CHAPTER I
INTRODUCTION

Adolescence (lat *adolescere* = (to) grow) is a transitional stage of physical and mental human development that occurs between childhood and adulthood. This transition involves biological (i.e. pubertal), social, and psychological changes, though the biological or physiological ones are the easiest to measure objectively.

Childhood and adolescence are crucial periods of life, since dramatic physiological, psychological and cognitive changes take place at these ages. The cognitive changes along with perceptual development may effect their motor coordinative abilities as well specially in tribal adolescents, who belongs to altogether different socio cultural environment.

Reaching for a pen, grasping a doorknob, driving, roller skating walking—etc. which are examples of few physical actions—all involve well-coordinated movements made with well-balanced postures. In fact, whenever we move the three basic functions of movement, balance, and coordination work in concert to produce graceful, purposeful motions of body parts. This is actually quite a feat, because moving is a complex process.

Scientist in the recent past through their research provided valuable information regarding the role of perceptual and cognitive abilities in motor coordination but much research needs to be done to ascertain the impact of perceptual and reasoning ability on motor coordinative abilities of young adolescent and specially tribal adolescents.
because the environment they live in should be a fine ground for learning new motor and well as perceptual skills. Whether this perceptual and reasoning ability influence their motor coordinative abilities, is the point of contention in the present study.

Keeping these facts in mind, the researcher decided to assess motor coordinative ability of tribal adolescents in the light of their perceptual and reasoning abilities.

In the following pages a brief description of theories and principles related with selected variables for the study are presented.

1.1 MOTOR COORDINATIVE ABILITIES:

The term motor is derived from the relationship of a nerve or nerve fibre to the one that connects the central nervous system with muscles through their convections the movement results. Effective motor movement can only results if there is harmonious working of the muscular and the nervous system. It helps in keeping a greater distance between fatigue and peak performance. The activities that involve hanging, jumping, dodging, leaping, kicking, bending, throwing enables a person to perform his daily work much effectively without reaching a point of wearing out, so quickly.

Humans possess the capacity to produce a seemingly endless variety of skills that are inextricably woven into the fabric of our lives. Numerous skills enable us to complete the daily tasks involved with work and school, as well as to participate in many physical activities, all of which offer different and unique challenges. The skills human possess are by no means static elements of their lives; they are continually being
enhanced, revised, and adapted through experiences. The ability to learn new skills allows them to improve the way they live in striking ways.

**Motor coordination** is the coordinated functioning of muscles or groups of muscles in the execution of a complex task (Vocabulary Definitions: Coordination. Ideas4us.com)

**Coordination** itself, however, is a global system made up of several synergistic elements and not necessarily a singularly defined ability (Grasso, B., 2008).

**Coordination** is, in essence, the ability to integrate all the components of fitness so that effective movements are achieved (MacBrian, 2008).

Rhythm, spatial orientation and the ability to react to both auditory and visual stimulus have also been identified as elements of coordination (Grasso, B., 2008).

Coordination is the quality, which enables the person to integrate all the powers, and capacities he has into the effective doing of an act. It is the ability to move and organize oneself around his/her own physical body. Coordinative abilities differ from technical skills in that they exist as prerequisites for subsequent motor actions.

Seven coordinative abilities can be differentiated by their characteristics, and while all seven are fundamental as a whole they may appear in quite different values in each person.
These abilities are:

**Combinatory Ability** – The ability to coordinate parts of body movements and single movements with one another in relation to a total movement of the body towards a given action.

**Orientation** – Knowing where we are at any given moment. It is the ability to analyze and change the position and movement of the body in space and at the same time relate to the area in which the action is taking place.

**Differential Ability** – The ability to achieve a high degree of accuracy and fine adjustment of separate body movements and mechanical phases of a total body movement.

**Agility** is the ability to exercise a fine coordination of the movements of various parts of the body as well as the ability to relax the muscles which produces a conscious tuning of the muscle tone.

**Balance** – The ability to maintain the whole body in dynamic equilibrium.

**Reactive Ability** (Good Reactions) – The ability to initiate quickly and to perform rapid and well-directed actions following a signal.

**Adaptive Ability** – The ability to modify a sequence of actions to new conditions, or observing anticipated changes in the situation, or to continue the sequence in another way.

**Rhythmic Sense** – The ability to observe the characteristic uniform recurrence of a beat within measured movement.
**Balance** - Balance is the quality of achieving an inner relationship between all the points of your body. It is an active state, constantly going on and continually shifting. Thus the balance you seek is dynamic balance, or balance in motion, nor in stillness (stances). Sometimes it is even possible to use a momentary loss of balance to facilitate faster movement.

Motor coordination can be broken into two components: gross motor coordination and fine motor coordination. Gross motor coordination refers to gross motor skills, such as walking, running, climbing, jumping, etc. Fine motor coordination refers to fine motor skills, such as drawing, writing, typing, etc. (Motor coordination, wikipedia).

Motor coordination is the combination of body movements created with the kinematics (such as spatial direction) and kinetic (force) parameters that result in intended actions. Such movements usually smoothly and efficiently work together. Motor coordination can occur between subsequent parts of the same movement and movements of several limbs. Motor coordination involves the integration of processes ranging from how muscles interact with the skeletal system to neural processes controlling them both in the spine and the brain.
1.2 PROPERTIES OF MOTOR COORDINATION

(i) Non exact reproduction

Examples of motor coordination are the ease with which people can stand up, pour water into a glass, walk, and reach for a pen with ease are some motor coordinative activity. These are created reliably, proficiently and repeatedly, but these movements rarely are reproduced exactly in their motor details, such as joint angles when pointing or standing up from sitting (Domkin, et al., 2000).

(ii) Combination

The complexity of motor coordination can be observed by the task of picking up a bottle of water and pouring it in a glass. This apparently simple task is actually a combination of complex tasks that are processed at different levels (Scholz, et al., 1999).

The levels of processing include:

(a) For the movement of a given object, the reach and hand configuration have to be coordinated,

(b) When lifting the cup or an object, the load and the grip force applied by the fingers need to be coordinated, and

(c) When pouring the fruit juice from the bottle to the glass, the actions of both arms, one holding the glass and the other that is pouring the fruit juice, need to be coordinated with each other. Additional levels of organization are required depending on whether the person will drink from the glass, give it to someone else, or simply put it on a table (Weiss, et al., 1998).
(iii) Degree of freedom problem

Several hypotheses have been developed in explanation of how the nervous system determines a particular solution from a large set of possible solutions that can accomplish the task or motor goals equally well (Bernstein, 1967).

