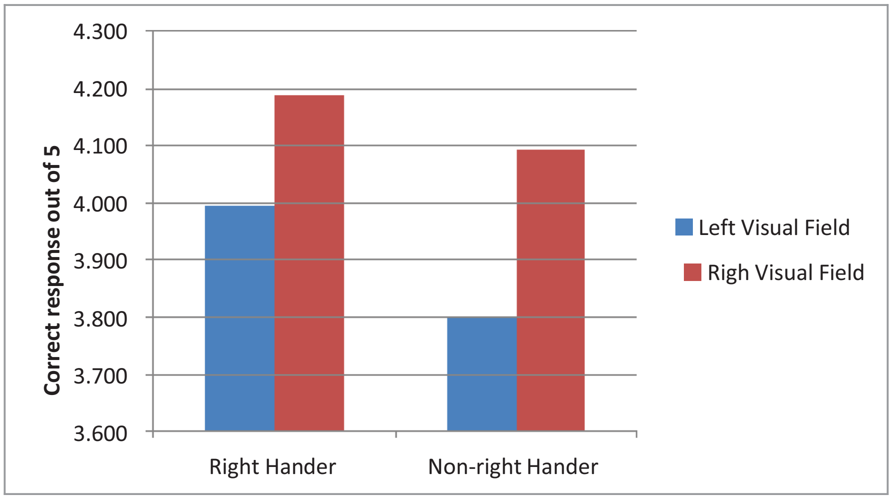


Fig 3.10 Interaction of Handedness x Visual field with Accuracy as the Dependent Measure in Experiment-II (words)

Figure 3.10 shows that visual field had differential effect on accuracy. Both groups of participants had higher accuracy in right visual field for word stimuli as compared to right visual field. This figure also demonstrated that both groups differed in their accuracy across the visual fields as both group had better accuracies in their right visual field compared to left visual field.

Above results indicate that in incongruent conditions subjects had low accuracy as compared to congruent condition. In between group non-right hander had competitively better accuracy in recognition of image stimuli in all three types of experiments. In the way of recognizing word stimuli both groups were shown right visual field superiority as they had high accuracy for recognition of word stimuli in the right visual field.

PARALLEL VISUAL FIELD: RESPONSE LATENCY

Parallel Visual Field presentation explained as, when the stimuli presented in both visual fields (Left Visual Field and Right Visual Field) simultaneously.

3.5 Reaction time for image stimuli in Parallel visual field:

In the second part of experiment, reaction time was observed by presenting stimuli in two different visual fields simultaneously. The descriptive statistics for reaction time of correct recognition of image stimuli for right hander and non-right hander in all three experiments are shown in table 3.21, 3.22 and 3.23

3.5.1 Processing Emotional Faces

Table 3.21 Means and SDs of response latencies(millisecond) for emotional faces by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	7198.72	4431.45	6855.58	6742.96
	SD	1107.31	1337.37	1365.48	1100.62
Non right	M	6863.0	6871.88	5304.46	5185.48
	SD	1566.68	1407.92	2211.37	2137.96

Descriptive statistics of all three experiments show similar patterns as in incongruent condition, participants were taken more time to recognize image stimuli than the congruent condition. It the descriptive statistics table means and standard deviation of reaction times in different conditions for recognising image stimuli in parallel visual field are presented.

3.5.2 Processing Geometrical Shapes

Table 3.22 Means and SDs of response latencies (millisecond) for geometrical shapes by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	5019.95	5117.77	6470.96	5442.48
	SD	1307.07	704.68	1537.45	1249.27
Non right	M	5448.44	5426.44	6021.08	4995.78
	SD	1372.712	606.96	1446.35	1156.74

3.5.3 Processing Color Patches

Table 3.23 Means and SDs of response latencies(millisecond) for color patches by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	5595.41	5358.00	6184.0	6774.76
	SD	1634.86	1205.99	1283.8	1700.17
Non right	M	4798.82	6250.36	5113.1	6823.71
	SD	1146.21	1832.32	1179.2	1206.39

To see Stroop interference and functional laterality pattern among Right hander and Non-right hander the reaction time of image stimuli in parallel visual field presentation were analysed in all three experiments by using 2x2 (Congruent, Incongruent x Left visual field, right visual field) within group and 2 (Right-handed, Non-right handed) between groups mixed repeated ANOVA (see table 3.24).

After computing 2(Right handers/non-right handers) x 2(congruent/incongruent)x2 (left visual field/right visual field) factorial mixed model ANOVA with repeated measures on the last two factors, mean and standard deviation of main and interaction effects are presented in table 3.25.

As per the between group analysis Experiment-I and III were shown significant differences in Right hander and Non-right hander group of samples as *F (1, 147) = 4.062, p<.01 and F (1, 147) = 3.896, p<.05* respectively but it was not found significant in experiment-II. In experiment I and III, reaction time of Non-right hander were faster than the Right hander. As per Experiment-I, non-right handers (M=6056.20, SD=1830.98) were faster in recognition of image stimuli than the right handers (M=6307.17, SD=1227.69) and in Experiment-II reaction time of non-right hander (M=5472.93, SD=1145.69) also faster as compared to right handers (M=5512.79, SD=1199.61).

Table 3.24 Summaries of ANOVAs separately performed on score of reaction time for Emotional, Geometrical and Color Stroop-like task (Image):

		Reaction Time					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	9333891.63	4.062**	235346.07	.163	7944443.21	3.869*
Congruency (B)	1	15092744.89	10.861**	34060604.33	24.68**	77516488.50	41.62**
Visual Field (C)	1	82800685.36	181.15**	36234756.341	25.43**	114460468.49	63.07**
AxB	1	251720271.77	181.15**	24721005.88	17.91**	11570479.16	6.213*
AxC	1	71054404.38	65.25**	126036.01	.088	73068094.92	40.26**
BxC	1	59133258.93	56.00**	42004001.71	25.11**	10947538.51	4.55
AxBxC	1	71707676.77	65.85**	140111.034	.084	2999846.41	1.248
Within	147	1088828.66		1672513.475		2404323.09	
Total							

*p<0.05, **p<0.01

Table 3.25 Summary of mean and standard deviation separately performed for main effect on reaction time for Emotional, Geometrical and Color Stroop-like task (Images):

		Reaction Time (milliseconds)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M SD	6307.17 1227.69	6056.20 1830.98	5512.79 1199.61	5472.93 1145.69	5978.04 1456.20	5746.49 1341.03
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M SD	6341.26 1354.82	6022.12 1703.85	5253.15 997.85	5732.57 1347.45	5500.64 1454.84	6223.89 1342.39
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M SD	6555.44 1562.71	5807.94 1495.96	5740.10 1415.89	5245.61 929.412	5422.83 1311.01	6301.70 1486.21

In all three experiments main effect of congruency and visual field were found significant as in Experiment-I Congruency $F(1, 147) = 10.861, p<.01$, Visual Field $F(1, 147) = 181.15, p<.01$, in Experiment-II Congruency $F(1, 147) = 24.688, p<.01$, Visual Field $F(1, 147) = 25.435, p<.01$ Experiment-III Congruency $F(1, 147) = 41.622, p<.01$, Visual Field $F(1, 147) = 63.077, p<.01$. As per mean score of reaction time in Left Visual Field (M=5807.94, SD=1495.96) is lower than the Right Visual Field (M=6555.44, SD=1562.74) in experiment I and same pattern were seen in experiment II as Left Visual Field (M=5545.61, SD=929.412) is lower than the Right Visual Field (M=5740.10, SD=1415.89) but in experiment –III it was seen in opposite manner. Subjects were performed fast in congruent condition (experiment III, M=5500.64, SD=1454.84) as compare to incongruent (experiment III, M=6223.89, SD=1342.39) conditions of second and third experiments (see table 3.25). Further analysis was also carried out to see interaction effect between Handedness x Visual Field and Handedness x Congruency in all experiments of parallel visual field observation for image stimuli. In experiment –I interaction effect was found significant as for Handedness x Congruency $F(1, 147) = 181.151, p<.01$ and for Handedness x Visual Field $F(1, 147) = 56.001, p<.01$(see table 3.24). Experiment second and third were also shown same pattern as their interaction effects were also found significant in the case of Handedness x Visual Field and Handedness x Congruency. For presenting a better picture of interaction effect, different line and bar diagram has been displayed in this segment (see fig 3.11 and 3.12).

Experiment –II demonstrated that significant interaction between Handedness x Congruency $F\ (1,\ 147) = 17.918,\ p<.01$ but it was not found significant in the interaction for Handedness x Visual Field $F\ (1,\ 147) = 0.088,\ p>.05$. The interaction effect was also found significant in experiment-III as Handedness x Congruency $F\ (1,\ 147) = 6.213,\ p<.01$ and Handedness x Visual Field $F\ (1,\ 147) = 40.266,\ p<.01$.

