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## 1. Learning Outcomes

After studying this module, you shall be able to

- Know what is the importance of cognition?
- Learn the relationship of cognition with other faculties.
- Identify the impact of cognition on its correlates.
- Evaluate application of cognition.

## 2. Introduction

In the previous modules, we have been well acquainted with the term and concept of cognition. However, just to review, cognition refers to set of variables related to quantitative and qualitative type of knowledge and its relationship amongst other types of knowledge elements. An imperative aim of cognitive science is to generate theoretical models that specify how people function. In this module, we will primarily focus on the interaction of cognition with other vital correlates such as intelligence, emotion, language, culture etc. The text will emphasize the determining impact of cognition on such areas and in return how cognitive process is affected by them. In other words, the cause and effect relationship between cognition and its correlates will be explored. The interrelationship between various faculties is highlighted and attempts are directed to answer questions such as, is cognition same as intelligence or a difference can be discerned, what comes first cognition or emotion, are cognition and language same fraternities or is personality a predictor of cognition etc.

## 3. Impact of Cognition on Its Correlates

### 3.1 Cognition and Intelligence

There are different views on relationship between cognition and intelligence. There is lack of integration on the view that whether cognition and intelligence are same or different. Majority of the researches believe that a thin line of difference does exist however, another view supports that cognition and intelligence are same. In line with the former view, cognition can be conceived as a process of integration, accommodation and application of knowledge. It includes the process by which sensory information can be used, stored, reduced, elaborated, transformed and recovered for its application to daily life activities. It encompasses the course of how information is acquired and way it is used, hence acquisition and application appear to be at the nucleus. Thus the implicit processes of sensation, attention, perception, thinking, learning, memory constitute the cognitive capacity of an individual. Intelligence, on the other hand, is viewed to be included as a part of cognitive process. It entails transforming cognitive knowledge into meaning and explicit application of this knowledge to solve daily life problems. Cognition acts as an umbrella term including all the vital processes such as perception, thinking, memory, attention and intelligence indeed being a part of the cognitive process. Also the fact that Intelligence Quotient or IQ is a measure of cognitive ability and application of such abilities to understand concepts and solve problems is also clear evidence that cognition and intelligence are two different constructs where former includes the latter.

The other view does not define a clear distinction between cognition and intelligence. They believe both the constructs to be similar with no defined boundaries. For instance, Wechsler Adult Intelligence Scale (WAIS) one of the most relied upon intelligence test measures intelligence but not common sense. The test is not able to explain why people with equal IQ perceive things differently or why success in life for IQ in gifted range is higher than genius. The difference between the two also seems to fade when emotional intelligence is equated with cognitive intelligence. The term cognitive intelligence here clearly assimilates both the constructs and has also separated itself with types of intelligence such as social intelligence, interpersonal intelligence etc. It has primarily referred to the intellectual abilities such as thinking, reasoning, logical differencing analyzing, prioritizing etc. In contrast, emotional intelligence involves the ability to monitor one's own and other's feelings and emotions, to discriminate amongst them and to use this information to guide one's thinking. Then emotional intelligence comprises of three factors broadly of self and other's i.e. appraisal and expression of emotions, regulation of emotions and utilization of emotions. The concept of emotional intelligence differs itself from conventional interrelationship between cognition and affect as it does not concentrate primarily on memory or judgment alone but on holistic general contribution of emotionality to personality. Thus difference between IQ and EQ is also quite clear.

- IQ is obtained through a ratio which is an index of a person's ability to learn, understand and use information in a meaningful way whereas EQ is an index of person's ability to recognize, appraise, manage and use one's emotions as well as others so as to facilitate a productive life.
- IQ deal's with abilities of understanding and comprehending information while EQ deals with recognizing and comprehending emotions.
- IQ is mathematical and logical powers of an individual and EQ is the emotional ability towards self and others.
- In an IQ test, items pertain to logical and abstract reasoning whereas in EQ test, scale items relate to emotional responses in different situations.
- IQ is a strong predictor of success in school and EQ is strong predictor of success in life.
- EQ can be learnt whereas IQ can't be taught as part of it is believed to be innate.
- Correlation of performance on IQ and EQ is not strong, for example, an autistic child may perform well on IQ but may not have a good index of EQ.
- IQ determines individual capacities and intelligence and EQ decides for your team work and crisis intervention.