1.3 THEORIES OF MOTOR COORDINATION

(A) Muscle Synergy:

Bernstein proposed the existence of muscle synergies as a neural strategy of simplifying the control of multiple degrees of freedom Bernstein N. (1967). A functional muscle synergy is defined as a pattern of co-activation of muscles recruited by a single neural command signal (Torres-Oviedo, G., 2006). One muscle can be part of multiple muscle synergies, and one synergy can activate multiple muscles. The current method of finding muscle synergies is to measure EMG (electromyography) signals from all muscles involved in a certain movement so that specific patterns of muscle activation can be identified. A few muscle synergies are combined at different proportions to form a continuum of muscle activation pattern for smooth motor control during various tasks. These synergies work together to cause movements such as walking or balance control when a perturbation is applied. Directionality of a movement has an effect on how the motor task is performed (i.e. walking forward vs. walking backward, each uses different levels of contraction in different muscles). Researchers measure EMG signals for perturbation applied in multiple directions in order to identify all the possible muscle synergies that are present (Torres-Oviedo, G., 2007).
Initially, it was thought that the muscle synergies eliminated the redundant degrees of freedom by constraining the movements of certain joints or muscles. However, it has been shown that constraining the movement of certain joints and muscles requires more energy and neural commands, and hence increases the number of neural signals required to perform the task (Tresch et al., 2006).

(B) **Uncontrolled Manifold Hypothesis**

A more recent hypothesis propose that the central nervous system does not eliminate the redundant degrees of freedom, but instead it uses all of them to ensure flexible and stable performance of motor tasks. The central nervous system makes use of this abundance from the redundant systems instead of restricting them like previously hypothesized. Uncontrolled Manifold (UCM) Hypothesis provides a way to quantify the muscle synergy (Latash, 2006). This hypothesis defines "synergy" a little differently than stated above; a synergy represents an organization of elemental variables (degrees of freedom) that stabilizes an important performance variable. Elemental variable are the smallest sensible variable that can be used to describe a system of interest at a selected level of analysis, and a performance variable refers to the potentially important variables produced by the system as a whole. For example, in multi-joint reaching task, the angles and the positions of certain joints are the elemental variables, and the performance variables are the endpoint coordinates of the hand (Latash, 2006).

This hypothesis proposes that the controller (the brain) acts in the space of elemental variables (i.e. the rotations shared by the shoulder,
elbow, and wrist in arm movements) and selects in the space of manifolds (i.e. sets of angular values corresponding to a final position). This hypothesis acknowledges that variability is always present in human movements, and it categorizes it into two types: (1) bad variability and (2) good variability. Bad variability affects the important performance variable and causes large errors in the final result of a motor task, and a good variability keeps the performance task unchanged and maintains successful outcome. It suggests that the brain only works to decrease the bad variability that hinders the desired final result, and it does so by increasing the good variability in the redundant domain.

(C) Inter-limb

Inter-limb coordination concerns how movements are coordinated across limbs. Scott Kelso and colleagues have proposed that coordination can be modelled as coupled oscillators, a process that can be understood in the HKB model (Haken, 1985).

The coordination of complex inter-limb tasks is highly reliant on the temporal coordination. An example of such temporal coordination can be observed in the free pointing movement of the eyes, hands, and arms to direct at the same motor target. These coordination signals are sent simultaneously to their effectors. In bimanual tasks (tasks involving two hands), it was found that the functional segments of the two hands are tightly synchronized. One of the postulated theories for this functionality is the existence of a higher, "coordinating schema" that calculates the time it needs to perform each individual task and coordinates it using a feedback mechanism. There are several areas of the
brain that are found to contribute to temporal coordination of the limbs needed for bimanual tasks, and these areas include the premotor cortex (PMC), the parietal cortex, the mesial motor cortices, more specifically the supplementary motor area (SMA), the cingulate motor cortex (CMC), the primary motor cortex (M1), and the cerebellum (Swinnen, 2009).

(D) Intra-limb

Intra-limb coordination involves the planning of trajectories in the Cartesian planes. This reduces computational load and the degrees of freedom for a given movement, and it constrains the limbs to act as one unit instead of sets of muscles and joints. In contrast to this model, the joint-space model postulates that the motor system plans movements in joint coordinates. For this model, the controlled parameter is the position of each joint contributing to the movement. Control strategies for goal directed movement differ according to the task that the subject is assigned. This was proven by testing two different conditions: subjects moved cursor in the hand to the target and (2) subjects move their free hand to the target. Each condition showed different trajectories: (1) straight path and (2) curved path.

(E) Eye-hand

Eye–hand coordination concerns how eye movements are coordinated with and affect hand movements. Typical findings relate to the eye looking at an object before the hand starts moving towards that object (Liesker, 2009).
Learning

Bernstein proposed that individuals learn coordination first by restricting the degrees of freedom that they use. By controlling only a limited set of degrees of freedom, this enables the learner to simplify the dynamics of the body parts involved and the range of movement options. Once the individual has gained some proficiency, these restrictions can be relaxed so allowing them to use the full potential of their body.

In the present study, out of seven coordinative abilities, agility has been chosen as coordinative variable. The description of the term agility with reference to motor coordinative ability is presented below-

1.4 AGILITY

Development of children consists of a variety of layers for example physical, mental, emotional, social each of which is a part of a whole. Motor development develops in parallel with mental and emotional development patterns. The acquisition of coordinative skills, however, is a result of the learning process (Muratli, 1997). The first and basic movements of child development cover the early childhood-adolescent stages. Basic skills are acquired at this period (Bekman, 2000).

Agility was defined as “the ability to change direction quickly and effectively while moving as nearly as possible as full speed (Baley, 1977).

Agility was defined as “the physical ability that enables rapid and precise change of body position and direction” (Johnson & Nelson, 1986).