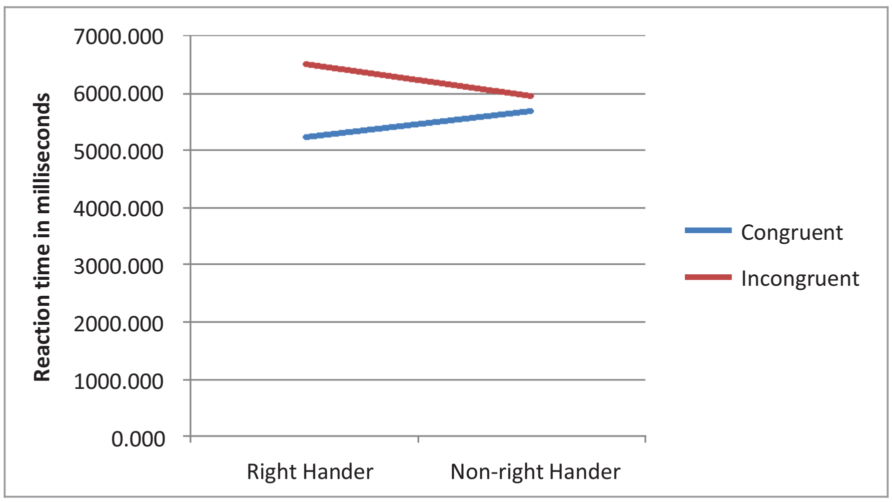


Fig 3.11 Interaction of Handedness x Congruency with Reaction for Correct Repose as the Dependent Measure in Experiment-II

Above diagram presents that, under incongruent condition non-right handers were taken less time compare to right handers. Surprisingly in both congruent and incongruent condition of the experiment-II non-right handers were consistence in their performance as compared right handers. This interaction shows that incongruent effect varied with the types of handedness.

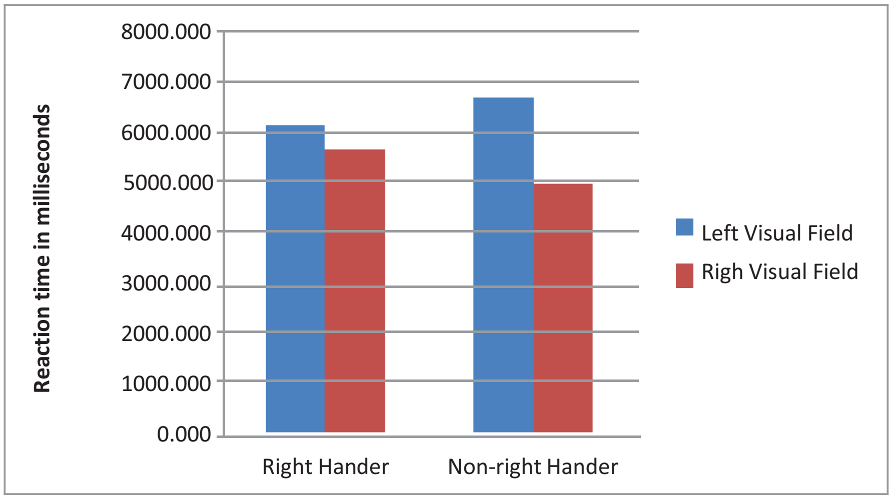


Fig 3.12 Interaction of Handedness x Visual Field with Reaction for Correct Response as the Dependent Measure in Experiment-III

Fig 3.12 shows that under two different visual field conditions, right handers were shown consistency in their reaction time but non-right handers differed across the visual fields. As right handers took comparatively less time in image recognition in right visual field as compare to left visual field and similar patter were seen with non-right handers. This interaction shows that visual field had differential effect on performance.

It was observed that in all three experiments subjects were taken more time to respond in incongruent condition as compare to congruent condition and the mean score of reaction time was comparatively high in right visual field (LH) recognition as compare to left visual field (RH) task recognition for image stimuli. So, in the second part of experiment also demonstrated the impact of Handedness, Visual field and Congruency in Parallel Visual Field presentation on recognition of image stimuli. Interaction effect has been displayed in Fig 3.11 and 3.12

3.6 Reaction Time for Word Stimuli in Parallel Visual Field

In this part of experiment, Verbal stimuli were presented in parallel visual field with congruent and incongruent conditions for two groups' Right hander and Non-right hander in all three experiments and reaction time were recorded for all responses further reaction time of incorrect responses eliminated from data after that analysis were done by using relevant statistical analysis.

To examine the objective of this study, 2 (Right-hander, Non-right hander) between group and 2 (Congruent, Incongruent) x 2 (Right Visual Field, Left Visual Field) within group repeated measure mixed ANOVA statistical analysis was used for data analysis in all three experiments (see table 3.29). Between group analysis was found significant in all three experiments as $F(1, 147) = 3.845, p<.05$, in Experiment-I $F(1, 147) = 12.108, p<.01$in Experiment-II *and* $F(1, 147) = 19.724, p<.01$*in Experiment-III.* Descriptive statistics of reaction time of two groups in all three experiments is presented in table 3.26, 3.27 and 3.28.

3.6.1 Processing Emotional Words

Table 3.26 Means and SDs of response latencies (millisecond) for emotional faces by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	5539.45	7390.75	7396.44	8147.48
	SD	1242.95	1888.31	1823.21	1234.48
Non right	M	5622.85	6982.21	7760.44	9132.09
	SD	1674.30	1150.16	1546.71	1695.77

3.6.2 Processing Geometrical Words

Table 3.27 Means and SDs of response latencies (millisecond) for geometrical shapes by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	7573.83	8411.94	7633.74	8884.19
	SD	1438.19	1325.82	1536.64	1666.15
Non right	M	8199.0	8018.02	9151.67	8956.94
	SD	1656.41	1429.88	1782.95	1450.56

3.6.3 Processing Color Words

Table 3.28 Means and SDs of response latencies (millisecond) for color patches by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	8132.72	8613.89	9257.9	9217.57
	SD	1484.21	1624.21	1669.7	1707.79
Non right	M	7462.66	8078.22	8324.7	8933.51
	SD	1752.20	1676.77	1571.6	1410.97

Mean reaction time of Right hander (M=7118, SD=1516) were faster than the non-right hander (M=7118, SD=1547) in experiment I and similar patter were seen in Experiment-II as right hander (M=8125, SD=1491) took less time than the non-right hander (M=8581, SD=1579). Opposite result was seen in experiment-III as non-right hander (M=8199, SD=1602) had low reaction time than the right hander (M=8805, SD=1621) for perception of verbal stimuli in parallel visual field. Further within groups analysis was demonstrated the main effect of Handedness, Congruency and Visual field on reaction time in all three experiments (see table 3.29).

Table 3.29 Summaries of ANOVAs separately performed on score of reaction time for Emotional, Geometrical and Color Stroop-like task (Words):

		Reaction Time					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	9701513.15	3.845*	30743657.339	12.108**	54376851.52	19.724**
Congruency (B)	1	441104803.46	169.03**	54408780.92	8.019**	109997699.51	48.06**
Visual Field (C)	1	263446442.67	111.01**	27173047.95	11.547**	25680430.15	9.87**
AxB	1	25946545.29	9.94**	17116071.18	8.019**	1242.86	.001
AxC	1	153319.33	.065	56243004.01	11.54**	5686566.08	2.186
BxC	1	10963263.49	5.001*	1471459.99	.601	2584895.19	.921
AxBxC	1	11464113.91	5.23*	1681477.246	.687	2454567.99	.875
Within	147	2192158.642		2449097.90		2805193.46	

*p<0.05, **p<0.01

Table 3.30 Summary of mean and standard deviation separately performed for main effect on reaction time for Emotional, Geometrical and Color Stroop-like task (Words):

		Reaction Time (milliseconds)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M SD	7118.53 1547.238	7374.39 1516.73	8125.92 1491.7	8581.40 1579.95	8805.52 1621.47	8199.77 1602.88
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M SD	6383.81 1488.93	8109.11 1575.04	8050.69 1462.57	8656.63 1609.07	8071.87 1634.34	8933.42 1590.01
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M SD	6579.79 1571.79	7913.13 1492.18	8139.56 1603.54	8567.77 1468.10	8294.49 1619.42	8710.79 1604.93

Main effect of Congruency was seen significant in all three experiments as *F (1, 147) =169.038, p<.01*(Experiment-I), *F (1, 147) = 8.019, p<.01*(Experiment-II), *F (1, 147) =*

48.068, p<.01(Experiment-III). In all three experiments or three different kinds of stimuli,reaction time was found high in incongruent condition as compare to congruent condition. Visual field was also observed as a main effect on reaction time and similar pattern was seen as congruency main effect. Main effect of visual field was found significant in every experiment and subject responded fast in Right Visual Field (LH) than the Left Visual Field (RH). Interaction effects of Handedness x Visual Field and Handedness x Congruency were also analysed for reaction time and observed that in Experiment-I Handedness x Congruency interaction found significant as $F\ (1,\ 147) = 9.943,\ p<.01$ it shows Non right hander perceived stimuli faster in incongruent condition than Right hander and Right hander performed well as compare to Non right hander in congruent condition (See fig 3.13)but Handedness x Visual Field interaction was not found significant as $F\ (1,\ 147) = .065,\ p>.05$

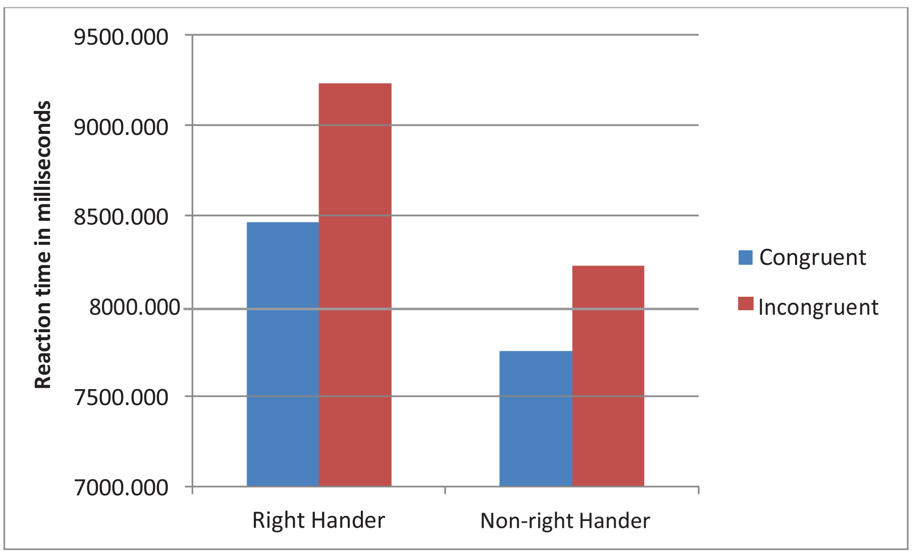


Fig 3.13 Interaction of Handedness x Congruency with Reaction for Correct Reponses as the Dependent Measure in Experiment-I

Fig 3.13 shows that under incongruent condition both groups of subjects were taken more time but in between the groups, right handers took more time in both congruent and in incongruent conditions. This interaction shows that incongruent effect varied with the types of handedness.