In spite of the differences, nevertheless, both the fraternities – cognition and intelligence seem to equally rely on each other. Without information processing system, its application cannot happen and no vitality of processing and integrating system can be gauged without assessing its applications. Therefore the two constructs, though distinct in conceptualization also seem to be dependently integrated, each assisting the other in way human beings perceive the world and act upon the environment.

## 3.2 Cognition and Emotion

The duality between cognition and emotion has fascinated the psychologists and philosophers since centuries. Most of the research in this area has been primarily based on identification of brain areas involved in the dynamic process. The recent development focuses on the interactional fit between both the aspects giving rise to complex behavior. The attempts of the conventional researchers have been to separate ‘cognitive brain’ from the ‘emotional brain’ whereas the recent trends have opposed such a clear distinction out of three reasons i.e. (a) brain regions involved in cognition are also functional in emotions (b) brain regions involved in emotions are also a part of the cognitive process and (c) cognition and emotion both are integrated in the brain. As a result, dividing the brain into cognitive and affective regions is inherently troublesome and thus not a possibility. However, a clear rejection of either of the views is not a possibility until we delve into the complex process.

### 3.2.1 Conceptualization of Cognition and Emotion

Cognitive capacity of strong controlled processes is considered unique to human species. The various domains of cognition such as attention, memory, perception, and learning seem to be completely goal directed and prevented from interferences. The strongest correlate of cognition is neural firing from dorso lateral prefrontal cortex. Most of the literature reveals engagement of cortical regions in the cognitive process. However, the same cannot be simply articulated for emotions. There is less agreement on definition of emotions nonetheless, some accepted meaning of emotions include it to be states as elicited by rewards and punishers; emerge from conscious appraisal of events; have physiological basis and range from simple (happy) to complex moral emotions (pride, jealousy). The brain structures involved in emotion include amygdala, ventral striatum and hypothalamus. The functioning of such sub cortical regions mediating emotions is at times believed to be a less conscious process. The human is many times unaware of the stimulus that triggers functioning in emotional brain areas. As a result of the inherent intricate processes involved in both cognition and emotion, it certainly becomes difficult to concretely define both the concepts.

### 3.2.2 Affective Brain Regions in Cognition

There has been constant disagreement over the regions that are purely affective and constitute affective brain. Hypothalamus was one of the primitive regions believed to play a strong role in emotions. Later, robust role of limbic system was identified in emotional regulation. However, the recent trends revealed that many areas in the limbic system such as hippocampus were not found to be connected to emotions and other areas which were observed to control emotions were not included in the limbic system like orbito prefrontal cortex. As a result, a pure composition of emotional brain has not been possible. Attempts have been directed to identify core and extended regions of the brain that play a role in emotions. Core regions are primary areas which are believed to have strong functioning whereas extended regions are those which have almost a secondary role to play in emotional regulation. Examples of core regions include amygdala, hypothalamus, nucleus accumbens, orbito prefrontal cortex, anterior cingulate cortex and ventromedial prefrontal cortex. Extended regions include ventral segmental area, hippocampus, basal forebrain, prefrontal cortex, anterior temporal lobe, posterior cingulated cortex and somatosensory cortex. Even with the identification of core and extended regions, the problem doesn't simplify as many of these regions are also included in the various other cognitive

functions. To cite an example, amygdala a core affective region is observed to have a crucial role in processing of fearful stimuli. To an extent, it is identified as the ‘fear centre’. However, the same area has been found to play a significant role in attention and associative learning as well (Whalen, 1998; Baxter & Murray, 2002 and Sander & Zalla, 2003). Various evidences converge to the view that amygdala does not only control emotions but also produces attentional responses (Schaefer et al, 2006 and Schaefer Gray, 2007).