Agility is the ability of the body or parts of the body to change direction quickly and to control body movement (Hockey, 1973).
Development of Agility:

AAHPER Youth Fitness Test (1976) found that there are annual incremental improvements of agility of both boys and girls throughout the period of childhood. Moreover, girls begin to level off after age 13, while boys continue to make improvements. Keogh (1965) indicated that agility and body coordination are closely related. Williams (1983) stated that agility improves throughout the period from childhood to adolescent years, resulting from increasing physical activity participation.

Agility is the ability to change the direction of the body in an efficient and effective manner and to achieve this you require a combination of:

**Balance**: The ability to maintain equilibrium when stationary or moving (i.e. not to fall over) through the coordinated actions of our sensory functions (eyes, ears and the proprioceptive organs in our joints)

**Static Balance** - ability to retain the centre of mass above the base of support in a stationary position

**Dynamic Balance** - ability to maintain balance with body movement

**Speed**: The ability to move all or part of the body quickly

**Strength**: The ability of a muscle or muscle group to overcome a resistance

**Co-ordination**: The ability to control the movement of the body in co-operation with the body’s sensory functions e.g. catching a ball (ball, hand and eye co-ordination)
1.5 INTELLIGENCE:

Cognition is the scientific term for mental processes. These processes include Attention, remembering, producing and understanding language, solving problems, and making decisions. Cognition is studied in various disciplines; for example in psychology and cognitive science, it usually refers to an information processing view of an individual's psychological functions. It is also used in a branch of social psychology called social cognition to explain attitudes, attribution and group dynamics.

Importance of cognitive skill development:

**Innate Abilities** - A person's innate abilities are at the foundation of the learning process. These represent the genetically determined abilities -- and limitations -- we possess at birth that we inherited from our parents. Mozart certainly possessed a greater innate musical capacity than can be said for most of us, but most of us can improve our musical ability with practice. Our upward limits are defined by innate abilities, but how near we come to performing at those upper limits is determined by other elements necessary to learning.

**Sensory/Motor Skills** - Sensory and motor skills build on the foundation of our innate abilities. Sensory skills are those such as vision, hearing, and touch. They are responsible for receiving information. Motor skills relate to muscles and movement and include crawling, walking, running, handwriting, and speaking. Motor skills give expression to the information our senses receive and process.
Both sensory and motor skills are partially determined by genetic code and partly learned through repetitive interaction with the environment. These skills, in almost everyone, can be improved with proper practice. This is the basis for athletic and music instrument practice, physical therapy, and other similar performance enhancement efforts.

**Cognitive Skills** - Cognitive abilities allow us to process the sensory information we collect. These include our ability to analyze, evaluate, retain information, recall experiences, make comparisons, and determine action. Although cognitive skills have an innate component, the bulk of cognitive skills are learned. When this development does not occur naturally, cognitive weaknesses are the result. These weaknesses diminish an individual's capacity to learn and are difficult to correct without specific and appropriate intervention. Like sensory and motor skills, cognitive skills can be practiced and improved with the right training. Changes in cognitive ability can be seen dramatically in cases where an injury affects a certain physical area of the brain. The correct therapy can actually "rewire" a patient's brain, and cognitive function can be restored or enhanced. This is also true in students. Weak cognitive skills can be strengthened, and normal cognitive skills can be enhanced to increase ease and performance in learning.

Man’s cognitive competence refers to his/her abilities or mental skills often they are termed as “intelligences” although all mentally sound people have these skills, yet they are not of equal degree in all humans. These proportions vary from person to person (Gardner, 1999).
While intelligence is one of the most talked about subjects within psychology, there is no standard definition of what exactly constitutes ‘intelligence.’ Some researchers have suggested that intelligence is a single, general ability, while other believe that intelligence encompasses a range of aptitudes, skills and talents.

Intelligence is “the ability to tackle problems successfully or to approach to products that are acceptable and esteemed in one or more cultures” (Gardner and Hatch, 1989).

“Individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought.” (Neisser, 1996)

“The ability to learn, understand and make judgments or have opinions that are based on reason”. (Cambridge Advance Learner’s Dictionary, 2006)

“Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience.” (Gottfredson, 1997)

1.6 THEORIES OF INTELLIGENCE:

Charles Spearman - General Intelligence:

British psychologist Charles Spearman (1863-1945) described a concept he referred to as general intelligence, or the \( g \) factor. After using a technique known as factor analysis to examine a number of mental
aptitude tests, Spearman concluded that scores on these tests were remarkably similar. People who performed well on one cognitive test tended to perform well on other tests, while those who scored badly on one test tended to score badly on other. He concluded that intelligence is general cognitive ability that could be measured and numerically expressed (Spearman, 1904).

**Louis L. Thurstone - Primary Mental Abilities:**

Psychologist Louis L. Thurstone (1887-1955) offered a differing theory of intelligence. Instead of viewing intelligence as a single, general ability, Thurstone’s theory focused on seven different “primary mental abilities” (Thurstone, 1938). The abilities that he described were:

- Verbal comprehension
- Reasoning
- Perceptual speed
- Numerical ability
- Word fluency
- Associative memory
- Spatial visualization

**Howard Gardner - Multiple Intelligences:**

One of the more recent ideas to emerge is Howard Gardner’s theory of multiple intelligences. Instead of focusing on the analysis of test scores, Gardner proposed that numerical expressions of human intelligence are not a full and accurate depiction of people’s abilities. His theory describes eight distinct intelligences that are based on skills and abilities that are valued within different cultures.
The eight intelligences Gardner described are:

- Visual-spatial Intelligence
- Verbal-linguistic Intelligence
- Bodily-kinesthetic Intelligence
- Logical-mathematical Intelligence
- Interpersonal Intelligence
- Musical Intelligence
- Intra personal Intelligence
- Naturalistic Intelligence

Gardner extended the idea of intelligence and took account of areas as special relations, interpersonal knowledge and music besides mathematical and linguistic ability. Intelligence is “the ability to tackle problems successfully or to approach to products that are acceptable and esteemed in one or more cultures” (Gardner and Hatch, 1989). Undertaking genetic and social research, he formed a list of eight intelligences. This novel idea regarding intelligence is very much different from the conventional concept, which normally considers just two intelligences, linguistics and mathematical.