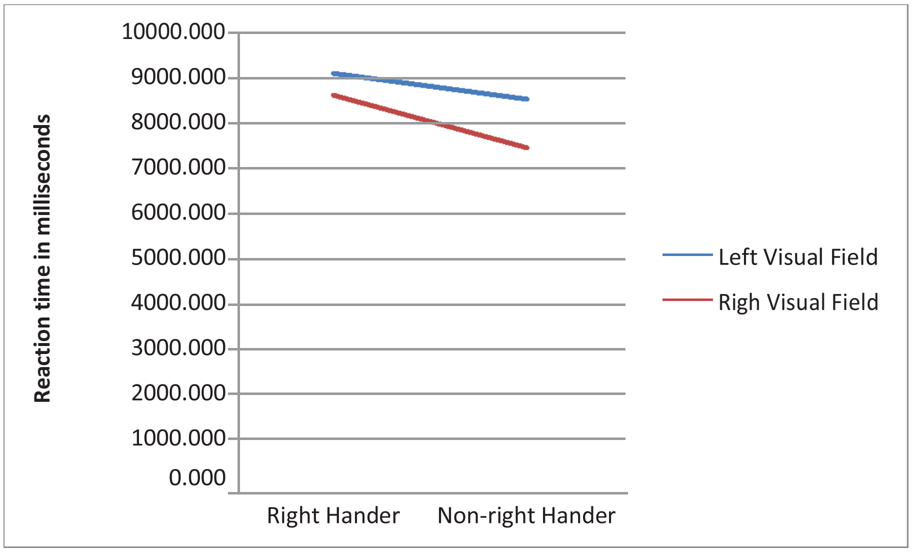


Fig 3.14 Interaction of Handedness x Visual Field with Reaction for Correct Reponses as the Dependent Measure in Experiment-I

Fig 3.13 shows that under two different visual field conditions, right handers were shown consistency in their reaction time but non-right handers differed across the visual fields. As right handers took comparatively less time in word recognition in right visual field as compare to left visual field and similar patter were seen with non-right handers. This interaction shows right visual field superiority for word recognition in both groups of participants. So that the visual field had differential effect on performance. In experiment II and III interaction effect were also analysed and found similar patterns.

Above results indicate that the visual field and congruency had also considerable impact on recognition of word stimuli. Both the groups were showed better recognition for word stimuli in the right visual field presentation as compared to left visual field presentation. Congruence also appeared as a factor that affected recognition. It was noted that across the visual field right hander were more consistence in performance as compared to non-right handers. Both groups took more time under incongruent condition compared to congruent condition.

PARALLEL VISUAL FIELD: ACCURACY

3.7 Accuracy for Image Stimuli in Parallel Visual Field

Accuracy was also observed in parallel visual field presentation to see the effect of Handedness, Visual field, and Congruency in visual perception of three different kinds of image stimuli like Emotional faces, Geometrical shapes and Color patches in Stroop like experiments. The frequency of correct recognition responses was analysed by using 2 x 2 x 2 (Handedness: right, non-right x Congruency: congruent, incongruent x Visual Field: left visual field, right visual field) mixed model ANOVA with repeated measures on last two factors. The descriptive statistics of accuracy of image stimuli of all three experiments are presented in table 3.31, 3.32 and 3.33.

3.7.1 Processing Emotional Faces

Table 3.31 Means and SDs of accuracy (out of 5 responses) for emotional faces by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.32	4.06	4.26	4.12
	SD	.89	.87	.77	.84
Non right	M	4.30	4.34	4.24	4.44
	SD	.69	.72	.81	. .60

3.7.2 Processing Geometrical Shapes

Table 3.32 Means and SDs of accuracy (out of 5 responses) for geometrical shapes by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.2	4.23	4.21	4.21
	SD	.75	.73	.83	.89
Non right	M	4.36	4.44	4.40	4.39
	SD	.72	.63	.67	. .71

3.7.3 Processing Color Patches

Table 3.33 Means and SDs of accuracy (out of 5 responses) for color patches by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.13	4.31	4.16	4.15
	SD	.77	.77	.89	.76
Non right	M	4.47	4.44	4.28	4.33
	SD	.71	.77	.87	. .70

The main effect of Handedness, *F (1, 147) = 10.023, p<.01,* on the accuracy of recognition of image task in experiment-III was significant as non-right hander (M=4.38, SD=.78) had better accuracy than the right hander (M=4.18, SD=.79) for image stimuli and same patterns were seen in Experiment-I and II (see table 3.34). The main effect of visual fields was not statistically significant in image stimuli, descriptive statistics suggest that both groups had better accuracy in LVF (RH) than the RVF (LH) in image task as well as non-right hander's accuracy was also high in incongruent condition than the congruent condition (see table 3.35). The main effect of congruency was observed non-significant, tells that subjects had no significant differences in terms of congruence condition. Further results were also demonstrating that subjects had better accuracy in LVF (M=4.31, SD=.75) than the RVF (M=4.29, SD=.74) for word stimuli tasks in Experiment II and III but results were not statistically significant.

Table 3.34 Summaries of ANOVAs separately performed on score of accuracy for Emotional, Geometrical and Color Stroop-like task (Images):

		Accuracy					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	2.182	3.45*	6.437	12.195**	5.754	10.023**
Congruency (B)	1	.159	.234	.121	.212	1.808	3.145
Visual Field (C)	1	.040	.068	.005	.009	.290	.490
AxB	1	. .018	.26	. .068	.118	.258	.448
AxC	1	2.893	4.88**	.139	.279	.203	.343
BxC	1	1.281	2.011	.475	.753	.123	.164
AxBxC	1	. .026	.041	. .005	.009	.626	.839
Within	147	. .637		. .631		. .764	

*p<0.05, **p<0.01

Table 3.35 Summary of mean and standard deviation separately performed for main effect on accuracy for Emotional, Geometrical and Color Stroop-like task (Images):

		Accuracy (frequency out of 5)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M SD	4.19 0.84	4.33 0.74	4.21 0.8	4.39 0.67	4.18 0.79	4.38 0.78
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M SD	4.255 0.79	4.265 0.80	4.30 0.70	4.30 0.796	4.33 0.75	4.23 0.84
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M SD	4.28 0.79	4.24 0.81	4.29 0.74	4.31 0.75	4.26 0.81	4.30 0.76

There was significant interaction of Handedness x Visual field, *F (1, 147) = 4.88,p<.05*in Experiment-I as presented in figure 3.15. But in rest of the two experiments this interaction effect was not found statistically significant.

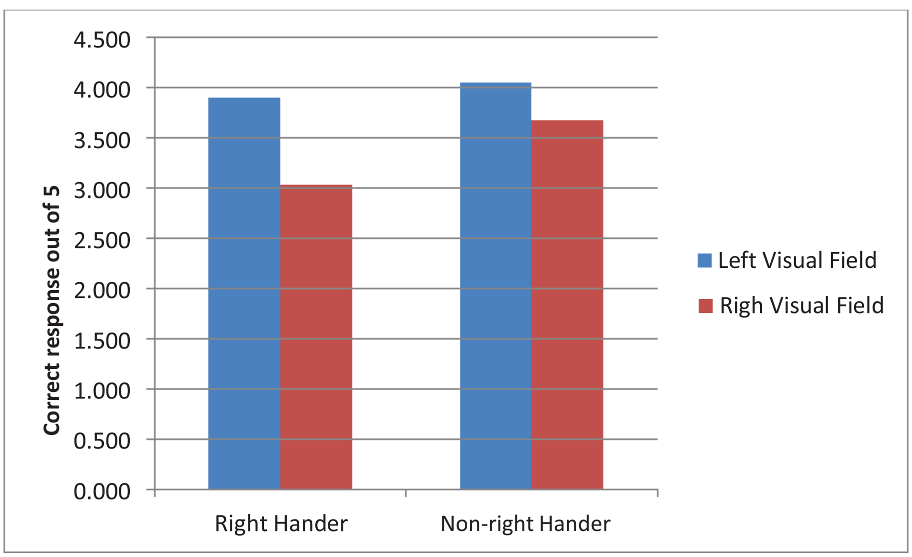


Fig 3.15 Interaction of Handedness x Visual Field with Accuracy as the Dependent Measure in Experiment-I (Image)

In fig 3.15 shows that visual field had differential effect on accuracy. Both groups of participants had higher accuracy in left visual field for image stimuli as compared to right visual field. This figure also demonstrated that both groups differed in their accuracy across the visual fields.

Above results indicate that, although most of the results were not significant but the pattern was like in incongruent conditions subjects had low accuracy as compared to congruent condition. In between group non-right hander had competitively better accuracy in recognition of image stimuli in all three types of experiments. In the way of recognizing image stimuli both groups were shown left visual field superiority.

