# Importance of Social Interactions:

People participate in social interactions every day with friends, family, co-workers and strangers. A strong set of social skills is critical in life—for example, they help us make new friends or make good first impressions at job interviews. Sociologists believe that social interactions are the underpinnings of over modern society and good social skills begin to develop at an early age and are essential for social development and acceptance within our society [1]. Social interactions refer to all forms of interpersonal communication between the participants. This could be bilateral (between two individuals) or group interactions (between multiple people). Irrespective, all the participants are engaged in continuous exchange of social information through their behaviors, mannerisms, gaze, posture, proxemics and kinesis [2].

## Psychological Support:

Recent studies by Segrin et al. have shown that poor social skills are antecedents to psychosocial problems including depression, loneliness, social anxiety, etc. The authors conducted a battery of tests on college students to determine the effect of stress on the students when they live at away from home. Figure XXX shows Depression and Loneliness plotted against stress levels of undergraduate students. Depression was measured using the Beck Depression Inventory which is a one-dimensional instrument that has been used in various studies and has been proven to have excellent reliability and validity. Loneliness was measured on the UCLA Loneliness Scale version 3 as an index into the students experience of loneliness. For both of these tests, the participating students were categorized into high, medium and low social skilled groups based on the Social Skills Inventory which a battery of tests administered to determine the socialization ability of an individual.

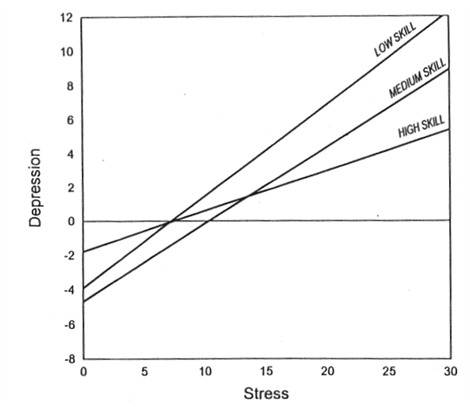
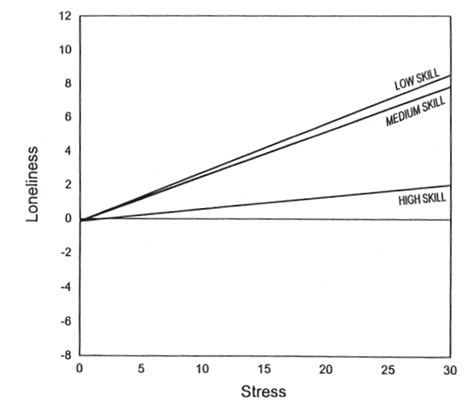


Figure XXX: Depression and Loneliness of students plotted against stress levels in high, medium and low social skilled undergraduate students. (Please see text for the scales used for the measurement.)

One can immediately identify a positive correlation between stress and an increased experience of psychosocial problems in all the students, but the ones that rank higher on social skills show higher resistance to stress and in turn higher resistance to mental breakdown. Students assessed with mild or lesser social skills were highly vulnerable to social issues as the stress increased.

Similar results were found in [7] and the authors conclude that people with high competence in communication are known to display immense capability towards adapting their social behavior based on others in their surrounding. Such competence has been acknowledged to reinforce social skills thereby creating a reinforcement feedback that allows these individuals to be successful in their social endeavors and in turn successful in their life. In a tangential study, though Magnusson was not looking for social interaction needs in people, found that social interaction is an important dimension in the cognitive organization of human behaviors. When college students were assessed individually and as a group to determine how they classified everyday activities into different situations, Magnusson discovered 5 dimensions (Principle Dimensions). These included two dimensions based on whether the students perceived a situation as being positive (*positivity*) or negative (*negativity*) influence on their behavior, two dimensions based on whether the situations were *active* or *passive,* and finally, the fifth dimension was based on *social interaction* with others. His study emphasizes how social interactions are perceived by individuals as an important scale for judgments on their activity of daily living.

It is imperative that efforts be made towards understanding development and learning of social skills in humans so that effective tools can be built to cater to people with needs.