Man’s cognitive competence refers to his/her abilities or mental skills often they are termed as “intelligences” although all mentally sound people have these skills, yet they are not of equal degree in all humans. These proportions vary from person to person. All human beings do not receive the same intelligence and the distribution is not the same. As health and wealth is distributed exactly according to the same pattern and law, intelligence is distributed among different people. It is a
normal distribution which is controlled and done by a specific principle which shows that the majority of people fall in the category of the average intelligent, some in the category of most intelligent and some people fall in the category of very tedious.

Many researchers have examined whether a particular caste, race or group of particular society or culture is better in term of intelligence. It has been a burning issue in America since long. The results of earlier researches which consider the whites to be a superior race by intelligence compare to the Negroes have been challenged. It has now been accepted that intelligence is not the inheritance of a particular group or race. There can be ‘bright’ and ‘dull’ in any race and caste. Cultural group and the environmental factors and influences make the differences in intelligence among different people of the societies (Chauhan, 1991).

Gardner proposed, in his theory of Multiple Intelligences, eight types of intelligences: linguistic, logical/mathematical, visual/spatial, musical, bodily/kinesthetic, interpersonal, intrapersonal and natural intelligence. Gardner proposed eight types of intelligence. He further says that there is a chance of presence of more intelligence which needs to be explored.

**Verbal/Linguistic Intelligence:** Verbal/linguistics intelligence demands susceptibility to spoken as well as written languages, the potential and capability to use language theory to achieve particular goals. It is the effective use of language (Christion and Kennedy, 1999). This is concerned with written and spoken expression. It is the
manipulation of language and communication of words skillfully (Mbuva, 2003).

A person having sound verbal/linguistics intelligence background not only listens to but also responds carefully to sounds, rhythm, colour and variety of the spoken words. Similarly, he/she acquires and learns through the practice of listening, reading, writing and discussing. Likewise, his or her listening is strong as he or she understands through, expresses the meaning in a better way, elucidates and can recall what he or she has listened to; more over he/she studies and speaks clearly, explains, explicates or clarifies and brings to mind what he or she has read, and last but not the least, he or she shows the potential to become proficient in other languages and uses the skills of listening, speaking, writing and reading and thus to convey and explain in order to convince others. (Laughlin, 1999).

Logical/Mathematical Intelligence: It requires reasoning whether deductively or inductively. It also uses and identifies intellectual patterns and links. It is relevant to those who enquire into different issues and try to reach at scientific conclusion (Gardner, 1999:42). It is the capability to create sequence in solving a problem to make scientific analysis of a problem, recognize patterns and to use numbers and do mathematical operations easily and to deal with different phenomenon successfully. The person, endowed with high degree of Logical/mathematical intelligence shows expertise while solving logical problems. Similarly, he is fond of complex operations i.e. computer programming and research methods. Even his anticipation and points of view are based on
mathematics. Moreover, his interest lies in different professions such as computer technology, law, engineering and chemistry (Laughlin, 1999).

Different kinds of people show a high-level of this kind of intelligence. For example, scientists, mathematicians, philosophers, logician, computer programmer, accountants. Apart from this, there are many instances of such people throughout the ages who showed this kind of logical or mathematical intelligence.

**Visual/Spatial Intelligence** : It is the potential to produce visual spatial representation of the world and move that representation either mentally or concretely. It promotes the capability to identify and operates the shape of wide space as well as the shape wide none restricted ones (Gardner, 1999: 43). It involves manipulating objects mentally in order to deal with and solve problems successfully. A person who possesses a high degree of visual/spatial intelligence acquires skills through observation, identifies different objects, shapes, colours, scenes and other necessary details and for this purpose he makes use of visual images in calling to mind those information. He also produces solid or visual representation of information. Moreover demonstrates liking for becoming artist, photographer, engineer, architect and designer (Laughlin, 1999).

**Musical/Rhythmic Intelligence** : It involves the potential to perform, compose or appreciate the pattern of music (Gardner, 1999). It also incorporates or covers susceptibility to pitch of sound or rhythm of sound. In addition, it is also responsive to emotional suggestions to these elements. Any person, blessed with visual/spatial intelligence generally
listens to different sounds and gives positive response (White, 1995: 181). He likes and tries to find out favorable time to listen to music or sounds of the environment, replies to music by dancing, collects information regarding music and tries to enhance the ability of singing and play the musical instruments. He often likes to play with sounds, he can also conclude musical phrases in a song and he or she may have a great intention for career such as singer, instrumentalist or sound engineer (Laughlin, 1999).

Usually composers, instrumentalists, vocalists and bird singing lovers possess a high level of this intelligence.

**Bodily/Kinesthetic Intelligence**: It is the potential to use different organs of the body adroitly to convey ideas and feelings. It is the capability to use different types of equipments, objects and apparatuses competently. Examples of this type of intelligence are body acting, carving, sports, drawing, calligraphy, dancing, medical operations, and scientific laboratory skills. People with high Bodily/kinesthetic intelligence discover environment through touch and movement, learn well by direct participation and remember what was done rather than what was said, enjoy learning through activities and practical experiences, remains sensitive to physical gestures, exhibits interest in athletics, dancing, acting etc.

**Robert Sternberg - Triarchic Theory of Intelligence:**

Psychologist Robert Sternberg defined intelligence as “mental activity directed toward purposive adaptation to, selection and shaping of, real-world environments relevant to one’s life” (Sternberg, 1985, p. 45).
While he agreed with Gardner that intelligence is much broader than a single, general ability, he instead suggested some of Gardner’s intelligences are better viewed as individual talents. Sternberg proposed what he refers to as ‘successful intelligence,’ which is comprised of three different factors:

Analytical intelligence: This component refers to problem-solving abilities.

Creative intelligence: This aspect of intelligence involves the ability to deal with new situations using past experiences and current skills.

Practical intelligence: This element refers to the ability to adapt to a changing environment.

1.7 REASONING ABILITY

Reasoning refers to the process of drawing conclusions or inferences from information. Reasoning always requires going beyond the information that is given (Bruner, 1957). In logic, an inference is called *deductive* if the truth of the initial information (or premises) guarantees the truth of the conclusion. The inference is called *inductive* if the truth of the premises makes the conclusion probable but not certain. Distinctions between deductive and inductive reasoning can be important in understanding logic; but in practice, these distinctions may exist more in the mind of the researcher developing a task than in the performance of examinees on that task. Many researchers have found that performance on deductive and inductive tests is strongly related (Wilhelm, 2005).