3.8 Accuracy for Word Stimuli in Parallel Visual Field

3.8.1Processing Emotional Words

Accuracy was also observed with reaction time to see the effect of Handedness, Visual field, and Congruency in visual perception of three different kinds of stimuli like Emotional, Geometrical and Color word in Stroop like experiments. The frequency of correct recognition responses was analysed by using 2 x 2 x 2 (Handedness: right, non-right x Congruency: congruent, incongruent x Visual Field: left visual field, right visual field) mixed model ANOVA with repeated measures on last two factors (see table 3.19). The descriptive statistics of accuracy of word stimuli are presented in table 3.36, 3.37 and 3.38

Table 3.36 Means and SDs of accuracy (out of 5 responses) for emotional faces by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.97	4.08	4.10	4.26
	SD	.89	.95	.77	.93
Non right	M	4.21	4.11	4.26	4.42
	SD	.90	.91	.93	. .82

3.8.2 Processing Geometrical Words

Table 3.37 *Means and SDs of accuracy (out of 5 responses) for geometrical shapes by handedness, congruence and presentation field under parallel visual field condition.*

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.16	4.15	4.10	4.18
	SD	.97	.85	.77	.92
Non right	M	4.36	4.43	4.18	4.47
	SD	.78	.69	.82	. .73

3.8.3 Processing Color Words

Table 3.38Means and SDs of accuracy (out of 5 responses) for color patches by handedness, congruence and presentation field under parallel visual field condition.

Handedness		Congruent		Incongruent	
		Right visual field	Left visual field	Right visual field	Left visual field
Right	M	4.11	4.17	4.26	4.97
	SD	.79	.83	.89	.94
Non right	M	4.18	4.23	4.28	4.21
	SD	.89	.76	.84	. .66

The main effect of Handedness was found significant in first two experiments but not in third experiment on the accuracy of recognition of word stimuli. The difference in mean scores of accuracies in experiment-I was very little as non-right hander (M=4.25, SD=.81) had slightly better accuracy as compared to right hander (M=4.35, SD=.91) and it was found significant, *F (1,*

147) = 3.92, p<.05 same pattern was seen in the Experiment-II as the main effect of Handedness, *F (1, 147) = 8.510, p<.01,* on the accuracy of recognition of word stimuli was significant as non-right hander had better accuracy (M=4.36, SD=.76) than the right hander (M=4.14, SD=.87) but not in third experiment (see table 3.39). The main effect of congruency, *F (1, 147) = 5.38, p<.05*was significant in Experiment-I as mean scores of accuracies of word stimuli in congruent condition (M=4.34, SD= .91) was greater that the incongruent condition (M=4.26, SD=.87). In the Experiment-II and III main effect of congruency and visual field were not significant.

Table 3.39 Summaries of ANOVAs separately performed on score of accuracy for Emotional, Geometrical and Color Stroop-like task (Words):

		Accuracy					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Variables	df	MS	F	MS	F	MS	F
Handedness (A)	1	3.218	3.922*	7.946	8.510**	1.501	1.806
Congruency (B)	1	3.887	5.385*	.010	.013	.013	.019
Visual Field (C)	1	1.027	1.264	2.314	3.494	.597	.849
AxB	1	.021	.029	.795	1.070	.174	.265
AxC	1	.436	.537	.468	.707	.356	.506
BxC	1	.895	1.046	.156	.323	2.011	3.291
AxBxC	1	.412	..481	.861	1.782	.507	.830
Within	147	.856		.483		.611	

*p<0.05, **p<0.01

Table 3.40 Summary of mean and standard deviation separately performed for main effect on accuracy for Emotional, Geometrical and Color Stroop-like task (Words):

		Accuracy (frequency out of 5)					
		Emotional Stroop-like task		Geometrical Stroop-like task		Color Stroop-like task	
Handedness		RH	NRH	RH	NRH	RH	NRH
	M	4.35	4.25	4.14	4.36	4.37	4.22
	SD	0.88	0.91	0.87	0.76	0.86	0.83
Congruency		Cong	Incong	Cong	Incong	Cong	Incong
	M	4.34	4.26	4.27	4.23	4.17	4.43
	SD	0.91	0.87	0.82	0.83	0.81	0.89
Visual Field		RVF	LVF	RVF	LVF	RVF	LVF
	M	4.38	4.21	4.2	4.30	4.20	4.39
	SD	0.87	0.93	0.83	0.82	0.85	0.84

Interaction effect were also analysed with all possible association to see the effect of congruency, visual field and handedness on accuracy of recognition of word stimuli in all three experiments but no one interaction was found statistically significant in all three experiments (see table 3.39). Although to see these interaction effects two diagrams presented in figure 3.16 and 3.17.

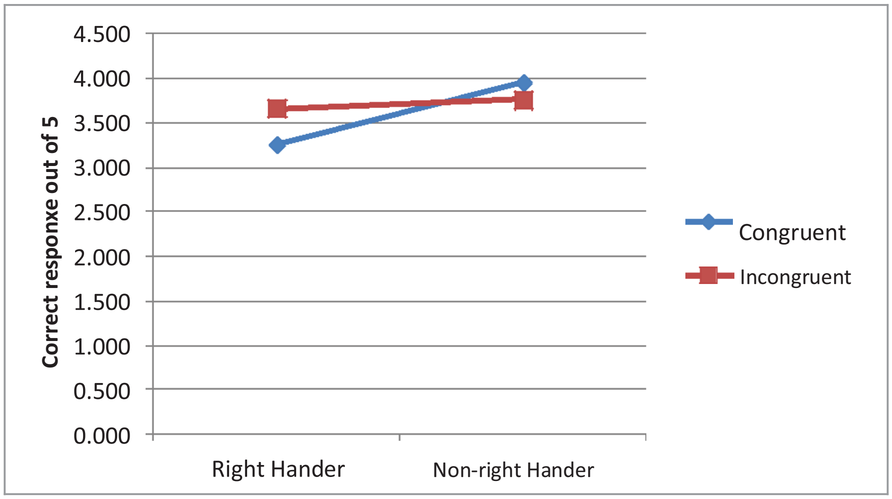


Fig 3.16 Interaction of Congruency x Handedness with Accuracy as the Dependent Measure in Experiment-II (word)

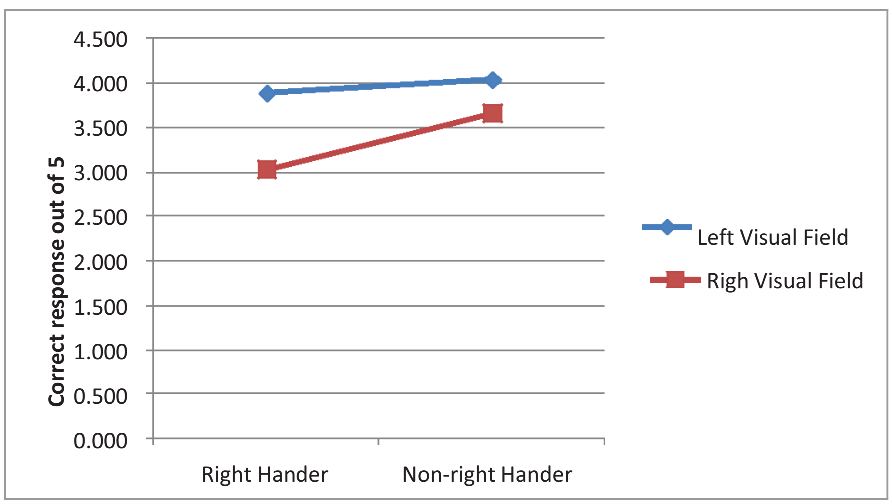


Fig 3.17 Interaction of Handedness x Visual field with Accuracy as the Dependent Measure in Experiment-II (words)

Above figures 3.16 and 3.17 show that the interaction of congruency and visual field with handedness respectively for accuracy of recognition of word stimuli in Experiment-II. The figure 3.16 indicates that, there are no differences in accuracy for word stimuli in congruent and incongruent condition for both groups of participants and figure 3.17 also demonstrates accuracy in left visual field and right visual field but consistence results were shown by both of the groups in both visual fields. So, these diagrams could not make any assumptions about effect of visual field and congruency in accuracy for word stimuli in parallel visual field.

At the end of the result chapter it can be précised that the Stroop-like tasks are the way through which we can understand various mechanism of perception and the thing that affects visual perceptions. Apart from different types of stimuli, congruence conditions as well as different visual fields affect our perception and recognitions of different tasks. Results were also demonstrated the effect of handedness on processing of information to recognize and retrieve something quickly and accurately. In this study it can be seen that Handedness or hemispheric dominance had a good impact on recognition of verbal and nonverbal tasks. So, the result demonstrates Stroop interference in both groups as right hander had comparatively more interference than the non-right hander group.

Chapter-4

Discussion:

This study had three major objectives; First, to investigate the effect of handedness on performance on Stroop like task; Second, to examine lateralization pattern; Third, to test incongruence effect among right and non-right-handed individuals. For this purpose, three Stroop like experiments were designed with the help of three different kinds of paired stimuli namely emotional faces and emotional words, geometrical shapes and geometrical words and color patches and color words. These experiments were conducted with right and non-right handed individuals. The data were collected in the form of reaction time and accuracy of recognition. The results have been presented in the previous chapter. This chapter discusses the findings. The discussion is organized in terms of visual presentation like split visual field and parallel visual field presentation as discuss below.