## Social Intelligence:

Studies in Cognitive Psychology support the hypothesis that social interactions play a vital role in the overall development of intelligence in humans, especially, in the development of Social Intelligence (or Interpersonal Intelligence as defined by Howard Gardner [10]) and Emotional Intelligence [11]. *Social Intelligence (SI)* can be defined as the competence in initiating and maintaining group interactions and behaviors. First defined by Edward Thorndike, Social Intelligence is “the ability to understand and manage men and women, boys and girls, to act wisely in human relations” [12]. Recently, Karl Albrecht [13] has proposed that Social Intelligence provides for five important aspects of everyday societal inner workings, including, 1) Situational awareness, 2) Presence, 3) Authenticity (or Individuality), 4) Clarity (of action), and 5) Empathy. *Emotional Intelligence (EI)* describes the ability, capacity, skill to identify, assess and manage the emotions of one’s self, others and of groups of individuals. Many models have been proposed in the past to explain EI, such as Ability based models [14], Mixed models [15] and Trait based models [16]. All these models provide a means to measure an individual’s social and emotional skill and place him/her on a scale of abilities/disabilities. Most of these measurements are based on the person’s social interaction skills and the metrics correlate directly to one’s ability in initiating, maintaining and delivering appropriate social cues. Recently, these EI metric scales have been used to diagnose autism spectrum disorders, including autism and Asperger syndrome, semantic pragmatic disorder or SPD, schizophrenia, and Attention-deficit hyperactivity disorder (ADHD). While most of these disorders are still a mystery to the medical community, increasing the social interactions of the individual has shown to alleviate some of the symptoms.

While most SI and EI models have been theoretical in their approach to expaling the importance of social interactions, primate researcher, Humphrey [17], has demonstrated the real-world effect of social interactions to cultural transmission of knowledge and the development of intelligence. His studies with rhesus monkey have emphasized the positive influence of social interactions on the development of general intelligence. For example, Helen (a rhesus monkey) had her visual cortex surgically removed and studies were conducted on her recovery of spatial vision. Over four years in the laboratory, Helen hardly recovered any of her spatial knowledge. However, when she was taken out of the laboratory into the real world and allowed to interact with objects and other monkeys, she regained three dimensional spatial vision within a few weeks. Humphrey argues that the interactions with other monkeys were key to Helen’s learning of spatial interactions (both with objects and other monkeys).

From a neuro-physiological perspective, advanced functional brain imaging is enabling researchers to study the workings of human brain under various functional conditions. Brothers [18] has worked extensively on the neuro-physiological patterns in primate brains that are associated with social behavior. Her work has established the presence of brain regions that are dedicated to *social cognition* (Social cognition is the processing of information that culminates in the accurate perception of dispositions and intentions of other people). She has proposed a network of neural regions that comprise the social brain: the orbito-frontal cortex (OFC), superior temporal gyrus (STG) and amygdala. Her work has been recently bolstered by [19], where the authors study autistics and controls under functional Magnetic Resonance Imaging (fMRI). The subjects watched another person’s eye expressions, and guessed what that person was thinking or feeling. The fMRI images confirmed Brothers observations of STG and amygdala activations during social cognition, and showed that people with autism display a cognitive disability in the amygdala which prevents them from making appropriate mental inferences of other people’s emotions or facial expressions. Authors conclude that a social brain does exist, and that teaching children and adults social skills could offer a means of increasing activations in the social brain. This conclusion is supported by the behavioral research in autism that employs social interaction training and language skill training in children to ameliorate the social deficits characteristic of autism spectrum disorders (ASD).

## Summary:

In summary, social interactions are vital aspect of everyday living in our society. Humans learn through their social interactions and these interactions form the basis of our psychological balance. While sociologists and psychologists have been studying social interactions from the perspective of learning innate human behavioral models, social interaction models have not been studied from an

# Non-verbal Cues:

Social interactions and social skills primarily correspond to the two main channels of communication

Verbal communication: Explicit communication through the use of words in the form of speech or transcript.

Non-verbal communication: Implicit communication cues that use prosody, body kinesis, facial movements and spatial location to communicate information that may be unique or overlapping with verbal information.

From the perspective of encoding information into non-verbal cues, speech, voice, face and body form the primary channels of communication in any social interaction . Speech forms the primary channel for verbal communication, while prosody (intonation, pace and loudness of one’s voice), face and body (posture, gesture and mannerisms) form the medium for nonverbal communication. Unlike speech, which is mostly under the conscious control of the user, the non-verbal communication channels are engaged from a subconscious level. Though people can increase their control on these channels through training, innately, individuals demonstrate certain inability to control their non-verbal cues. This inability to control non-verbal channels is referred to as the leakiness and humans (evolutionarily) have learnt to pick up these leaked signals during social interactions. For example, people can read very subtle body mannerisms very easily to determine the mental state of their interaction partner. Eye Gaze is a classic example of such subtle cues where interaction partners can detect interest, focus, involvement and role play, to name a few. On this leakiness scale, it has been found that the voice is the leakiest of all channels, implying that emotions of individuals are revealed first in their voice before any of the other channels are engaged. The voice is followed by body, face and finally the verbal channel, speech. The leakiness is plotted on the abscissa of Figure XXX with the ordinate showing the amount of information encoded in these three channels. It can be seen that the face communicates the most amount of non-verbal cues, while the prosody (voice) forms the first channel to leak emotional information.