When people reason, they must, in Bruner’s (1957) helpful phrase, go “beyond the information given”. They do this in one or both of the
following ways: They attempt to infer (either automatically or deliberately) concepts, patterns, or rules that best (i.e., most uniquely) characterize the relationships or patterns they perceive among all the elements (e.g., words, symbols, figures, sounds, movements) in a stimulus set. Better reasoning is characterized by the use of concepts or rules that simultaneously satisfy the opposing needs for abstraction (or generalization) and specificity. Such concepts or rules tend to be at least moderately abstract yet precisely tuned. Put differently, a poor inference is often vague and captures only a subset of the relationships among the elements in the set. They attempt to deduce the consequences or implications of a rule, set of premises, or statements using warrants that are rendered plausible by logic or by information that is either given in the problem or assumed to be true within the community of discourse. They often seem to do this by creating and manipulating mental models of the situation. Such models tend to represent explicitly only what is assumed to be true about the situation. Better reasoning involves providing warrants that are more plausible or consistent with the rules of logic or the conditions embodied in a comprehensive mental model. More advanced deductive reasoning involves providing either multiple (possibly divergent) warrants for a single claim or an increasingly sophisticated chain of logically connected and separately warranted assertions.

The mental models theory (Johnson-Laird, 2004) of deductive reasoning posits that the individual first transforms the premises of an argument into another representation that is consistent with the premises. Importantly, multiple mental models that are consistent with the
premises must often be constructed and then compared in order to reach a valid conclusion. Each mental model represents a possible state of affairs that must be evaluated. Bara, Bucciarelli, and Johnson-Laird (1995) identified the following factors that affect syllogistic inference in the mental models approach: (a) assembling a propositional representation of premises; (b) constructing models that integrate information from premises; (c) formulating a conclusion which integrates relationships not expressed in the premises; (d) searching for alternative models to refute conclusions; and (e) recognizing similarities between models. All these processes require working memory resources.

Human reasoning occurs at different levels of awareness. Most cognitive scientists distinguish between tacit and intentional (or explicit) reasoning processes (Evans & Over, 1996). Tacit processes that facilitate reasoning occur without conscious intervention and outside awareness; they typically do not require attention. Such thinking is sometimes described as associative, because it depends on the network of ideas and associations in memory. Tacit processes are used when we make a decision in a quick or intuitive way, often because it feels right rather than because we have a clearly articulated set of reasons. We are aware of the outcome of these tacit processes, but not of the processes themselves. Tacit processes are particularly important in focusing attention and in building an initial mental model of a problem. Effective problem solvers typically attend to different features of the problem than do less effective problem solvers. Effective problem solvers know what to seek and know what to ignore (Horn & Masunaga, 2006). In part, this is due to greater experience; in part, to better use of past experiences. Other researchers
describe this automatic attention as the extent to which the person is attuned to certain aspects of a situation and not others.

Successful problem solvers form problem representations that are not only more abstract than those of novices, but also more finely tuned to the problem at hand. Markman and Gentner (2001) argue that the formation of moderately abstract conceptual relations may be a precursor to the detection of coherent patterns that help successful problem solvers make connections to similar problems with known solutions. Further, moderately abstract, principle-based concepts are easier to retain and manipulate in working memory, thereby freeing attentional resources for higher-level processes. There is thus an important synergy between good knowledge and good reasoning.

Sternberg (1986) offered a helpful way to categorize the kinds of mental processes used on commonly investigated reasoning tasks: He calls them selective encoding, selective comparison, and selective combination. We will alter these labels somewhat in the discussion that follows. Recall from the discussion of mental models that although a test item or experimental task may elicit these processes for some or even most people, it may elicit other (non-reasoning) processes for any particular person or item. As Sternberg puts it, “the extent to which a task elicits reasoning is a function of the interaction between person and task, rather than merely a function of the task”.

The general speed or efficiency with which we process information possibly as a result of more efficient brain structures (Jensen, 1998). Although disattenuated correlations between reaction time (RT) and g
can be substantial when samples vary widely in ability, samples more typical of those used in other research on abilities yield correlations between RT and $g$ in the $r = -.1$ to -.4 range (Deary & Stough, 1996; Jensen, 1982; Roberts & Stankov, 1999). In principle, processing speed could be estimated on any elementary cognitive task that minimizes the import of learning, motivation, strategy, and other confounding variables. In fact, response latencies on many tasks show a pattern of increasing correlation with an external estimate of $g$ as task complexity decreases. In other words, response latencies for simpler tasks typically show higher correlations with $g$ than do response latencies for more complex tasks. But this is unsurprising. The more complex the task, the more room there is for subjects to use different strategies or even to be inconsistent in the execution of different components across items.

1.8 PERCEPTION:

Perception refers to the process of taking in, organizing, and interpreting sensory information. Perception is multimodal, with multiple sensory inputs contributing to motor responses (Bertenthal 1996). An infant’s turning his head in response to the visual and auditory cues of the sight of a face and the sound of a voice exemplifies this type of perception.

Infants’ perceptual skills are at work during every waking moment. For example, those skills can be observed when an infant gazes into a caregiver’s eyes or distinguishes between familiar and unfamiliar people. Infants use perception to distinguish features of the environment, such as height, depth, and color. “The human infant is recognized today as
‘perceptually competent’; determining just how the senses function in infancy helps to specify the perceptual world of babies”. The ability to perceive commonalities and differences between objects is related to the cognitive domain foundation of classification. Infants explore objects differently depending upon object features such as weight, texture, sound, or rigidity (Palmer 1989). Parents and professionals may have observed young children exploring a slope, such as a slide, by touching it with their hands or feet before they decide whether to slide down it or not. Research by Adolph, Eppler, and Gibson (1993) suggests that learning plays a part in young children’s decision making in physically risky situations, such as navigating slopes, and that exploratory behavior may be a means to this learning. Perception is also strongly related to the social–emotional domain, such as when young children perceive the differences between various facial expressions and come to understand what they may mean.