4.1 Split visual field presentation

In split visual field condition one pattern is seen in one visual field and the other pattern is seen in the other visual field. The findings across three kinds of tasks consistently revealed that, the non-right hander participants had faster reaction time for recognizing verbal and nonverbal stimuli than their right hander counterparts in terms of accuracy, the findings followed the trend noted in the case of reaction time measure; In the first experiment the non-right handers displayed greater accuracy than the right handers. However, in the second and third experiment there was no difference. In case of accuracy the non-right handers performed at higher level than the right handers. These findings clearly demonstrated that non-right handers were faster as well more accurate in perceiving and recognizing stimuli in the split visual field setting.

Franzon and Hugdahl (1986) had reported longer reaction time in incongruent condition for naming color stimuli when color word was presented in incongruent combinations.

Stroop like experiments follow an operational view of congruence (Silvers, 2003). In this study stimuli were presented in congruent and incongruent conditions to. Right handers and non-right handers both are affected by incongruence while recognizing pairs of stimuli in all three experiments. It indicates that incongruence is one of the factors that affect visual perception. It was found that non-right handers showed low interference in the incongruent condition as compare to right handers and their accuracy was also relatively greater in the incongruent condition.

The findings of current study that non-right-handed individuals perform better as compared to right handed individuals in terms of their reaction time and accuracy for both types of stimuli (word and images) as well as in incongruent conditions. This trend is supported with the past studies by Benbow (1986), Beratis et al. (2010) and Jorgenson et al. (1980) showed findings indicating opposite patterns. Benbow (1986) noted that left and mixed handers were influenced by testosterone during the period of fetal development that exhibits in terms of their bihemispheric representation of cognitive functions. In other studies, handedness is associated with cognitive function alteration, that leads to low interference in Stroop like task among left handers than the right-handed individuals (Beratis et al.;2010). Jorgenson et al. (1980) found shorter latencies under incongruent condition for color stimuli among left handed individuals. These research findings explain that due to bilateral dominance in cognitive task left handed individuals showed low level of interference under incongruent condition especially in Stroop like experiment. Simon et al. (1985) reported that opposite pattern in their study that the right handers were faster than the left handers in responding to both word naming and ink color in Stroop task.

In split visual presentation condition, the results also showed the effect of visual field on the perception of word and image stimuli in all three experiments. The findings of current research show shorter reaction time in right visual field (LH) for word stimuli and less time in left visual field (RH) for image stimuli among. right and non-right handers.

Above results illustrate the role of hemispheric dominance on performance on the perceptual task involved in perceiving linguistic materials, images or shapes. Right hemispheric dominance has been reported by Francoand Sperry (1977) of the recognition of stimuli as geometrical shapes. So, the dominance of right hemisphere for shapes was seen in the current study. If we talk about emotional faces as stimuli, it does not look like shapes but as per conceptualization of images of faces defined by the combinations of different shapes like circle, oval, sphere, rectangle etc. Everything in the environment is made up by different shapes. It’s our habit to perceive stimuli with the combination of different kinds of shapes. So, the right hemisphere advantage can also be seen in face recognition (Comalli, Waphner& Werner, 1962, Dutta and Mandal, 2002). Some studies also talk about lateralized visual face biases such that information of the left half-face is favoured over the information of the right half-face (Dutta & Mandal, 2001).

In the present study participants took more time in perceiving shapes in left visual filed (RH) when stimuli were presented under incongruent condition as compared to congruent condition. So, the hemispheric dominance operates under incongruent condition. Gier et al. (2010) had shown that when shape stimuli presented in incongruent condition with words the reaction time were slower than the congruent condition in the same visual field.

Gazzaniga, Ivryand Mangun (1998) as well as Sousa (1995) had reported that only few split-brain patients demonstrated language ability or perception of linguistic stimuli in the left visual field (right hemisphere). So, these findings also support the hypothesis related with left hemisphere dominance for verbal materials or performance on verbal tasks. In the present study also, it was noticed that under congruent condition both of the subject groups showed greater recognition of verbal stimuli when they were presented in the right visual field (LH). Interference by incongruence was also observed in this study as participants took more time under incongruent condition as compared to the congruent condition in the same visual field.

Handedness has been documented as one of the key factors in visual perception in several studies. In the current study interaction of visual field with handedness was also observed. The right handers and non-right handers had faster recognition for image stimuli in left visual field in all three experiments. The right handers were faster than the left handers in left visual field (RH) for image stimuli.The same pattern was seen with word stimuli under congruent condition too. Under incongruent condition right handers were slower than the non-right handers for verbal stimuli in the right visual field as well as in left visual field for image stimuli. Almost same pattern was evident n with all three types of stimuli in all the three experiments.

However, the present results showing greater left hemisphere dominance among right handers as compared to non-right handers. It may be worthwhile to note that unilateral dominance has been reported in various split-brain researches with right handed individuals. However, the non-right handers (including left and mixed handers) generally show bilateral dominance especially on verbal tasks. This difference has also been noticed in performance between male and female participants. Female shows greater bilateral dominance on verbal tasks as compared with their male counterparts. Hand preference is a marker of higher level of cognitive processing pertaining to visual, verbal and visuospatial tasks. It was documented that for performance on a given task depended upon unilateral or bilateral dominance of hemisphere in an individual and such hemispheric dominance can vary in people differing in handedness. Indeed, handedness is one of the key markers of laterality pattern in an individual (Levy & Reid, 1978).

Performance differences on visual and verbal tasks among the people with diverse hand preferences have also different neuropsychological explanations. Some researchers relate to structural differences noticed in terms of corpus callosum as well as in some other brain mechanism. These structural differences found in differently handed persons are also observed in male and female participants. Gender differences have been also pointed out in term of cognitive ability among male and female by huge number of researches (Jain and Singh, 2008). Apart from structural differences role of steroid hormones cannot be ignored (Innocenti, 1994McEwen, Gould, Orchinik, Weiland, & Wooley, 1995).

Halpern, Haviland & Killian(1998) found that the dominance of one hemisphere especially right hemisphere in left handed persons give them advantage to perform better on cognitive as well as verbal tasks. These individuals also appear more intellectual or god gifted. Gordon and Kravetz (1991) have analysed the relationship between handedness and cognitive ability in context of gender. The left-handed females performed better on visual spatial task while left handed males performed better on verbal sequential tasks. Gender and handedness both have moderating impact on cognitive task performance (Harshman et al., 1983).

The present findings related to split visual field presentation in terms of reaction time showed that, non-right handers were faster than right handers in recognizing images in the first experiment but very small differences were seen in second and third experiments. Non right handers consistently took lesser time in responding to word stimuli than their right hander counter parts in all the three experiments. Uniformity in results were seen all three experiments with few exceptions.

4.2 Parallel visual field presentation

The second part of experiment involved stimulus presentation in both the visual fields with pair of stimuli shown in the left and right visual fields simultaneously and reaction time and accuracy were recorded.

Results of the present study clearly showed incongruence generated interference in both of the groups. Right handed and non-right-handed individuals had difficulty in recognizing visual stimuli under parallel visual field presentation. The participants from both the groups took more time to recognize stimuli under incongruent condition as compared to congruent condition. The non-right handers took relatively lesser time to perceive the stimuli and the accuracy was also relatively greater than the right handed individuals. In congruent condition the participants performed better in terms of reaction time and accuracy for verbal stimuli when they were presented in right visual filed (LH) compare to condition when verbal material was presented in the left visual field (RH). In incongruent condition the pattern of findings was same but they took comparatively more time to respond and accuracy rate was also low. When shapes and figures were presented in the left visual field (RH) the recognition of stimuli was faster as compared to the condition when nonverbal materials were shown in right visual field (LH).

The present findings lend support to the view that under incongruent condition, the processing for visual stimuli takes longer duration than the congruent condition. The findings of the current research also indicate hemispheric lateralization for specific tasks. Thus, right hemisphere seems to be lateralized for visual stimuli or for perception of shapes and figures and left hemisphere as localized for verbal tasks (Greger & Windhorst, 1996). Thus, congruency effect was more in expression when the stimuli were not in tune with hemispheric specialization.

In Stroop like experiment researchers suggested that the left hemisphere generally shows Stroop interference to greater extent as compared with right hemisphere and it projects in terms of slow reaction time and accuracy in color naming (Coney, Collins-Abemethy, 1994; MacLeod, 1991). Same patterns were observed in this study when stimuli were presented in the parallel visual field. This implies left hemisphere dominance for recognition of verbal stimuli. This dominance of function seems to be correlated with hand preference among the participants. Dominance of function generally interferes and makes the recognition of the stimuli by avoidance of the incongruent stimuli.

Stroop interference has been explained by several researchers in terms of hemispheric dominance. One of the relevant explanations draws upon cell functioning. According to Goldstein (1999) two different types of cells present in human brain react differently to shape and figure stimuli. These two cells are known as primary cell and elaborative cell. Goldstein says that primary cell responds to basic shapes and elaborative cell responds to specific shapes. Specific shapes are the combinations of different basic shapes. So, our habit does not allow to ignore shape while recognizing word. It is similar to the fact that a literate person cannot ignore ‘word’ while visualizing a ‘shape’. In Stroop like task as used in the current research we present two stimuli at the same time in two visual fields as both cells get activated. That creates confusion and interferes with the process of recognizing stimuli fastly and accurately.

Some studies suggest that, when we see two different stimuli in two visual fields then the speed of perceptual processing becomes fast because of simultaneous division of task in two hemispheres. When stimuli have more than one element like face image or shape and its name in word, both elements get processed automatically (Posner & Snyder, 1975). Thus, perception gets affected when stimuli present in incongruent condition.