### **3.2.3 Cognitive Brain Regions in Emotions**

The prefrontal cortex (PFC) is believed to have a significant role in the control and execution of cognitive functions. It is observed to exhibit critical role in attention, maintenance and manipulation of information, detection of conflict and expression of cognitive control in challenging situations. However, as discussed above, PFC is also identified as the extended affective region. Various PFC territories such as anterior cingulate cortex, orbito prefrontal cortex and ventromedial prefrontal cortex are involved in emotions (Rolls, 2005; Damasio, 1999 and Davidson & Irwin, 1999). Nonetheless, the recent literature focuses on robust role of PFC in the cognitive process. This duality leads to strong compartmentalization of PFC into areas that control emotions and others that control cognition (Blush, Luu & Posner, 2000). For instance, orbito prefrontal cortex and ventromedial cortex play a role in emotions whereas dorsolateral prefrontal cortex dominates cognitive control. With such strong heterogeneity, it thus becomes almost a challenge to mark affective brain separate from cognitive brain.

### **3.2.4 Integration of Cognition and Emotion**

Above text clearly depicts that the view for separation of cognitive and affective brain areas is primarily deficient and both the fraternities seem to somehow merge with each other. Advancements in the literature have been able to generate evidences for fusion of cognition and emotion such as depicted in functional studies, structural connectivity, circuits for cognitive emotional integration and functional connectivity. *Functional studies* indicate that lateral prefrontal cortex (LPFC) is the area of integration for both cognition and emotion. Especially, dorsolateral prefrontal cortex (DLPFC) which has primarily been identified as cognitive area is also believed to be a core affective area. Support for hypothesis comes from working memory studies, behavioral inhibition experiments and proposals for integration of cognition and motivation. Territories of LPFC such as ventromedial prefrontal cortex, orbito prefrontal cortex and anterior cingulate cortex have been found to be the areas where interaction of both emotion and cognition takes place. On the other hand, *Structural connectivity* of anatomical information suggests that any brain region is just a few synapses distant from the other where brain almost appears as a small world topology. In a research PFC was found to be most distant from sensory areas which meant that PFC almost received processed information for higher cognitive treatment. Another finding revealed amygdala as equally distant from sensory areas and as the hub of forming various other cortical connections. This core affective area is thus found to be at nucleus for interaction of cognition and emotion (Young, Scanell, Burns & Blakemore, 1994). Nevertheless, *Circuits of interaction* also indicate evaluation of sensory information through the visual cortex. Both amygdala and orbito prefrontal cortex are appropriately well situated from the visual cortex for adequate sensory evaluation. Both the areas also share strong reciprocal connections in order to make better perceptual and emotional sense of the sensory information. A cognitive affective control circuit is also highlighted instead of the pure cognitive-executive control circuit.

Finally, to summate the cognitive affective integration, a conceptual model was proposed by Pessao, 2008. The proposal stated that any given brain area forms multiple neural connections. As a result the brain area is involved in multipurpose functioning and similarly, the neural computation may be used by many areas. This neural mapping forms the basis of behavior. Thus with this multifarious complexity, it is almost impossible to separate the cognitive and affective connections of behavior. Consequently, a change in the affective dimension of behavior also introduces a change in the cognitive dimension. Hence cognitive and affective categories integrate with each other to form complex behavior.

### 3.3 Cognition and Language

The relationship between cognition and language has long amazed cognitivists and linguists. The question whether cognition and language are two separate entities or language emerges from general cognitive abilities still lacks a firm conclusion. Also, certain other questions such as do people who speak different languages think differently or certain development of cognitive abilities is essentially required for language acquisition still pose a challenge. Such concerns have been pervasive in the fields of psychology, linguistics, neuroscience and anthropology.

#### 3.3.1 Concept of Cognition and Language

The entanglement of cognition and language has been difficult to resolve. However, the cognitive revolution has aimed to propose cognition as a powerful entity with set of various mental abilities including language. The controversy has invited broadly two perspectives, one which is known as general cognitive view and the other as mental module approach. The former approach suggests general purpose cognition as the foundation for all abilities of human intelligence. The support for this universal ability has been gathered from tasks such as pattern completion and category induction. The latter view stressed onto the differences between language and other abilities. It suggested cognition to involve distinct mental abilities, each requiring a different learning mechanism. The support for this view emerges from neuroimaging findings where separate brain areas are found in functioning of various cognitive abilities such as memory, learning, language, motor coordination etc. The recent trends to understand the architecture of cognition have focused on the interdisciplinary and interaction of cognition with other mental abilities.