What a person learns is as a result of and specified by the laws of perceptual organization. The German word “pragnanz” has been used to describe the particular perceptual configuration achieved, out of a myriad of potential configurations. Pragnanz or good form and the laws of grouping under it: assimilation, figure-ground differentiation, context, contrast, similarity, closure, constancy, grouping and good form:

1. Assimilation: Perls et al. (1980) opined that learning when digested and not swallowed whole may be assimilated, that this assimilation is the aftermath of contact (except annihilation) which results in accomplished learning. According to Isangedighi (1996),
assimilation is a term used in reference to the adoption techniques involved in the use of schemas. Assimilation, he asserted, has biological, social and mental characteristics. Biologically, it is about taking in and ingesting of food by the body. Mentally, assimilation connotes the inflow and reception of information, which borders on reasoning or thinking process of learning and conforming to the social milieu.

2. Figure and background: Figure is the point of interest with ground the setting or context. The exchange between figure and ground is dynamic, for the same ground may, with waves of interests and attention yield different figures. It could also be that a given figure, if it contains details, may itself become ground in the event that some detail of its own emerges as figure.

3. Grouping: Contrast, similarity, context, constancy, good form, because of the counteraction of two or more of these sub-themes, one is combining them in treatment, which reinforces good form or practice. Indeed, many phenomena could not exist if their opposites did not exist; in fact the validity of opposites depends upon appropriate context.

4. Closure: To effect closure, the Gestaltists presented incomplete objects whose achievements must be done by a kind of subjective filling-in of blank spaces.

1.9 DEPTH PERCEPTION:

Depth perception refers to the ability to see and understand the 3-D spatial relationship and relative distance between objects and oneself. Its
primary value is to make hand-eye coordination efficient and provide for safe movement through space. Infants are born with an immature vision system that gradually develops to take in better and more precise visual information while the brain learns to look for cues gleaned from experience.

**Physiology**: The retina is the curved two-dimensional surface at the back of the eye containing photoreceptor cells called rods and cones. Cones perceive color, fine detail and respond rapidly to stimuli so they can register changes to images quickly. Signals travel from the retina to the visual cortex of the brain, which develops as it learns to interpret the 2-D images it receives and use their messages to recreate the 3-D world. Infants are attracted by movement and instinctively seek stimulation that gives them the cues they need to develop depth perception.

**Monocular Cues**: Monocular cues are those detected with one eye. Babies begin learning their meanings before their eyes start tracking together. Types of monocular cues include motion parallax cues that teach the infant that as he moves, closer surfaces appear to move farther and faster than distant ones do. (Think of driving down a road lined with trees. The ones close to you zip by faster than the ones in the distance that seem to move more slowly.) Optic flow, revealed at 3 to 4 weeks of age by blinking when an object approaches, teaches babies that moving toward a surface makes things appear bigger and that the reverse is also true. This tells infants in which direction they are moving.

**Binocular Cues**: Once the infant develops stereoptic vision, at 3 to 4 months old, cues that compare information from the two eyes teach the
brain new ways to perceive the dimensionality of space. Each retina sends a slightly different image to the brain, which assesses the degree of this binocular disparity to figure out the image's depth. Convergence describes the changes in muscular tension when the eyes rotate inward or outward to focus effectively. This feedback provides valuable information on depth when objects are less than 20 feet away.

Binocular depth perception is one of the most demanding visual tasks that we carry out. The horizontal separation of the eyes in the head means that each eye obtains an image of the world from a slightly different viewpoint. The differences between these images, called binocular disparities, present significant challenges that the brain's visual system must overcome in order to make use of them. Binocular vision must be highly accurate: the CNS needs to be able to register a difference between the two eyes that is smaller than the width of a single cone photo receptor. To extract these fine differences, individual features in the left eye’s image must be matched with the correct partner features in the right eye. This kind of problem is faced by the brain in many other circumstances. For example, object recognition requires that sensory input be matched against what is in the memory.

**Pictorial Cues**: By 6 months of age, the brain is building knowledge of pictorial cues through observation. Atmospheric perspective, for example, tells the brain that hazy objects are usually farther away than sharp ones. Linear perspective reminds babies that lines (such as railroad tracks) converge as they disappear into the distance. Occlusion tells babies that nearby surfaces or objects overlap far
surfaces and distant objects. If the baby sees a whole chair and part of a bookcase, she learns that the chair is in front of the bookcase. By 7 to 10 months, infants’ depth perception ability matches that of an adult.

1.10 PSYCHOMOTOR ABILITIES:

Psychomotor development refers to the maturation of psychological and muscular elements that constitute behaviour. While intellectual development refers to the maturation of memory, reasoning and thought processes. Psychomotor and intellectual developments are continuous processes, primarily dependent on maturation of the central nervous system and occur in the same sequence in children. The rate of development varies, even in a specific child and temporary pause may occur. Development may be slowed in the premature baby or in a child whose activity is limited by applying more stimulation. Psychomotor and intellectual developments are affected by innate intelligence, familiar pattern, and environmental factors. For example, the higher the intelligence, the faster the development, but late walking, talking or bladder control may occur more commonly in a particular family while lack of appropriate stimulation may impede normal development. Physical factor, such as hypotonic or poor vision may also alter normal psychomotor development.

Edwin Fleishmer identified the dimension underlying human performance into tow categories the physical proficiency and psychomotor area. The factor of strength endurance, power stamina, flexibility, coordination and balance constituted the physical proficiency whereas reaction time, speed of movement, visual perception and rate of
control were the abilities. Considered under psycho-physiological or psychomotor area.

Speed of movement is that quality which follows one to carry out either a movement or identical movement as quickly as possible. Speed of movement is accordingly that quality which permits very rapidly action from the point of view, of a segment or of the whole body. Speed of movement is most strictly observed in motor behaviour where the resistance to be overcome is relatively weak. A logical version of the determining factors of speed of movement appears to be overcome the frequency of stimuli, depending on the willpower, on mental determination and on nervous mobilization, the state of certain muscular strength and muscular power.

The speed or reaction is that quality which makes it possible to initiate a kinetic response as fast as possible following a perceptive stimulus. When the time of the event or task is relatively short reaction time becomes major factor. Reaction time is affected by a number of stimulus variable and individual variables, stimulus variables include mode of stimulus, stimulus intensity, the presence or absence of forewarning eyes and the complexity of stimulus or response. The efficiency of reaction time is conditioned by a number of elements such as the level of familiarity with the perceptual situation. The level of familiarity with the kinetic responses to be produced, the excellence of general physical condition as certain research would seem to indicate.