Handedness is one the factors that has an impact on visual perception because of its association with differential brain organization and corresponding differences in the functioning. Right handed and non-right handed individuals participated in this study and their performance was measured with the help of Stroop like tasks. In the present study between group differences were observed in terms reaction time and accuracy. It was found that non-right handed individuals are consistent in their performance in parallel visual field presentation also. In most of the experimental conditions non-right-handed individuals took lesser time to recognize stimuli under incongruent condition as compared to their right-handed counterparts. The current study also explored through the interaction effect between handedness and congruence. It was noticed that non-right handers have a low level of influence on word and image recognition under incongruent conditions. Interaction of handedness and visual field was also analysed for both types of stimuli i.e. verbal and nonverbal. The interaction of visual field and congruence did influence the recognition of nonverbal stimuli. Both the groups displayed good recognition for nonverbal task in the left visual field as compared to right visual field presentation. It may be noted that right hemisphere advantage has been documented by Barnett (2008), Beratis et al.(2010) and other previous studies for nonverbal task. In the present study stimuli were taken in the form of emotional faces instead of colours as we generally use in traditional Stroop task. The present findings support left hemisphere advantage for verbal task as we can see in previous studies (see Goldenberg & Arnet1991).

An interesting observation was that, right handers performed better when the verbal stimuli were shown in the right visual field and nonverbal stimuli were presented in left visual field. A different pattern was noticed for the non-right handers. In one of the studies it was documented that left-handed individuals displayed left side superiority and right handers right side superiority on motor task performance because of their dominant hands (Peters, 1994). Hand preferences involve hand dominance which is regulated by opposite hemisphere. So, hand dominance can also be related to hemispheric dominance. Thus, the right handers' dominant hemisphere would be left hemisphere and for left handers it could be right hemisphere. Differences in the allocation of attention resource have also been noticed among right handers and left handers when the task needed bimanual synchronization (Amazeen, Treffner, & Turvey, 1997; Amazeen, Ringenbach, &Amazeen, 2005,Peters& Servos, 1989). This type of bias has also been noticed in which individuals responded at a faster rate to the visual stimuli when it is presented in the same visual field according to their hand dominance (Pierce, Harris, & Henderson, 1996). These effects were also observed in greater degree when stimuli presented in the left visual field for left handed individuals and in right visual field for right handed individuals (Rubichi & Nicoletti, 2006; Simon & Rudell, 1967).

Hemispheric differences in individuals during the performance on Stroop like task were also observed. The patterns of hemispheric differences were evaluated through presentation of stimuli in the two different visual fields i.e. right visual field and left visual field. One common observation has been that right handers had left hemisphere dominance and non-right handers had right hemisphere dominance. As conceptualized in past research the right hemisphere works in an integrative fashion. Also, the right hemisphere is also able to perceive stimulus as a whole not in parts so it is known as a holistic way of organization (Levy-Agresti & Sperry, 1968; Spinnler, 1969). In other words, right hemisphere does not work on fragmentation of images but as a whole (Lansdell, 1961). The current research indicates that, right hemisphere dominance occurs in the non-right-handed individuals so the level of interference on Stroop like task was less salient among right handed participants.

In Stroop like experiment it can be easily observed that who is facing difficulty when stimulus is presented under incongruent conditions. If a participant is capable to handle incongruence effect on visual task it suggests that the brain is working differently. In other words, information processing within and between hemispheres can be reflected in terms of individual's performance on certain tasks. These measures are indirect measures to appreciate hemispheric organization and their way of processing. Hemispheric processing has also been documented in terms of serial and parallel processing. The right hemisphere is generally recognized as a parallel processor and the left hemisphere as a serial processor (Cohen, 1973). Some contradictory observation has also been noted that indicates that the right hemisphere works as serial processor for face perception and for melodies (Milner, 1962, Rizzolati, Umilta, &Berlucchi, 1971).

In the present study recognition accuracy was also computed and analyzed. It was observed that when stimuli were presented in language dominated area for the right handers the right visual field (LH) accuracy decreased under incongruent conditions. One explanation for these findings comes from the work of Dyer and Harker (1973). They noted that under incongruent condition when pair of stimuli in the form of word-color presented in language dominant hemisphere, semantic meaning of the word get in the way with the perception of color. Because of dominance of language in this hemisphere individual cannot ignore the verbal content of stimulus. One interesting findings has been noted in this study that non-right handers did not show strong influence of hemispheric dominance. It may be on account of bilateral dominance that does facilitate perception of visual stimuli under incongruent condition.

The findings of current research should also be examined in terms of methodology used which has important implications for the observed findings. This issue has been discussed by Hugdahl and Franzon (1985). Thus, when pair of stimuli like color-word are presented in a display this may have differences in the distance of stimulus from fovea in each visual field. Another argument in this regard is that when stimuli are presented horizontally, there could be an advantage for subject to recognize the stimulus. So, the mode of presentation is a methodological concern when a researcher compares reaction time and accuracy (Barton, Goodglass and Shai, 1965). In his study, stimuli were presented in equal distance from center of screen as well as it was projected in 15.6 inch diagonally on a screen display that makes experiment error free especially in terms of display advantage.

Findings of split brain research give us proper insight that, why reaction time is faster in the left visual field (RH) among split-brain patient in Stroop like task? In research conducted on split brain patient Levy and Levy (1978) observed that right hemisphere works holistically whereas the left hemisphere considered as analytical. This observation has been done on the basis of reaction time measure during visual task performance. Further it was noted by some researchers that, the reaction time was faster when the pair of stimuli (color-word) presented to the right hemisphere. As right hemisphere works on holistic principles so it takes less time to recognize two stimuli at the same time. Similar result is documented by Manelis and Grebennikova (1985), that slower reaction time when color word and color patch stimuli were simultaneously presented in right visual field (LH) as compared to left visual field (RH). So parallel processing can be observed as part of right hemisphere functioning.

As compare to split visual field presentation, in parallel visual field presentation participants took slightly extra time to perform on the Stroop task. Huge number of studies have suggested that in "human population, the left hemisphere is superior to the right hemisphere for language functions, whereas the right hemisphere is superior to the left hemisphere for visuo-spatial functions". However, a small percentage of population doesn't follow the same pattern (Bishop, 1990; Levy-Agresti& Sperry, 1968; McManus & Bryden, 1991; Levy-Agresti& Sperry, 1968). This hemispheric superiority can be an advantage when stimuli were presented in split visual field. Alternatively, it could be a disadvantage when the stimuli are presented in parallel visual field. So, on the basis of this study it can be stated that when stimuli present in the dominant field and the same time other stimuli present in non-dominant field can affect the performance. In the split visual field presentation pair of stimuli were localized in a single visual field so the information processing during perception take place directly to the corresponding hemispheres without any interference and hemispheric dominance work like as facilitator (Charness& Shea, 1981; Kimura, 1966; Mandal & Singh, 1990; Strauss & Moscovitch, 1981; Tucker, 1981). So, in the present study, differences in performance in split visual field presentation and parallel visual field presentation are logical.

Before comparing the results of this study with classical Stroop task, performances it should be noted that different types of stimuli are used in the experiment of current study in which color has been replaced by emotional faces, geometrical shapes and color names replaced by geometrical shapes name and name of emotional faces. In the experiments of this stimuli were also presented not only in incongruent condition but also in two different visual fields. The results however showed almost same pattern like classical Stroop task. So here one inference we can draw that the perceptual style could not be affected by the nature of stimulus.

Chapter- 5

Epilogue:

This chapter summarizes the findings, suggests a theoretical framework, and states the implication of the findings; also, it briefly mentions the agenda for future research and describes the limitation of the study.

5.1 Summary of Findings

Functional lateralization research from the last more than 25 years has clearly demonstrated that the two hemispheres of human brain differ in their functions in which they process different kind of emotion and cognitive information (Sperry, 1974). Hemispheric processing differences are often categorized in various researches and documented that, in the form of analytical and holistic. So there is a common conclusion regarding left hemisphere function as a analytical at same time right hemisphere known as holistic processor of information (Bogen, 1996, Gazzaniga, 1970 and Ornstein, 1972). This difference can be explained functionally as dominance performance of serial operations by the left hemisphere as like processing of stimulus element one-at-a-time, before beginning the next, first completing last one, and dominance performance by right hemisphere work as a parallel processing approach in which right hemisphere process multiple stimuli, individual element can be completed at different times (Moscovitch, 1979 and Townsend, 1974).

In human being different lateralized functions can be seen in which handedness recognize as a most obvious lateralization. Among the world population around 90% are right handed persons and they do most of the task with the right hand and it control by left frontal lobe motor areas therefore researchers believe that right handedness is consequences of left hemisphere dominance. Left handedness is universal recognized phenomenon (Perelle & Ehrman, 1994) around 10-12% world population are left handers (Halpern, Haviland, & Killian, 1998; Oldfield, 1971). As handedness is directly associated with lateralization so it is a central concern where people are searching different lateralization pattern among different handed persons can have a different their cognitive and mental functioning (Anstey et al., 2004; Bu¨chel et al., 2004; Geschwind, Miller, DeCarli, &Carmelli, 2002). In this way huge number of studies focus on to make association between handedness and different visual and verbal task processing (Gordon &Kravetz, 1991; Halpern et al., 1998; Kopiez, Galley, & Lee, 2006; Porac & Searleman, 2002).