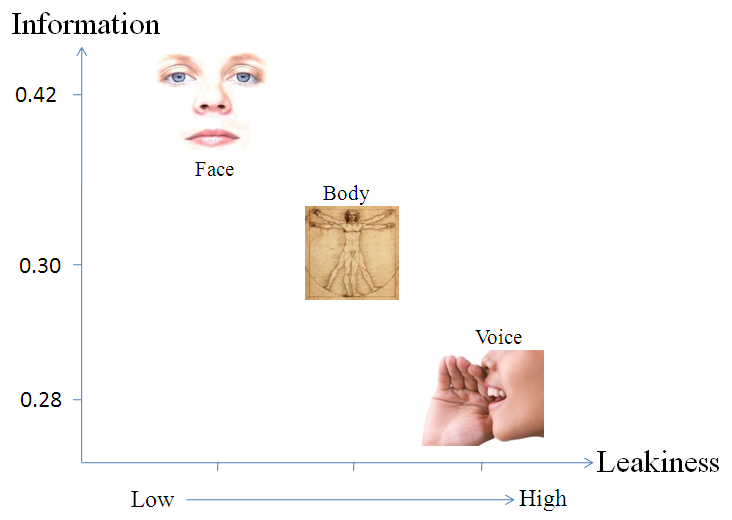


Figure XXX: Plot of communicative information encoded in the three important non-verbal channels of encoding. Speech forms the verbal channel. Face, body and voice form the non-verbal communication channels.

From the perspective of decoding non-verbal communication cues, the non-verbal channels can be analyzed under,

a) the auditory channel (includes conscious, verbal speech and unconscious, nonverbal voice),

b) the visual channel (includes nonverbal face and body mannerisms and gestures, which are distributed fuzzily between the conscious and unconscious mediums),

c) the combined Audiovisual channel (includes simultaneous verbal and nonverbal communication mediums), and

d) touch (includes the nonverbal conscious haptic sensory perceptions).

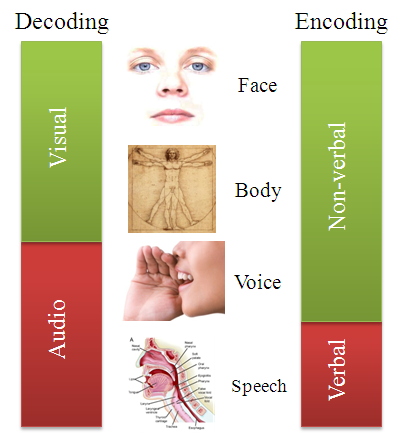


Figure XXX: Shows the encoding and decoding aspects of interpersonal communication. From an encoding perspective, humans use verbal and non-verbal cues to communicate while from a decoding perspective, face and body encoded data is received visually and verbal speech and non-verbal prosody are received through audio.

From a communication point of view, nearly 64% of all information communication happens through non-verbal cues. Out of this large chunk, 48% of the communication is through visual encoding of face and body kinesis and posture while the rest is encoded in the prosody. Thus, inability to access any part of this information results in a reduced involvement in the social interactions.

## Summary:

# Visual Impairment - a hindrance to Social Interaction:

As discussed in the Section XXX, social interactions related problems manifest differently based on the disability under consideration.

## Summary:

# Sensing Non-verbal Cues:

## Egocentric sensing

## Exocentric sensing

## Summary:

# Processing Non-verbal Cues:

## Summary:

# Delivering Non-verbal Cues:

## Summary:

# Design of assistive technology:

## Summary:

# Research Questions:

What are the most important non-verbal cues that are important for enriching social interactions for people who are blind and visually impaired?

What assistive technology framework can be developed towards addressing the important needs identified in research question 1?

Given the above framework, how effectively can the egocentric and exocentric social interaction cues be extracted in real-time?

How effectively can the interaction partner’s non-verbal cues be delivered to individuals who are blind and visually impaired?