Perception of the space field primarily depends on visual and auditory information integrated with temporal judgments. Perception of
stable two dimensional space may depend on geostatic qualities of closure, figure-ground, proximity and similarly, whereas the principles of known standards, linear perceptive texture, and interposition become important when forming perception of stable three dimensional space.

The study of movement in two dimensional and three dimensional spaces has been referred to as “event perception”, and perception of this nature are linked with the judgment of time. The perception of movement in space is a function of the six of the object and their luminescence, as well as their speed and other available events. When two or more objects move in the same space field, they are generally interpreted as assuming some human function (one may be perceived as pushing another or one may be reported as being in a house with another trying to get in). In general, when complex movement of several objects are initiated in space field, the total field is perceived as a dynamic whole, with relationship between the objects rather than their discrete functioning being most after reported. Judgment of velocities in three-dimensional space depend on the position and movement of the observer, the perceived distance of the object from the observer, and the perceived six of the object in motion.

1.11 HAND EYE COORDINATION

Eye-hand coordination is defined as a perceptual-motor skill involving the integration and processing in the central nervous system of visual and tactile input so that a purposeful motor movement can be made. Eye-hand coordination is divided into 2 components. Proaction (closed motor skill) and Reaction (open motor skill). Proaction refers to
action, which is initiated or controlled by the athlete. Reaction refers to movement that occurs in response to another action.

Hand-eye coordination is the ability of the vision system to coordinate the information received through the eyes to control, guide, and direct the hands in the accomplishment of a given task, such as handwriting or catching a ball. Hand-eye coordination uses the eyes to direct attention and the hands to execute a task.

Vision is the process of understanding what is seen by the eyes. It involves more than simple visual acuity (ability to distinguish fine details). Vision also involves fixation and eye movement abilities, accommodation (focusing), convergence (eye aiming), binocularity (eye teaming), and the control of hand-eye coordination. Most hand movements require visual input to be carried out effectively. For example, when children are learning to draw, they follow the position of the hand holding the pencil visually as they make lines on the paper. Between four and 14 months of age, infants explore their world and develop hand-eye coordination, in conjunction with fine motor skills. Fine motor skills are involved in the control of small muscle movements, such as when an infant starts to use fingers with a purpose and in coordination with the eyes.

Infants are eager to move their eyes, their mouths, and their bodies toward the people and objects that comfort and interest them. They practice skills that let them move closer to desired objects and also move desired objects closer to themselves. By six months of age, many infants begin reaching for objects quickly, without jerkiness, and may be able to
feed themselves a cracker or similar food. Infants of this age try to get objects within their reach and objects out of their reach. Many infants are also able to look from hand to object, to hold one object while looking for a second object, and to follow the movements of their hands with their eyes. At this age, most infants begin to poke at objects with their index fingers. After six months, infants are usually able to manipulate a cup and hold it by the handle. Many infants at this age also begin to reach for objects with one arm instead of both. At about eight months of age, as dexterity improves, many infants can use a pincher movement to grasp small objects, and they can also clap and wave their hands. They also begin to transfer objects from hand to hand, and bang objects together.

Hand-eye coordination development milestones are as follows.

**Birth to three years**

Between birth and three years of age, infants can accomplish the following skills:

- Start to develop vision that allows them to follow slowly moving objects with their eyes
- Begin to develop basic hand-eye skills, such as reaching, grasping objects, feeding, dressing
- Begin to recognize concepts of place and direction, such as up, down, in
- Develop the ability to manipulate objects with fine motor skills

**Three to five years**

Between three and five years of age, little children develop or continue to develop the following skills:
- continue to develop hand-eye coordination skills and a preference for left or right handedness
- continue to understand and use concepts of place and direction, such as up, down, under, beside
- develop the ability to climb, balance, run, gallop, jump, push and pull, and take stairs one at a time
- develop eye/hand/body coordination, eye teaming, and depth perception

Five to seven years

Children between five and seven years old develop or continue to develop the following skills:

- improve fine motor skills, such as handling writing tools, using scissors
- continue to develop climbing, balancing, running, galloping, and jumping abilities
- continue to improve hand-eye coordination and handedness preference
- learn to focus vision on school work for hours every day.

The 26th State of the India i.e. Chhattisgarh was formed in the year 2000. 1/3 of the Population of Chhattisgarh is of schedule tribe, that’s why it is one of the major tribal states of the country. Despite numerous efforts by government this community is still socio-economically backward. They lack basic amenities such as health, hygienic drinking water and other necessary facilities for growth and development. In this
background, the researcher decided to study motor coordinative ability of tribal adolescent boys and girls in the light of their perceptual and reasoning ability.

1.12 AIMS AND OBJECTIVES OF THE STUDY

The main objectives of the present study are –

1. To investigate the effect of depth perception on motor coordinative ability of tribal adolescents.
2. To investigate the effect of hand eye coordination on motor coordinative ability of tribal adolescents.
3. To investigate the effect of reasoning ability on motor coordinative ability of tribal adolescents.

The ancillary aims and objectives of the present study in detail are as follows:

- To study developmental process of selected motor coordinative ability in tribal adolescent boys.
- To study developmental process of selected perceptual abilities in tribal adolescent boys.
- To study developmental process of reasoning ability in tribal adolescent boys.
- To study developmental process of selected motor coordinative ability in tribal adolescent girls.
- To study developmental process of selected perceptual abilities in tribal adolescent girls.
- To study developmental process of reasoning ability in tribal adolescent girls.
- To see the effect of depth perception on motor coordinative ability i.e. agility of tribal adolescent girls.
- To see the effect of depth perception on motor coordinative ability i.e. agility of tribal adolescent girls.
- To see the effect of reasoning ability on motor coordinative ability i.e. agility of tribal adolescent boys.
- To see the effect of reasoning ability on motor coordinative ability i.e. agility of tribal adolescent girls.
- To see the effect of hand eye coordination on motor coordinative ability i.e. agility of tribal adolescent boys.
- To see the effect of hand eye coordination on motor coordinative ability i.e. agility of tribal adolescent girls.
- To compare motor coordinative ability of tribal adolescents on the basis of gender.
- To compare depth perception of tribal adolescents on the basis of gender.
- To compare hand eye coordination of tribal adolescents on the basis of gender.
- To compare reasoning ability of tribal adolescents on the basis of gender.
1.13 STATEMENT OF PROBLEM