Varity of researches carried out with different findings in which one more common findings documented in different researches as in the right handed person left visual field superiority observed for verbal materials so that left hemisphere recognized for processing of verbal task more dominantly in right handed persons whereas it could be differ in non right handed persons (Springer, 1977; White, 1969, 1973; McKeever, 1974: Moscovitch, 1973). Left hemisphere dominance for verbal task has been examined in different language speakers and found that the same pattern in English and Chinese speakers (Feustel& Tsao, 1978).

It would be interesting to observe how this left hemisphere specialization for processing verbal materials and right hemisphere specialization for visual information would affect the perception of images of emotional face and emotional words responses in the Stroop like task. It would also be seen how much this specialization effect or influence on the effect of Stroop tasks among different handed persons in their hemispheric functioning.

In the present study experiment was designed with some changes on traditional Stroop task procedure. Firstly, emotion faces/emotional words, geometrical shapes/geometrical words and color patches/color names stimuli used in place of colour inks and colour name. Secondly, stimuli were presented in two different visual fields i.e. right visual field (RVF) and left visual field (LVF) and in addition reaction times and, accuracy was recorded.

The measure purpose of this study was to investigate Stroop-like incongruency effect when emotional face, geometrical shape and color patches, are presented in pair of stimuli in the form of image and word in split visual field to right-handed and non-right-handed individuals. And to investigate Stroop-like incongruency effect when emotional face, geometrical shape and color patches are presented in pair of stimuli in the form of image and word in parallel visual field to right-handed and non-right-handed individuals.

Experiment was designed on the base of Weekes and Zaidel's (1996) Stroop-like task. This study was examined with the help of self-developed JAVA based program for Stroop like task in which five different emotional faces/geometrical shape/color patches and five emotional word/geometrical words/color names used in the form of stimuli. We presented stimuli with the help of JAVA based program and recorded Reaction time and Accuracy. Stimuli were displayed on 39.62 cm diagonal screen and response recorded in milliseconds. Subject's handedness was defined with help of 10-item self-report questionnaire. In this questionnaire ten items measure hand preference (using a knife, combing hair, picking up a book, writing on paper etc.). These items have appeared in earlier studies (Coren, 1989; Mandal et.al. 2001; Porac, Coren, & Duncan, 1980; Suar at. Al., 2007).

Five different kinds in each categories of emotional faces (happy, sad, neutral, disgust and fear), geometrical shape (circle, square, triangle, rectangle and pentagon) and color (red, green, blue, black and brown) patches and their names were used as stimuli. All stimuli were displayed in proper size so that subject can easily perceive it. There was a fixation point presented in the centre of screen prior to every stimulus and it was in the form of circle with the radius of 1 cm. Stimuli presented in two different visual field i.e. Right visual field (RVF) and Left visual field (LVF) in two different conditions i.e. split visual field and parallel visual field, were shown 10 cm from fixation point.

After taking consents from subjects, self-report 10-items questionnaire were administered to determined handedness level. After defining their handedness level subject's eye sight were verified by performing some visual task by using one eye and both. We allowed participant to use their spectacles if needed. All procedure of experiment was explained to participants and answered their doubts. Five trials had given to every subject in the beginning of the experiment.

These were the instruction given to subject: In all three experiments pair of stimuli (one image and one word) will be display in two different visual fields i.e. in left visual field and/or in right visual field followed by a fixation point for 2000msec. Stimuli will be present on screen only for 180msec preceded by four alternative response separately for each image and word. You have to respond one out of four alternatives for each stimulus (shapes and word) with the help of keyboard on the basis of your perception as soon as possible with accuracy. You can stop only after the END screen appears on your monitor. It will take five to ten minutes for completion.

Experiments were run in noise free environment and subject sited in the level of monitor and two fit far from display. Subject responded to all 120 trials (40 trials each in three experiments) with help of key board by using key A,S, D and W for word and 1,2,3, and 4 for image. Reaction times (in milliseconds) of all one hundred twenty trials were recorded with accuracy by the program in MS-excell and further data were used for analysis.

The sample of this study consisted of 149 participants in which 80 predominantly Right handed and 69 non-right handed. Subjects were voluntary participated in this study; predominantly left and mixed handed participant were included in non-right handed subjects. All participants were undergraduate and post graduate students from different streams between 17-25 years of the age had a basic knowledge of computer operating and their eye sight was also normal. Subjects were comfortable with English language and they knew all English words and their meanings of stimuli. Two hypotheses are proposed and two research questions are raised. These are given below with the corresponding results.

Table 5.1Hypotheses, Research Questions and Findings

Hypothesis/ Research Questions	Research Findings
H1: On Stroop like task the right- handers would show greater degree of right visual field dominance for verbal stimuli and left visual field dominance for image stimuli as compared to non right handers. This would lead to more accurate recognition and faster response for verbal stimuli and image stimuli, respectively.	The right handers were faster displaying high accuracy for word stimuli when stimuli presented in right visual field than the non-right handers in the all three Experiments. For image stimuli the right handers showed better performance when stimuli were presented in left visual field than the non-right handers in all three Experiments. These findings were strong under split visual field presentations than parallel visual field presentation. Surprisingly all these findings were quite consistent in the three experiments involving emotional, geometrical and color stimuli.
H2: On Stroop like task the right- handers would appear to be more susceptible to incongruence effect under split as well as parallel visual fields than their non right hander counterparts. This would lead to poor recognition and slow response in split as well as parallel visual fields.	In both visual field presentations i.e. split visual field and parallel visual field, non-right handers were faster in reaction and greater accuracy compared to right handers. So, the results demonstrated that, non-right handers had less incongruence effect in both types of stimuli i.e. word and images as compared to right handers in almost all the three experiments. The nature of stimuli was different in all three experiments but the incongruence effect was reported consistently as right handers had high incongruence effect during the recognition of different stimuli under both kinds of visual presentations.

Hypothesis/ Research Questions	Research Findings
RQ1: What are the differences in pattern of hemispheric lateralization among differently handed people?	The right handers showed more left hemisphere lateralization for word stimuli as compared to non-right handers even when the stimuli were different in nature. For image stimuli it was found that right handers were comparatively more lateralized in favour of the right hemisphere compared to non-right handers in both types of visual presentations i.e. split and parallel visual field presentations
RQ2: What is the nature of relationship between cognitive interference and stimulus congruence in the people with varying hand preferences? Which kind of hand preference (right/non-right handed) would be associated with greater tolerance for interference?	In all three experiments where three different types of stimuli were used, non-right handers were less affected in recognitions of stimuli in incongruent conditions as compared to right handers. Although both groups of participants took relatively more time under incongruent conditions than the congruent conditions.

The result of this study on the basis of Stroop-like experiment give us enough findings in support of hypothesis that, the ability of visual perception can be differ of a person in terms of their handedness. The findings of current study indicate that congruency effect in both of the groups. Right handed and non-right handed individuals have faced difficulties to respond stimuli in the incongruent conditions for all types of stimuli like emotional faces, geometrical shape, color patches and their names. Among these groups of participants, non-right handers were more accurate and faster in terms of reaction time than the right handers. The findings of this study related to congruency in line with the study of Simon, Paullin, Overmyer and Berbaum (1985).

They found among different handed individuals reactions to incongruent stimuli were slower than to congruent stimuli in Stroop task. But in this study stimuli were not used as classical experiment of Stroop task. So, we can say that incongruency interference can also occur across the visual field and across the different intensity of emotional driven stimuli as well not directly emotionally inclined stimuli like geometrical shapes and color patches.

This study also demonstrated that non-righthanded individuals perform better as compare to right handed individuals in terms of their reaction times for word and image stimuli in parallel visual field presentations and similar pattern of results were seen in split visual field presentations. In split visual field presentations non-right handers had overall better performance as compared to right handers. These results were showing because of unilateral or bilateral hemispheric dominance in an individual. Study suggests that right handers show high level of unilateral dominance as compare to non-right handers so that right hander can outperform in split visual field and non-right hander performed better in parallel visual field presentations. Benbow (1986, 1988), Beratis et al. (2010) and O'Boyle et al. (1995)documented that the non-right handed subjects were perceived the stimuli in a lesser amount of time as compare to right handed subjects in in the visual perception of Stroop task.

There were enough results found in the favour of right hemisphere advantage for images like emotional faces, geometrical shape and for color patches stimuli as well as left hemisphere advantage was found for word stimuli. However, Right hemisphere advantage documented by Barnett (2008), Beratis et al. (2010) and numerous of previous studies. It should be noted that, in this study stimuli were taken in the form of different images like emotional faces, geometrical shapes in place different color ink words as we generally take in traditional Stroop task and stimuli were presented in two different visual field presentations like split and parallel visual field. In addition to the findings of current research supports left hemisphere advantage for verbal task as we can see in the various previous results like Goldenberg &Arnet (1991) and others.

The study was concentred upon the different handed especially right and non-right-handed samples. The results of the current study deliver sufficient support to proposed two hypothesis, as well as it also supports different findings and theories that discussing an interaction of handedness and perception or cognitive functions. Further this study also gives different insight to understand the effect of handedness on Stroop like task as well as hemispheric dominance on perception of verbal and nonverbal materials. Apart from handedness, visual field is also a factor that effects visual perception that was also explained in this study.

5.2 Theoretical Framework

The findings that emerge from the study can be organized in a theoretical- conceptual framework. They are suggestive of the fact that the pattern of recognition of word and image stimuli varied across right and non-right handers. It also varied across the two visual fields, i.e. split visual field and parallel visual field. Non-right handers emerged as non-dominant or bilaterally dominant groups of people and these people have lower level of incongruence generated interference as compared to the right handers. With the findings of this study it can also be stated that individual ways of perceiving stimuli are quite strong and consistently influence one's perception. It appears that in Stroop like experiments the different visual field presentation methods can be helpful to decipher perceptual style and lateralization pattern.