In order to understand the link between cognition and language, it is important to throw light on famous linguist Noam Chomsky's view of generative linguistics. This view has constantly prevailed for years and produced a landmark in the linguist field. Chomsky conceptualized language abilities as similar to any mental organ. He believed that children are equipped with set of specific language abilities also called the language acquisition device or universal device. His view of language acquisition was completely in opposition to the conventional behaviorist view which proposed that most of the language is learnt through behavioral modeling or imitation of parents. He suggested that children do not learn language through general problem solving skills but rather through innate language specific abilities. His theory was called generative linguistics as its primary goal was to define mental structures that could potentially generate grammatically valid sentences. Chomsky also proposed 'autonomy of syntax' hypothesis which stated that syntax is unique human capacity which operates independent of meaning of words in the sentence. With the advent of artificial intelligence in psychology and the metaphor of brain as computer and mind as its software led Chomsky also to state grammar as set of rules for

generation of words. In the later years of the century with the increasing interdisciplinarity, the tendency of the psychologists was to view cognition and language as common whereas linguists gave special treatment to the existence of language as unique and independent of cognition. Three major developments during 1980's and 1990's had major influence in redefining of cognition language relationship i.e. connectionism, cognitive linguistics and cognitive neuroscience.

**Connectionism** implicated intelligent behavior to emerge from large number of neuron like processing units connected together into network topology that facilitated parallel processing. Such connectionism was also applied to English language to give past tense form of present tense verb such as know/knew, meaning of ambiguous words in sentence formation such as 'he drove the wheels' and development of abstract categories from regular texts. This model developed commonality of computational architecture assuming base for cognition and language.

**Cognitive linguistics** identified a subset of functional linguists who did not conform with Chomsky's view of special identity to language and generative grammar. They also rejected autonomy of syntax and suggested that language is for effective communication and grammatical rules are governed by the purpose and nature of communication. They proposed in understanding language with all its diversities such as narratives, dialects, discourse, psychosocial underpinnings of language etc.

**Cognitive neuroscience** also provided appeal to the cognitive linguistic perspective which emphasized the co-development of language and perceptual motor skills. It also supported language acquisition to be based on semantics and proposed for effective communication. It supported the epigenetic view of language i.e. it develops from the interaction of genes and environment during the prenatal and postnatal periods. They also proposed that neural correlates of grammar operate in harmony with other language components.

The above view has depicted smooth transitions of relationships between cognition and language. The recent trend in their interaction has focused on the reducing distance and greater interdisciplinary of both the fraternities strongly contributing to the mind brain analogy.

### 3.4 Cognition and Personality

The duality of the fact that all people are same and yet none of them are same is a strong challenge for personality theorists. The complexity is also reflected in the impact of individual differences on cognitive capacities. Historically the attempts have been directed towards finding a plausible link between cognition and personality. With the advent of cognitive revolution, the relationship between both the fraternities was first explicated by role of emotions in distortions of cognitive processing (Beck, 1967). Later, effects of state anxiety on cognitive performance were explored by Spielberger, 1972. The relationship of wider variety of traits with cognitive performance has been at focus since long. Recent studies have focused on developing information processing models based on specific traits. Following, customized models based on traits have been created to enhance performance in various organizations. Various theories have been proposed which aim to explain the link between cognition and personality from varied angles.