It is not always possible for researcher to formulate his problem simply, clearly and completely. He may obtain rather general, defuse, even confused notion of the problem. This is in the nature of the complexity of scientific research. It may even take an investigator years of exploration, thought, and research before he can clearly say what question he has been seeking answer to. Nevertheless adequate statement of the research problem is one of the most important parts of research. Hurlock mentioned that the problem is stated in interrogative form, the simplest way is here the best way. Also note that the problem states a relation between variables. (Kerlingar, 1983)

In order to materialize the objective of the present study stated in this chapter, as per canons of scientific enquiry, the best way is to frame relevant and research-worthy problems and that too in the form of an interrogative statements (Kerlingar, 1965), and to seek scientific solution to those problem through empirical verification of the related and research-worthy hypothesis. Therefore, an attempt has been made to frame the pinpointed problems in a question form. The same are registered, here as under:

- Is there any relationship between motor coordinative ability and age?
- Is there any relationship between perceptual ability and age?
- Is motor coordinative ability vary according to gender?
- Is depth perception vary according to gender?
- Is reasoning ability vary according to gender?
- Do level of perceptual abilities (Superior-Inferior) in any way affect the motor coordinative ability of tribal adolescents?
- Do level of reasoning ability (Superior-Inferior) in any way affect the motor coordinative ability of tribal adolescents?

1.14 DELIMITATIONS:

It is to be registered here that these piece of research should not be over-generalized as they are delimited to the population from which the sample will be drawn.

The study is delimited to selected variables i.e. hand eye coordination, depth perception, agility, and reasoning as well as one demographic variable sex of the selected subjects. The study is delimited to know the effect of reasoning and perceptual abilities of adolescents of tribal origin from Chhattisgarh state, on their motor coordinative abilities.

1.15 LIMITATIONS:

In present study some factors like physical fitness, nutritional status and environmental factors are beyond the control of the investigator, and these factors might affect the results.

1.16 HYPOTHESIS:

With an intention to offer a scientific solution to above-mentioned problem in the light of previous findings, the following hypothesis have been proposed for verification.
Differential Hypothesis

1. Ageing will show its impact upon mono-ocular depth perception (Left eye) of the tribal adolescent boys.

2. Ageing will show its impact upon mono-ocular depth perception (right eye) of the tribal adolescent boys.

3. Ageing will show its impact upon binocular depth perception of the tribal adolescent boys.

4. Ageing will show its impact upon hand eye coordination of the tribal adolescent boys.

5. Ageing will show its impact upon reasoning ability of the tribal adolescent boys.

6. Ageing will show its impact upon motor coordinative ability i.e. agility of the tribal adolescent boys.

7. Ageing will show its impact upon mono-ocular depth perception (Left eye) of the tribal adolescent girls.

8. Ageing will show its impact upon mono-ocular depth perception (Right eye) of the tribal adolescent girls.

9. Ageing will show its impact upon binocular depth perception of the tribal adolescent girls.

10. Ageing will show its impact upon hand eye coordination of the tribal adolescent girls.

11. Ageing will show its impact upon reasoning ability of the tribal adolescent girls.
12. Ageing will show its impact upon motor coordinative ability of the tribal adolescent girls.

13. Gender will show its impact on mono ocular depth perception (Left eye) of tribal adolescents.

14. Gender will show its impact on mono ocular depth perception (Right eye) of tribal adolescents.

15. Gender will show its impact on binocular depth perception of tribal adolescents.

16. Gender will show its impact on hand eye coordination of tribal adolescents.

17. Gender will show its impact on reasoning ability of tribal adolescents.

18. Gender will show its impact on motor coordinative ability of tribal adolescents.

19. Level of mono-ocular depth perception (left eye) will influence motor coordinative ability of tribal adolescent boys.

20. Level of mono-ocular depth perception (right eye) will influence motor coordinative ability of tribal adolescent boys.

21. Level of binocular depth perception (left eye) will influence motor coordinative ability of tribal adolescent boys.

22. Level of hand-eye coordination will influence motor coordinative ability of tribal adolescent boys.
23. Level of reasoning ability will influence motor coordinative ability of tribal adolescent boys.

24. Level of mono-ocular depth perception (left eye) will influence motor coordinative ability of tribal adolescent girls.

25. Level of mono-ocular depth perception (right eye) will influence motor coordinative ability of tribal adolescent girls.

26. Level of binocular depth perception will influence motor coordinative ability of tribal adolescent girls.

27. Level of hand eye coordination will influence motor coordinative ability of tribal adolescent girls.

28. Level of reasoning ability will influence motor coordinative ability of tribal adolescent girls.

**Interactional Hypotheses**

29. Binocular depth perception and reasoning ability will show its joint effect on motor coordinative ability of tribal adolescent boys.

30. Binocular depth perception and hand eye coordination will show its joint effect on motor coordinative ability of tribal adolescent boys.

31. Hand eye coordination and reasoning ability will show its joint effect on motor coordinative ability of tribal adolescent boys.

32. Binocular depth perception and reasoning ability will show its joint effect on motor coordinative ability of tribal adolescent girls.
33. Binocular depth perception and hand eye coordination will show its joint effect on motor coordinative ability of tribal adolescent girls.

34. Hand eye coordination and reasoning ability will show its joint effect on motor coordinative ability of tribal adolescent girls.

1.17 SIGNIFICANCE OF THE STUDY

The findings obtained from this research work related to motor coordinative abilities of tribal adolescents with special emphasis on their reasoning as well as perceptual abilities will help in enhancing the knowledge of the educationist and physical educators so that the shortcomings if any of the tribal adolescents in this regard could be rectified with the help of specific programs.

Hence, the study will significantly increase the knowledge about motor coordinative ability in light of reasoning and perceptual abilities of tribal adolescents by which the policy makers can act accordingly in order to enhance motor coordinative ability of tribal adolescents so that they can participate and enjoy success in all forms of life.