5.3 Implication of the study

There are quite a few implications of this study. First, this study showed that the Stroop-like effects, operationally defined as differences between congruent and incongruent conditions, existed in both types of visual field presentations i.e. split and parallel visual fields. The fact that incongruence interference occurs in both visual field presentations can be of help for those persons who are working with brain-damaged patients. Second, in recruitment and selection of pilots and multitasking professionals, one can have less interference when two contradictory stimuli are presented and processed simultaneously as noted in the non-right handers than the right handers. If single task focus is required in any profession than right handers would present better options for recruiters as they will have unilateral dominance. Third, the use of these Stroop-like tasks may help determining hemispheric dominance. Moreover, by practicing with the uses of different stimuli in Stroop-like task an individual can also develop a new way of cognizing and perceiving that may help minimizing incongruence related interferences in real life contexts.

5.4 Agenda for future research

Every research raises additional questions for further investigations. In this study word and image stimuli, reaction time and accuracy were analysed separately. So, better understanding of interference of incongruence effect may be obtained by examining the interaction of word and image stimuli. This study focused upon right and non-right handers. However, for a comprehensive or better understanding in non-right handers group, left and mixed hander groups may be analysed. This study is undertaken in normal ecological settings and, therefore its findings cannot be generalized to other settings. Sometimes ecological settings may require to perform certain task without interference. So ecological factors can be taken as variables in future research.

5.5 Limitations

There are certain limitations of the study which must be acknowledged. A gender-based study may help to find out the role of gender in cognitive interference in Stroop-like experiments. Second, socio-cultural and genetic factors do contribute to perception and cognition but the present study could not segregate the contribution of socio-cultural and genetic factors. Further research may take up such variables as a part of research design.

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APPENDIX

Handedness measure

Personal Information **SL.No………**

Name:......................................Age:...........................Sex:..............................

Education:..............................Contact:..

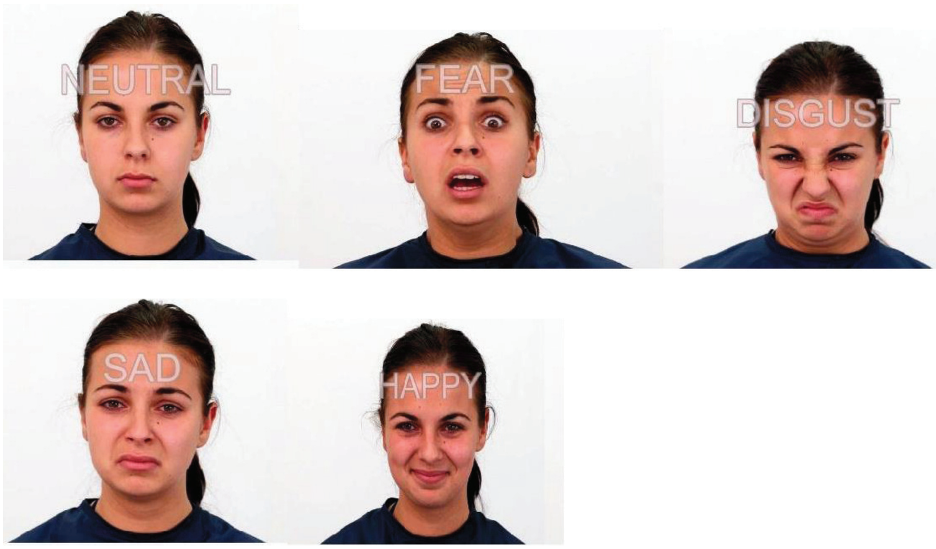
- Which hand do you use to do the activities listed on the following question?

1. AL (Always Left): Almost always use the LEFT hand.
2. UL (Usually Left): Usually use the LEFT hand
3. EQ (Equally): Use both hands
4. UR (Usually Right): Usually use the RIGHT hand
5. AR (Always Right): Almost always use the RIGHT hand.

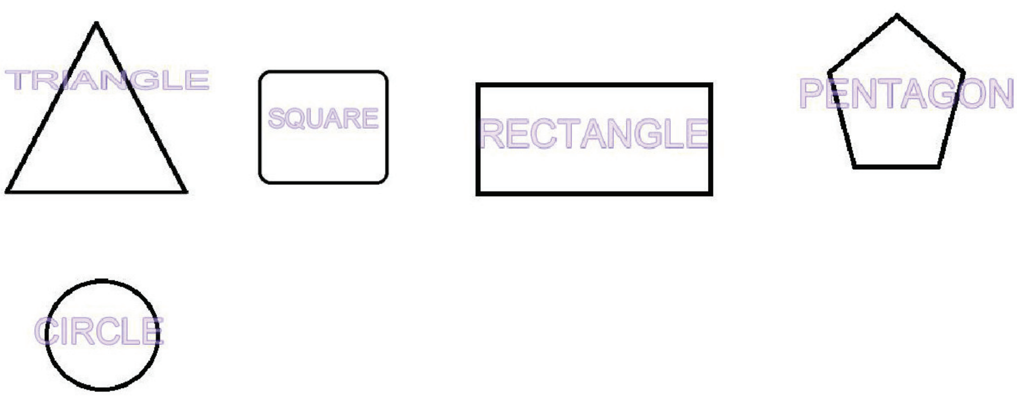
	Which hand do you apply........ ?	1	2	3	4	5
1	Using a knife?	AL	UL	EQ	UR	AR
2	Combing hair?	AL	UL	EQ	UR	AR
3	Picking up a book?	AL	UL	EQ	UR	AR
4	Picking up a heavy suitcase?	AL	UL	EQ	UR	AR
5	Brushing teeth?	AL	UL	EQ	UR	AR
6	Throwing a ball to hit a target?	AL	UL	EQ	UR	AR
7	Unscrewing a jar lid (which hand unscrews a jar lid?)	AL	UL	EQ	UR	AR
8	Using an eraser on paper?	AL	UL	EQ	UR	AR
9	Hammering on a nail? (Which hand holds hammer)	AL	UL	EQ	UR	AR
10	Writing on paper?	AL	UL	EQ	UR	AR

Total Scores.. Handedness Type..

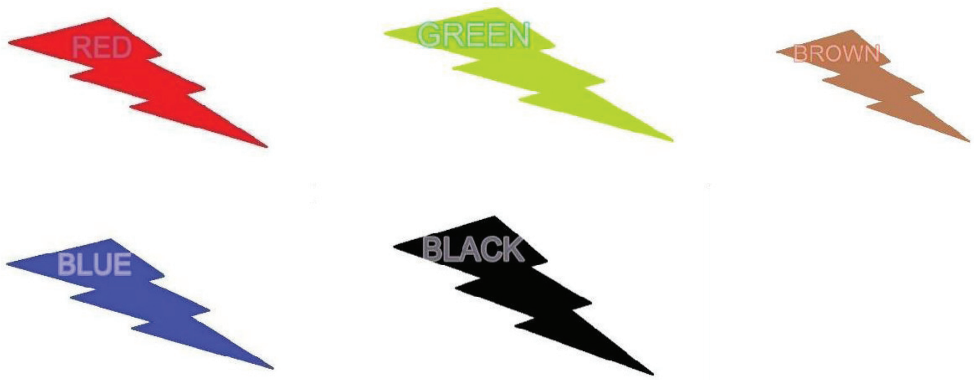
Congruent Stimuli of Emotional faces and Emotional Words



Congruent Stimuli of Geometrical shapes and Geometrical words

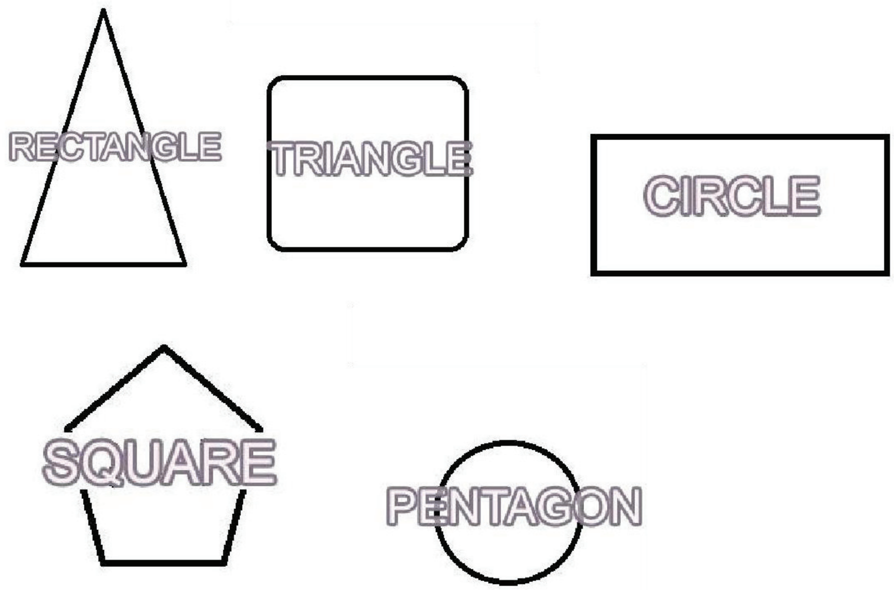


Congruent Stimuli of Emotional faces and Emotional Words



Incongruent Stimuli of Emotional faces and Emotional Words

Incongruent Stimuli of Geometrical shapes and Geometrical words



Inongruent Stimuli of Emotional faces and Emotional Words