#### 3.4.1 Biological Theory

The biological explanation of personality and cognition was stated by Eysenck's Arousal Theory, 1967. The Yerke's & Dodson Law, an inverted U depicts the relationship between

cortical arousal and performance. According to the theory, medium level of arousal is believed to be optimum for performance whereas extreme levels of arousal on either ends of the continuum i.e. high or low produce negative effects on performance. For example, fatigue or excessive anxiety both can be damaging for performance and adequate level of anxiety can facilitate performance. The theory also links arousal with personality traits stating that cortico arousal in an introvert is easily established than in an extrovert. In other words, introverts may exhibit performance deficits in over arousal situations whereas extroverts may depict the same in under arousal circumstances. The findings have been replicated in various other experiments such as time pressures or caffeine influences. Under both the states, extroverts were found to perform better than introverts. Another biological explanation proposing the link between cognition and personality was stated by Reinforcement Sensitivity Theory (Corr, 2004). The theory aimed to establish link between impulsivity, anxiety and sensitivity of brain for rewards and punishments. These traits were believed to be important predictors of motivation and learning. The evidence of such interactions has been found in certain tasks such as performance etc. Recent evidences using neuroimaging techniques such as fMRI have sought links between regional brain activation and personality effects such as extraversion and working memory.

#### ***3.4.2 Information Processing Theory***

The proposition also supports link between personality traits and information processing capacity. The hypothesized link is established with three progressive steps i.e. defining the nature of relationship, delineating a broad theory with general predictions and finally developing a detailed computational model simulating the relationship. The formation of the customized computational model faces a challenge of describing the concepts very clearly and eliminates biases related to the concepts. Also the dynamic nature of the personality effects has to be taken into consideration so as not to state short term impact on cognition. Hence, information processing approach has to rely on strategies of self-regulation and self-knowledge to develop strategic computational models based on the established link.

#### ***3.4.3 Personality and self-regulation***

The theory assumes that behavior is guided by schemata or self-representations that define goals for an individual. In case of performance, the person may get motivated to establish some minimum level of result attuned with maintenance of self-esteem. The nature of these motivations then is believed to be guided by the personality traits of the individual. For instance, Mathews & Deary, 2003 found that people with high levels of anxiety tend to underestimate their performance. Also, anxious people tend to overestimate the presence of threatening situations and negative consequences. The theory primarily supports the view that information processing biases should be understood in light of individual differences.

#### ***3.4.4. Cognitive Adaptive Theory of Traits***

This theory supposes that traits have functional coherence than structural coherence. Also those traits are extremely subjective in nature and there is no single process that mediated between trait and its behavioral expression. These traits tend to get associated with multiple, independent biases reflected in variety of neural, computational and self-regulative processes. On the other hand, traits represent adaptation towards various challenges of life. A healthy adaptation leads to successful conquering of life threats and challenges. Thus, the cognitive correlates of personality traits may lead to strong acquisition and skill development. Adaptation may act as complex interface between cognitive capacities, personality construction and acquired learned skills. For example, the attention and memory bias of introverts towards threat may lead them to develop

adequate social skills for dealing with such challenges. Thus the cognitive attribute of a given trait interacts with development of skill that supports the adaptation as a process.

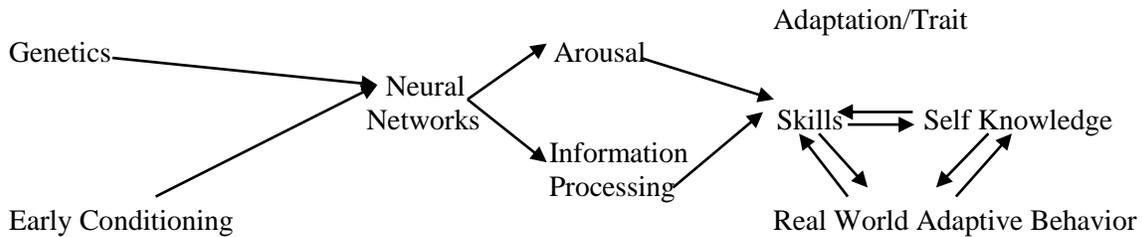


Fig1. Cognitive Adaptive Process Supporting Personality Traits

### 3.4.5 Link between Personality and Cognitive Domains

The link between personality and various domains of cognition such as attention, distractibility, memory, language, and fluid intelligence have also been stated.

*Attention and Personality* are believed to be closely associated. Attention can be understood as the limited capacity of the individual to process selected piece of information. Personality is viewed to influence this limited capacity like for example anxious people generally seem to exhibit attentional deficits and higher distractibility. Extraversion is related to low attention capacity and introversion with greater attention span and lower arousal. Similarly, high impulsivity is related to greater arousal and attentional deficits.

In case of *personality and distractibility*, extraversion and distractibility were found to be positively correlated. Also, neuroticism and anxiety were found to depict higher distractibility. Abnormal personality traits such as schizotypal personality are related with poor executive functioning and higher distractibility.

Another imperative cognitive dimension of *memory* has also been viewed to share personality influences. Extraverts were found to have a higher short term memory recall but a poor long term memory. Anxiety and neuroticism as personality variables were found to have detrimental influences on working memory capacity and multitasking (Aschkraft & Krause, 2007). Early studies also established that people with trait anxiety are more vulnerable to encode threatening stimuli in comparison to people with state anxiety and also to depict a memory bias in recall of threatening stimuli than neutral stimuli (Willaims et al, 1997).

Personality influences are also viewed on the acquisition and use of *language capacity* of an individual. Extraverts as a part of profile are believed to be more equipped in language than introverts but no literature supports higher linguistic processing and verbal ability in extroverts than introverts. However, extroverts were found to be more fluent in both first and second language use with fewer errors in speech than introverts. In terms of speech production, introverts may be slow which can be attributed to deliberated information processing whereas extroverts may be fast because of speedy information processing and reduced social anxiety (Dewaele & Furnahm, 1999). In case of verbal problem solving ability, extroverts are found to be deficient but in instances of expression they perform better than introverts (Weinman, 1987).

The relation between personality and fluid intelligence is diverse. Fluid intelligence is an index of reasoning and problem solving ability in contrast to crystallized intelligence, an index of knowledge acquired throughout life (Cattell, 1971; Chamorro-Premuzic & Furnham, 2004). A weak relationship has been observed between personality and fluid intelligence (Ackerman & Heggstad, 1997; Ashton et al., 2000). However, several attempts have been directed towards

exploring the potential relation between intelligence and big five factors of personality (Neuroticism, Extraversion, Openness to Experience and Conscientiousness). A small positive correlation was found between fluid intelligence, openness to experience and Conscientiousness (Ashton et al, 2000; Goff & Ackerman, 1992). Austin et al 2002, observed a negative correlation between neuroticism, psychoticism with intelligence. Overall, weak to moderate correlations are observed between varied personality dimensions and general fluid intelligence.

Most of the above correlates such as intelligence, emotion, language and personality exhibit a robust relationship with cognition. This also depicts the importance and application of cognition in enhancing various related domains such as crystallized and fluid intelligence, emotional intelligence, appropriate emotional regulation and expression, language acquisition and use, linguistic proficiency and personality construction.

## 5. Summary

- Cognition reflects quantitative and qualitative type of knowledge and its relationship with other faculties of knowledge.
- The interactional fit of cognition with other variables such as intelligence, emotions, language, personality, culture etc enables a holistic perspective to the vitality and application of cognition in our daily lives.
- Cognition and intelligence, though perceived similar are two different fraternities where cognition is an umbrella term and intelligence is one of the domains of cognition.
- Cognition can be understood as the process of acquisition and internalization of knowledge whereas intelligence involves giving meaning to the cognitive knowledge and applying it to solve everyday problems.
- Cognitive intelligence as indexed by intelligence quotient (IQ) and emotional intelligence as gauged by emotional quotient (EQ) form an integral part of intelligence. IQ deal's with abilities of understanding and comprehending information while EQ deals with recognizing and comprehending emotions.
- The relationship of cognition and emotion cannot be understood as two separate independent faculties but rather as interacting with each other to produce complex behavior.
- The interplay of cognition and language is viewed in use of speech in everyday problem solving. Cognition is considered as powerful entity with set of various mental abilities including language. However, different brain regions are observed in functioning of cognition and language.
- Cognition and personality both are viewed to impact each other. Various factors of personality such as introversion, extraversion, neuroticism, psychoticism, conscientiousness have been well correlated with cognitive variables such as attention, memory, language, fluid intelligence etc.

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